Supplementary materials for

Proteomic Analysis Reveals Overlapping Functions of Clustered Protocadherins

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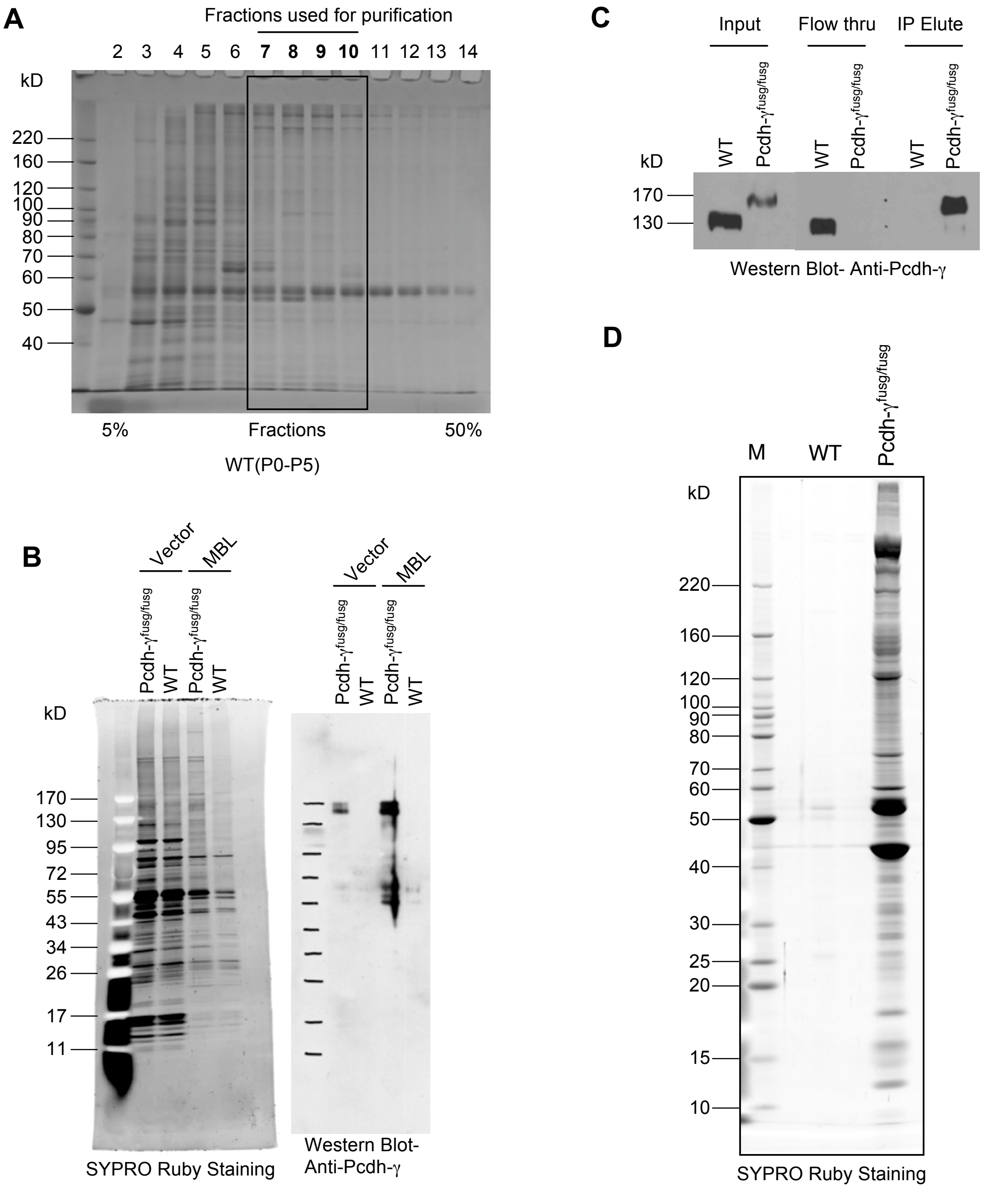
Figure legend for supplementary figures

Figure S1. Optimization of the affinity-purification procedure for Pcdh-γ protein complexes from the mouse brains. **A.** The Coomassie blue staining of sucrose gradient fractions on a SDS-PAGE gel showed that overall protein complexity decreased in Pcdh-γ peak fractions (7-10) that were used for final affinity-purification. **B.** Comparison of different affinity-resins by SPYRO Ruby staining and anti-Pcdh-γ western blot analysis. The fractions (5-6) from the sucrose gradient (in A) were used for immunoprecipitation. Vector: goat anti-GFP agarose (MB-0732); MBL, rat anti-GFP agarose (D153-8). Vector resins have significantly higher background in SPYRO Ruby staining compared to MBL resins even though both resins can specifically bind to Pcdh-γ-GFP (western blot on the left). Note that some background bands were still seen from the negative control (wild type) using MBL resins when fractions 5-6 of the sucrose gradient were used for purification. **C**. A western blot shows the input, flow-through and elute of an affinity purification of Pcdh-γ-GFP using the peak sucrose fractions (7-10) from *Pcdh-*$\gamma^{fusg/fusg}$ mouse brains using MBL anti-GFP resins. Equal amount of wild-type brain lysates were used as the negative control. **D.** The SPYRO Ruby staining of the eluted proteins from C showing the specificity of affinity-purification using both Pcdh-γ-GFP peak fractions and MBL anti-GFP resins.

Figure S2. Western blot analysis of Pcdh-γ associated proteins in the total brain lysates. Total brain lysates from the P0 brains of both wild type and *Pcdh-*$\gamma^{del/del}$ mice were subjected to SDS-PAGE and western blot analysis using specific antibodies. No decrease of CamKII-α, -β, –γ and SNIP protein levels was found in *Pcdh-*$\gamma^{del/del}$ samples. β-tubulin served as a loading control. "*" marks a non-specific band detected by anti-CamKII-α antibodies.

Figure S3. High-magnification active-caspase-3 staining of chicken spinal cords. The same images in Figure 7D are shown in a higher magnification for easy visualization of caspase-3 positive cells.

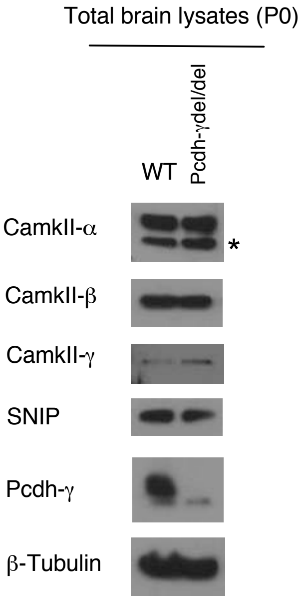
Supplementary Figure S1



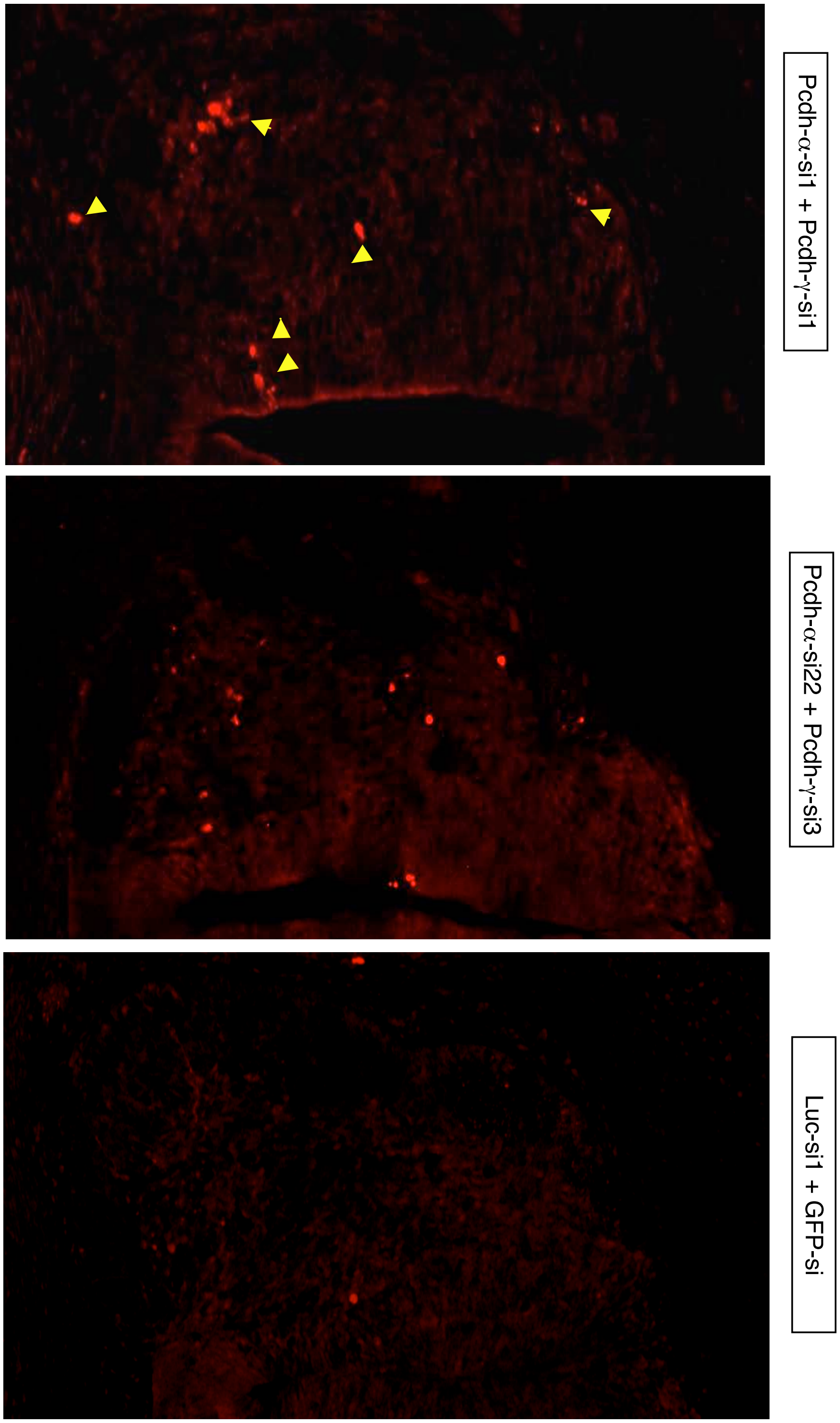
IP: Fraction 5-6

IP: Fraction 7-10

Supplementary Figure S2



Supplementary Figure S3



Supplementary Table S1. Complete list of the MS identified proteins in Pcdh-γ complexes

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
	Cytoskeleton						
1*	Actin, beta, cytoplasmic Actin, gamma, cytoplasmic 1	Actb Actg1	gi|6671509 gi|6752954	42	3	10	100
2	Actin-binding LIM protein 1	Ablim1	gi|38016178	97	4	5	100
3	Ankyrin 2, brain isoform 2	Ank2	gi|77681962	117	3	4	100
4	Capping protein (actin filament) muscle Z-line, beta isoform b	Capzb	gi|6753262	31	4	15	100
5	CLASP1	Clasp1	gi|124486879	169	3	2	100
6*	CLIP-associating protein CLASP2 isoform a CLIP-associating protein CLASP2 isoform b	Clasp2	gi|126506304 gi|126506306	141	2	2	100
7	Drebrin 1	Dbn1	gi|34328251	72	14	20	100
8	Internexin neuronal intermediate filament protein, alpha	Ina	gi|34328368	55	21	41	100
9	Lamin B2	Lmnb2	gi|113195686	67	10	19	100
10	Microtubule-associated protein 1 B	Mtap1b	gi|6678946	270	2	1	100
11*	Microtubule-associated protein tau isoform a Microtubule-associated protein tau isoform b	Mapt	gi|84370347 gi|84370355	45 39	4	8 10	100
12	Myosin heavy chain 10, non-muscle	Myh10	gi|33598964	229	64	29	100
13	Myosin IB	Myo1b	gi|86990450	129	7	6	100
14	Myosin Va	Myo5a	gi|115511052	216	46	24	100
15	Myosin Vb	Myo5b	gi|46399202	211	3	2	100
16	Myosin XVIIIa	Myo18a	gi|22094119	231	2	1	100
17	Myosin, heavy polypeptide 14	Myh14	gi|29336026	228	5	2	100
18	Myosin, heavy polypeptide 9, non-muscle isoform 1	Myh9	gi|114326446	226	23	12	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
19*	Myosin, light polypeptide 6B Myosin, light polypeptide 6, alkali, smooth muscle and non-muscle	Myl6b Myl6	gi|26986555 gi|33620739	23 17	2	9 13	96
20	Neurofilament 3, medium	Nefm	gi|112363107	96	7	9	100
21	Neurofilament, light polypeptide	Nefl	gi|39204499	62	23	40	100
22	Spectrin alpha 2	Spna2	gi|115496850	285	48	24	100
23	Spectrin beta 1	Spnb1	gi|84490394	268	2	1	100
24	Spectrin beta 2 isoform 1	Spnb2	gi|117938332	274	53	29	100
25	Spectrin beta 3	Spnb3	gi|55926127	271	10	6	100
26	Tubulin, alpha 1	Tuba1a	gi|6755901	50	22	61	100
27	Tubulin, alpha 1a	Tuba3a	gi|6678465	50	6	15	100
28	Tubulin, alpha 1B	Tuba1b	gi|34740335	50	7	23	100
29	Tubulin, alpha 1C	Tuba1c	gi|6678469	50	22	62	100
30	Tubulin, alpha 4	Tuba4a	gi|6678467	50	19	55	100
31	Tubulin, beta	Tubb2b	gi|21746161	50	26	68	100
32	Tubulin, beta 2	Tubb2a	gi|33859488	50	28	68	100
33	Tubulin, beta 2c	Tubb2c	gi|22165384	50	22	52	100
34	Tubulin, beta 3	Tubb3	gi|12963615	50	26	54	100
35	Tubulin, beta 4	Tubb4	gi|31981939	50	20	47	100
36	Tubulin, beta 5	Tubb5	gi|7106439	50	23	55	100
37	Tubulin, beta 6	Tubb6	gi|27754056	50	16	38	100
38	Vimentin	Vim	gi|31982755	54	16	32	100
	Cell adhesion						
39	Cadherin 4 (R-cadherin)	Cdh4	gi|6753376	100	5	6	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
40	Catenin, alpha 1	Ctnna1	gi|6753294	100	2	3	100
41	Catenin, alpha 2 isoform 2	Ctnna2	gi|6753296	105	7	8	100
42	Catenin, beta 1	Ctnnb1	gi|6671684	85	7	10	100
43	Limbic system-associated membrane protein	Lsamp	gi|30425330	38	2	8	98
44	Protocadherin 17	Pcdh17	gi|62988326	126	2	3	100
45	Protocadherin alpha 11	Pcdha11	gi|23956048	103	3	3	100
46	Protocadherin alpha 12	Pcdha12	gi|21426883	103	4	5	100
47	Protocadherin alpha 2	Pcdha2	gi|51092277	102	2	2	99
48	Protocadherin alpha 3	Pcdha3	gi|21426881	102	2	2	98
49	Protocadherin alpha 5	Pcdha5	gi|20137002	102	2	2	99
50	Protocadherin alpha 7	Pcdha7	gi|23956046	101	2	2	100
51	Protocadherin alpha 9	Pcdha9	gi|21426885	107	2	2	100
52	Protocadherin alpha subfamily C, 2	Pcdhac2	gi|51092283	109	2	3	98
53	Protocadherin beta 14	Pcdhb14	gi|32189405	87	2	3	100
54	Protocadherin beta 17	Pcdhb17	gi|32308225	88	3	5	100
55	Protocadherin beta 18	Pcdhb18	gi|18087797	87	3	4	100
56	Protocadherin beta 19	Pcdhb19	gi|89363034	88	3	5	100
57	Protocadherin beta 20	Pcdhb20	gi|89994747	88	3	5	100
58	Protocadherin beta 22	Pcdhb22	gi|32189396	87	3	4	100
59	Protocadherin beta 5	Pcdhb5	gi|16716429	87	2	3	100
60	Protocadherin beta 8	Pcdhb8	gi|16716433	85	2	2	98
61	Protocadherin gamma subfamily A, 1	Pcdhga1	gi|18087753	101	4	6	100
62	Protocadherin gamma subfamily A, 11	Pcdhga11	gi|18087773	101	4	7	100
63	Protocadherin gamma subfamily A, 12	Pcdhga12	gi|18087775	101	4	6	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
64	Protocadherin gamma subfamily A, 3	Pcdhga3	gi|18087757	100	3	4	100
65	Protocadherin gamma subfamily A, 4	Pcdhga4	gi|31982598	100	5	8	100
66	Protocadherin gamma subfamily A, 8	Pcdhga8	gi|18087767	101	2	3	100
67	Protocadherin gamma subfamily A, 9	Pcdhga9	gi|18087769	101	3	4	100
68	Protocadherin gamma subfamily B, 4	Pcdhgb4	gi|18087737	99	2	4	100
69	Protocadherin gamma subfamily B, 6	Pcdhgb6	gi|18087741	101	3	4	100
70	Protocadherin gamma subfamily B, 8	Pcdhgb8	gi|18087745	101	3	4	100
71	Protocadherin gamma subfamily C, 3	Pcdhgc3	gi|18087747	101	9	11	100
72	Protocadherin gamma subfamily C, 4	Pcdhgc4	gi|18087749	101	4	6	100
73	Snap-25-interacting protein	P140	gi|116089329	131	3	3	99
	Traffiking/transport						
74	Adaptor protein complex AP-2, alpha 1 subunit isoform b	Ap2a1	gi|116256510	105	11	12	100
75	Adaptor protein complex AP-2, alpha 2 subunit	Ap2a2	gi|40254646	104	10	12	100
76	Adaptor-related protein complex 2, beta 1 subunit isoform b	Ap2b1	gi|21313640	105	12	12	100
77	ATP-binding cassette transporter sub-family A member 16	Abca16	gi|46369473	192	2	3	95
78	ATP-binding cassette transporter sub-family A member 9	Abca9	gi|22267466	183	2	2	99
79	Clathrin interactor 1	Clint1	gi|113865873	68	3	6	100
80	Clathrin, heavy polypeptide (Hc)	Cltc	gi|51491845	192	10	6	100
81	EF hand domain containing 2	Efhd2	gi|31981086	27	3	10	100
82	ELKS/RAB6-interacting/CAST family member 2	Erc2	gi|37360977	116	9	9	100
83*	FXYD domain-containing ion transport regulator 2 isoform a FXYD domain-containing ion transport regulator 2 isoform b	Fxyd2	gi|16554570 gi|16554572	8 7	2	41 45	98

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
84	Kinesin family member 2A	Kif2a	gi|6680560	81	4	5	100
85	Rab11-family interacting protein 2	Rab11fip2	gi|75677518	60	2	5	100
86	Rab6-interacting protein 2 isoform 1	Erc1	gi|120300971	128	3	3	100
87	Solute carrier family 25, member 12	Slc25a12	gi|27369581	75	15	22	100
88	Solute carrier family 25, member 4 (Ant1)	Slc25a4	gi|91680541	33	13	39	100
89	Solute carrier family 25, member 5 (Ant2)	Slc25a5	gi|22094075	33	11	35	100
90	Synaptic vesicle glycoprotein 2 a	Sv2a	gi|11528518	83	2	3	100
91	Transportin 1 isoform 1	Tnpo1	gi|115385968	102	2	2	100
	Signaling						
92	14-3-3 gamma	Ywhag	gi|21464101	28	6	23	100
93	14-3-3 theta	Ywhaq	gi|6756039	28	4	13	100
94	14-3-3 zeta	Ywhaz	gi|6756041	28	7	30	100
95*	Calcium/calmodulin-dependent protein kinase II gamma isoform 1 Calcium/calmodulin-dependent protein kinase II gamma isoform 2 Calcium/calmodulin-dependent protein kinase II gamma isoform 3	Camk2g	gi|75991700 gi|85362729 gi|85362742	60 56 58	5	9 10 10	100
96	Calcium/calmodulin-dependent protein kinase II, beta	Camk2b	gi|31982483	60	8	14	100
97	Calcium/calmodulin-dependent protein kinase II, delta isoform 1	Camk2d	gi|70906479	58	2	4	100
98	Epidermal growth factor receptor pathway substrate 15, related	Eps15l1	gi|6679669	99	2	2	100
99	Interleukin 17 receptor	Il17ra	gi|6680411	98	2	4	98
100	Latrophilin 1	Lphn1	gi|56118951	139	2	2	100
101	MAP/microtubule affinity-regulating kinase 1	Mark1	gi|21704014	89	2	3	98

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
102	Olfactory receptor 1122	Olfr1122	gi|22128887	37	2	7	99
103	Postsynaptic density protein 95	Dlg4	gi|6681195	80	3	5	99
104	Protein phosphatase 1, regulatory subunit 9A	Ppp1r9a	gi|31711997	123	3	2	100
105	Protein phosphatase 1, regulatory subunit 9B	Ppp1r9b	gi|50053703	90	11	16	100
106	Retinoid X receptor alpha	Rxra	gi|6755384	51	2	5	100
	Nucleic acid/protein processing						
107	B-cell leukemia/lymphoma 11B isoform b	Bcl11b	gi|120586999	87	2	4	98
108	cAMP-regulated guanine nucleotide exchange factor II	Rapgef4	gi|9790087	113	2	2	100
109	DEAD (Asp-Glu-Ala-Asp) box polypeptide 1	Ddx1	gi|19527256	83	2	2	99
110	DEAH (Asp-Glu-Ala-His) box polypeptide 15 isoform 2	Dhx15	gi|110835723	91	2	2	99
111	DEAH (Asp-Glu-Ala-His) box polypeptide 36	Dhx36	gi|30794390	114	2	2	98
112	Elongation factor Tu GTP binding domain containing 2	Eftud2	gi|6755594	109	2	3	100
113	Eukaryotic translation elongation factor 1 alpha 1	Eef1a1	gi|126032329	50	4	8	100
114*	H3 histone, family 2 isoform 2 H3 histone, family 3A H3 histone, family 3B Histone 1, H3a Histone 1, H3b Histone 1, H3c Histone 1, H3d Histone 1, H3e Histone 1, H3f Histone 1, H3g Histone 1, H3h Histone 1, H3i Histone 2, H3b Histone 2, H3c2	Hist2h3c1 H3f3a H3f3b Hist1h3a Hist1h3b Hist1h3c Hist1h3d Hist1h3e Hist1h3f Hist1h3g Hist1h3h Hist1h3i Hist2h3b Hist2h3c2	gi|30061401 gi|6680159 gi|6680161 gi|32880233 gi|30061339 gi|30089712 gi|30061337 gi|30061341 gi|7305139 gi|21489955 gi|30061343 gi|30061345 gi|30061347 gi|21489953	20 15	4	16 21	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
115	Heat shock protein 1 (chaperonin)	Hspd1	gi|31981679	61	2	3	100
116	Heat shock protein 8	Hspa8	gi|31981690	71	20	32	100
117	Heterogeneous nuclear ribonucleoprotein M	Hnrnpm	gi|21313308	78	6	10	100
118*	Histone 1, H2aa	Hist1h2aa	gi|28316756	14	2	12	100
	Histone 1, H2ab	Hist1h2ab	gi|87299611				
	Histone 1, H2ac	Hist1h2ac	gi|30061363				
	Histone 1, H2ad	Hist1h2ad	gi|30061357				
	Histone 1, H2ae	Hist1h2ae	gi|30061367				
	Histone 1, H2af	Hist1h2af	gi|30061379				
	Histone 1, H2ag	Hist1h2ag	gi|30061361				
	Histone 1, H2ah	Hist1h2ah	gi|30061327				
	Histone 1, H2ai	Hist1h2ai	gi|30061393				
	Histone 1, H2ak	Hist1h2ak	gi|30061371				
	Histone 1, H2an	Hist1h2an	gi|30061365				
	Histone 1, H2ao	Hist1h2ao	gi|30061375				
	Histone 2, H2aa1	Hist2h2aa1	gi|20799907				
	H2A histone family, member J	H2afj	gi|29244126				
	H2A histone family, member Z	H2afz	gi|7949045				
	Histone 3, H2a	Hist3h2a	gi|30061353				
	H2A histone family, member X	H2afx	gi|7106331	15		11	
119	Histone 1, H2bh	Hist1h2bh	gi|30061387	14	2	19	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
120*	Histone 1, H4a Histone 1, H4b Histone 1, H4c Histone 1, H4d Histone 1, H4f Histone 1, H4h Histone 1, H4i Histone 1, H4j Histone 1, H4k Histone cluster 2, H4 Histone 4, H4	Hist1h4a Hist1h4b Hist1h4c Hist1h4d Hist1h4f Hist1h4h Hist1h4i Hist1h4j Hist1h4k Hist2h4 Hist4h4	gi|30061403 gi|30061405 gi|30061349 gi|30089714 gi|30061355 gi|23943922 gi|46430493 gi|30061351 gi|30061359 gi|21361209 gi|28316746	11	6	49	100
121	Ligase III, DNA, ATP-dependent	Lig3	gi|71061470	113	2	2	100
122	Matrin 3	Matr3	gi|25141233	95	9	12	100
123	Nuclease sensitive element binding protein 1	Ybx1	gi|113205059	36	3	12	100
124	Poly (ADP-ribose) polymerase family, member 1	Parp1	gi|20806109	113	12	13	100
125	Poly A binding protein, cytoplasmic 1	Pabpc1	gi|31560656	71	8	16	100
126	Poly A binding protein, cytoplasmic 2	Pabpc2	gi|6754972	69	5	8	100
127	Ribosomal protein L23	Rpl23	gi|12584986	15	2	18	100
128	Ribosomal protein S4, X-linked	Rps4x	gi|6677805	30	2	11	100
129	RNA binding motif protein 14	Rbm14	gi|86262142	69	3	5	100
130	U5 snRNP-specific protein	Snrnp200	gi|40018610	245	3	1	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
	Metabolism						
131	ATP synthase, H+ transporting, mitochondrial F1 complex, alpha subunit	Atp5a1	gi|6680748	60	24	53	100
132	ATP synthase, H+ transporting, mitochondrial F1 complex, gamma subunit	Atp5c1	gi|11602916	33	3	11	100
133	ATPase, Ca++ transporting, cardiac muscle, slow twitch 2	Atp2a2	gi|6806903	110	3	4	100
134	ATPase, H+ transporting, lysosomal V1 subunit A	Atp6v1a	gi|31560731	68	3	6	100
135	N-acetyltransferase 12	Nat12	gi|124487477	40	2	10	98
136	Nuclear VCP-like	Nvl	gi|33468981	94	2	4	100
	Others						
137	Green fluorescent protein	GFP	gi|115291372	29	9	31	100
138	Inner membrane protein, mitochondrial	Immt	gi|70608131	84	17	24	100
139	LEM domain containing 2	Lemd2	gi|22122563	31	2	8	99
140	Prestin	Slc26a5	gi|28933459	81	2	3	100
141	Sorting and assembly machinery component 50 homolog	Samm50	gi|30519943	52	2	5	100
142	Sterile alpha and TIR motif containing 1	Sarm1	gi|40254247	80	2	3	99
143	WD repeat domain 37 isoform a	Wdr37	gi|27369593	55	2	5	99
144	WD repeat domain 47	Wdr47	gi|31088910	102	2	2	100
145	PREDICTED: ATP-binding cassette, sub-family A (ABC1), member 12 isoform 3	Abca12	gi|149233925	292	2	2	98
146	PREDICTED: similar to Bifunctional aminoacyl-tRNA synthetase		gi|94364712	166	2	1	99
147	PREDICTED: similar to Calcium/calmodulin-dependent protein kinase type II gamma chain		gi|149265235	68	4	6	100

No.	Protein	Gene Name	Accession Number	MW (kDa)	Unique Peptides	Percent Coverage	Protein ID probability
148	PREDICTED: similar to Ina protein		gi|149270717	49	27	52	100
149	PREDICTED: similar to l-Afadin isoform 4	Mllt4	gi|149268963	209	2	1	99
150	PREDICTED: similar to lysyl-tRNA synthetase isoform 1		gi|82916992	68	5	8	100
151	PREDICTED: similar to protocadherin		gi|149269983	88	2	3	98
152	Hypothetical protein 4732456N10		gi|29244176	58	2	4	100
153	Hypothetical protein LOC380768		gi|56606029	80	3	4	100
154	Hypothetical protein LOC67412		gi|120953219	103	3	4	100

*: Proteins that contained similar peptides and could not be differentiated based on MS/MS analysis alone.

Supplementary Table S2

Comparison of Pcdh-associated proteins with PSD components identified in proteomic studies

References:

44. Witzmann FA, Arnold RJ, Bai F, Hrncirova P, Kimpel MW, et al. (2005) A proteomic survey of rat cerebral cortical synaptosomes. Proteomics 5: 2177-2201.
45. Trinidad JC, Thalhammer A, Specht CG, Lynn AJ, Baker PR, et al. (2008) Quantitative analysis of synaptic phosphorylation and protein expression. Mol Cell Proteomics 7: 684-696.
47. Jordan BA, Fernholz BD, Boussac M, Xu C, Grigorean G, et al. (2004) Identification and verification of novel rodent postsynaptic density proteins. Mol Cell Proteomics 3: 857-871.
48. Dosemeci A, Makusky AJ, Jankowska-Stephens E, Yang X, Slotta DJ, et al. (2007) Composition of the synaptic PSD-95 complex. Mol Cell Proteomics 6: 1749-1760.
49. Collins MO, Husi H, Yu L, Brandon JM, Anderson CN, et al. (2006) Molecular characterization and comparison of the components and multiprotein complexes in the postsynaptic proteome. J Neurochem 97 Suppl 1: 16-23.
50. Cheng D, Hoogenraad CC, Rush J, Ramm E, Schlager MA, et al. (2006) Relative and absolute quantification of postsynaptic density proteome isolated from rat forebrain and cerebellum. Mol Cell Proteomics 5: 1158-1170.

Protein	Gene Name	Accession Number	Cheng et al	Trinidad et al	Jordan et al	Dosemeci et al	Witzmann et al	Collins et al
14-3-3 gamma	Ywhag	gi|21464101	-	-	+	+	-	+
14-3-3 theta	Ywhaq	gi|6756039	+	-	+	+	+	+
14-3-3 zeta	Ywhaz	gi|6756041	+	-	+	+	+	+
Actin, beta, cytoplasmic	Actb	gi|6671509	+	+	+	+	-	+
Actin-binding LIM protein 1	Ablim1	gi|38016178	+	+	+	-	-	+
Adaptor protein complex AP-2, alpha 1 subunit isoform b	Ap2a1	gi|116256510	+	+	+	+	-	+
Adaptor protein complex AP-2, alpha 2 subunit	Ap2a2	gi|40254646	+	+	+	+	+	+
Adaptor-related protein complex 2, beta 1 subunit isoform b	Ap2b1	gi|21313640	+	+	+	+	+	+
Ankyrin 2, brain isoform 2	Ank2	gi|77681962	+	+	+	+	-	+
ATP synthase, H+ transporting, mitochondrial F1 complex, alpha subunit	Atp5a1	gi|6680748	-	+	+	+	+	+
ATP synthase, H+ transporting, mitochondrial F1 complex, gamma subunit	Atp5c1	gi|11602916	+	+	+	-	+	+
ATPase, Ca++ transporting, cardiac muscle, slow twitch 2	Atp2a2	gi|6806903	+	+	-	+	-	+
ATPase, H+ transporting, lysosomal V1 subunit A	Atp6v1a	gi|31560731	+	+	+	+	-	+
ATP-binding cassette transporter sub-family A member 16	Abca16	gi|46369473	-	-	-	-	-	-
ATP-binding cassette transporter sub-family A member 9	Abca9	gi|22267466	-	-	-	-	-	-
B-cell leukemia/lymphoma 11B isoform b	Bcl11b	gi|120586999	-	-	-	-	-	-
Cadherin 4 (R-cadherin)	Cdh4	gi|6753376	-	-	+	-	-	-
Calcium/calmodulin-dependent protein kinase II gamma	Camk2g	gi|75991700	+	+	+	+	+	+
Calcium/calmodulin-dependent protein kinase II, beta	Camk2b	gi|31982483	+	+	+	+	+	+
Calcium/calmodulin-dependent protein kinase II, delta isoform 1	Camk2d	gi|70906479	+	+	+	+	+	+
cAMP-regulated guanine nucleotide exchange factor II	Rapgef4	gi|9790087	-	-	+	+	-	+
Capping protein (actin filament) muscle Z-line, beta isoform b	Capzb	gi|6753262	-	+	+	+	-	+
Catenin, alpha 1	Ctnna1	gi|6753294	+	+	+	+	-	+
Catenin, alpha 2 isoform 2	Ctnna2	gi|6753296	+	+	+	+	-	+
Catenin, beta 1	Ctnnb1	gi|6671684	+	+	+	+	-	+
CLASP1	Clasp1	gi|124486879	-	+	-	-	-	-
Clathrin interactor 1	Clint1	gi|113865873	-	-	-	-	-	-
Clathrin, heavy polypeptide (Hc)	Cltc	gi|51491845	+	+	+	-	+	+
CLIP-associating protein CLASP2 isoform a	Clasp2	gi|126506304	-	+	+	+	-	+
DEAD (Asp-Glu-Ala-Asp) box polypeptide 1	Ddx1	gi|19527256	-	+	+	+	-	+
DEAH (Asp-Glu-Ala-His) box polypeptide 15 isoform 2	Dhx15	gi|110835723	-	+	-	-	-	-
DEAH (Asp-Glu-Ala-His) box polypeptide 36	Dhx36	gi|30794390	-	-	-	-	-	-
Drebrin 1	Dbn1	gi|34328251	+	-	+	-	-	+
EF hand domain containing 2	Efhd2	gi|31981086	-	-	-	-	-	-
ELKS/RAB6-interacting/CAST family member 2	Erc2	gi|37360977	-	+	-	+	-	+
Elongation factor Tu GTP binding domain containing 2	Eftud2	gi|6755594	-	-	-	-	-	-
Epidermal growth factor receptor pathway substrate 15, related	Eps15l1	gi|6679669	-	+	-	+	-	+
Eukaryotic translation elongation factor 1 alpha 1	Eef1a1	gi|126032329	-	+	+	+	-	+
FXYD domain-containing ion transport regulator 2	Fxyd2	gi|16554570	-	-	-	-	-	-
H3 histone, family 3B	H3f3b	gi|6680161	-	-	-	-	-	-

Heat shock protein 1 (chaperonin)	Hspd1	gi|31981679	-	+	-	+	-	+
Heat shock protein 8	Hspa8	gi|31981690	-	+	+	+	-	+
Heterogeneous nuclear ribonucleoprotein M	Hnrnpm	gi|21313308	-	+	-	-	-	-
Histone 1, H2aa	Hist1h2aa	gi|28316756	-	-	-	-	-	-
Histone 1, H2bh	Hist1h2bh	gi|30061387	-	-	+	-	-	-
Histone 1, H4b	Hist1h4b	gi|30061405	-	-	+	-	-	-
Inner membrane protein, mitochondrial	Immt	gi|70608131	-	+	+	+	-	+
Interleukin 17 receptor	Il17ra	gi|6680411	-	-	-	-	-	-
Internexin neuronal intermediate filament protein, alpha	Ina	gi|34328368	+	+	+	+	-	+
Kinesin family member 2A	Kif2a	gi|6680560	+	+	-	-	-	-
Lamin B2	Lmnb2	gi|113195686	+	+	-	-	-	-
Latrophilin 1	Lphn1	gi|56118951	+	+	-	+	-	+
LEM domain containing 2	Lemd2	gi|22122563	-	-	-	-	-	-
Ligase III, DNA, ATP-dependent	Lig3	gi|71061470	-	-	-	-	-	-
Limbic system-associated membrane protein	Lsamp	gi|30425330	+	-	-	-	-	+
MAP/microtubule affinity-regulating kinase 1	Mark1	gi|21704014	-	+	+	-	-	-
Matrin 3	Matr3	gi|25141233	-	+	-	-	-	-
Microtubule-associated protein 1 B	Mtap1b	gi|6678946	+	+	+	-	+	-
Microtubule-associated protein tau	Mapt	gi|84370347	-	+	+	+	+	+
Myosin heavy chain 10, non-muscle	Myh10	gi|33598964	+	-	+	+	-	+
Myosin IB	Myo1b	gi|86990450	-	+	+	-	-	+
Myosin Va	Myo5a	gi|115511052	+	+	+	+	-	+
Myosin Vb	Myo5b	gi|46399202	+	+	+	-	-	-
Myosin XVIIIa	Myo18a	gi|22094119	+	+	+	-	-	+
Myosin, heavy polypeptide 14	Myh14	gi|29336026	-	+	-	+	-	+
Myosin, heavy polypeptide 9, non-muscle isoform 1	Myh9	gi|114326446	-	+	+	+	-	+
Myosin, light polypeptide 6B	Myl6b	gi|26986555	+	+	-	-	-	-
N-acetyltransferase 12	Nat12	gi|124487477	-	-	-	-	-	-
Neurofilament 3, medium	Nefm	gi|112363107	-	-	+	-	-	-
Neurofilament, light polypeptide	Nefl	gi|39204499	-	+	+	+	-	+
Nuclear VCP-like	Nvl	gi|33468981	-	-	-	-	-	-
Nuclease sensitive element binding protein 1	Ybx1	gi|113205059	-	-	-	-	-	-
Olfactory receptor 1122	Olfr1122	gi|22128887	-	-	-	-	-	-
Poly (ADP-ribose) polymerase family, member 1	Parp1	gi|20806109	-	+	-	-	-	-
Poly A binding protein, cytoplasmic 1	Pabpc1	gi|31560656	-	-	-	+	-	+
Poly A binding protein, cytoplasmic 2	Pabpc2	gi|6754972	-	-	-	-	-	-
Postsynaptic density protein 95	Dlg4	gi|6681195	+	-	+	+	+	+
Prestin	Slc26a5	gi|28933459	-	-	-	-	-	-
Protein phosphatase 1, regulatory subunit 9A	Ppp1r9a	gi|31711997	-	+	+	+	-	+
Protein phosphatase 1, regulatory subunit 9B	Ppp1r9b	gi|50053703	-	+	+	+	-	+
Rab11-family interacting protein 2	Rab11fip2	gi|75677518	-	+	+	-	-	+

Rab6-interacting protein 2 isoform 1	Erc1	gi|120300971	+	-	+	-	-	-
Retinoid X receptor alpha	Rxra	gi|6755384	-	-	-	-	-	-
Ribosomal protein L23	Rpl23	gi|12584986	+	+	+	+	-	+
Ribosomal protein S4, X-linked	Rps4x	gi|6677805	+	+	-	-	-	+
RNA binding motif protein 14	Rbm14	gi|86262142	-	+	-	-	-	+
Snap-25-interacting protein	P140	gi|116089329	+	-	+	+	-	+
Solute carrier family 25, member 12	Slc25a12	gi|27369581	-	-	+	+	-	+
Solute carrier family 25, member 4 (Ant1)	Slc25a4	gi|91680541	+	+	+	+	-	+
Solute carrier family 25, member 5 (Ant2)	Slc25a5	gi|22094075	+	+	+	+	-	+
Sorting and assembly machinery component 50 homolog	Samm50	gi|30519943	-	+	-	-	-	-
Spectrin alpha 2	Spna2	gi|115496850	+	+	+	+	+	+
Spectrin beta 1	Spnb1	gi|84490394	+	+	+	-	-	+
Spectrin beta 2 isoform 1	Spnb2	gi|117938332	+	+	+	+	-	+
Spectrin beta 3	Spnb3	gi|55926127	+	+	+	-	-	+
Sterile alpha and TIR motif containing 1	Sarm1	gi|40254247	-	-	-	-	-	-
Synaptic vesicle glycoprotein 2 a	Sv2a	gi|11528518	-	+	-	-	-	-
Transportin 1 isoform 1	Tnpo1	gi|115385968	-	-	-	-	-	-
Tubulin, alpha 1	Tuba1a	gi|6755901	+	-	+	+	-	+
Tubulin, alpha 1a	Tuba3a	gi|6678465	+	-	+	+	-	+
Tubulin, alpha 1B	Tuba1b	gi|34740335	+	+	+	+	-	+
Tubulin, alpha 1C	Tuba1c	gi|6678469	+	-	+	+	-	+
Tubulin, alpha 4	Tuba4a	gi|6678467	+	-	+	+	-	+
Tubulin, beta	Tubb2b	gi|21746161	+	+	+	+	+	+
Tubulin, beta 2	Tubb2a	gi|33859488	+	-	+	+	+	+
Tubulin, beta 2c	Tubb2c	gi|22165384	+	+	+	+	+	+
Tubulin, beta 3	Tubb3	gi|12963615	-	+	+	+	+	+
Tubulin, beta 4	Tubb4	gi|31981939	-	+	+	+	+	+
Tubulin, beta 5	Tubb5	gi|7106439	+	-	+	+	+	+
Tubulin, beta 6	Tubb6	gi|27754056	+	+	+	+	+	+
U5 snRNP-specific protein	Snrnp200	gi|40018610	-	-	-	-	-	-
Vimentin	Vim	gi|31982755	-	+	+	+	-	+
WD repeat domain 37 isoform a	Wdr37	gi|27369593	-	+	-	+	-	+
WD repeat domain 47	Wdr47	gi|31088910	-	+	-	-	-	+