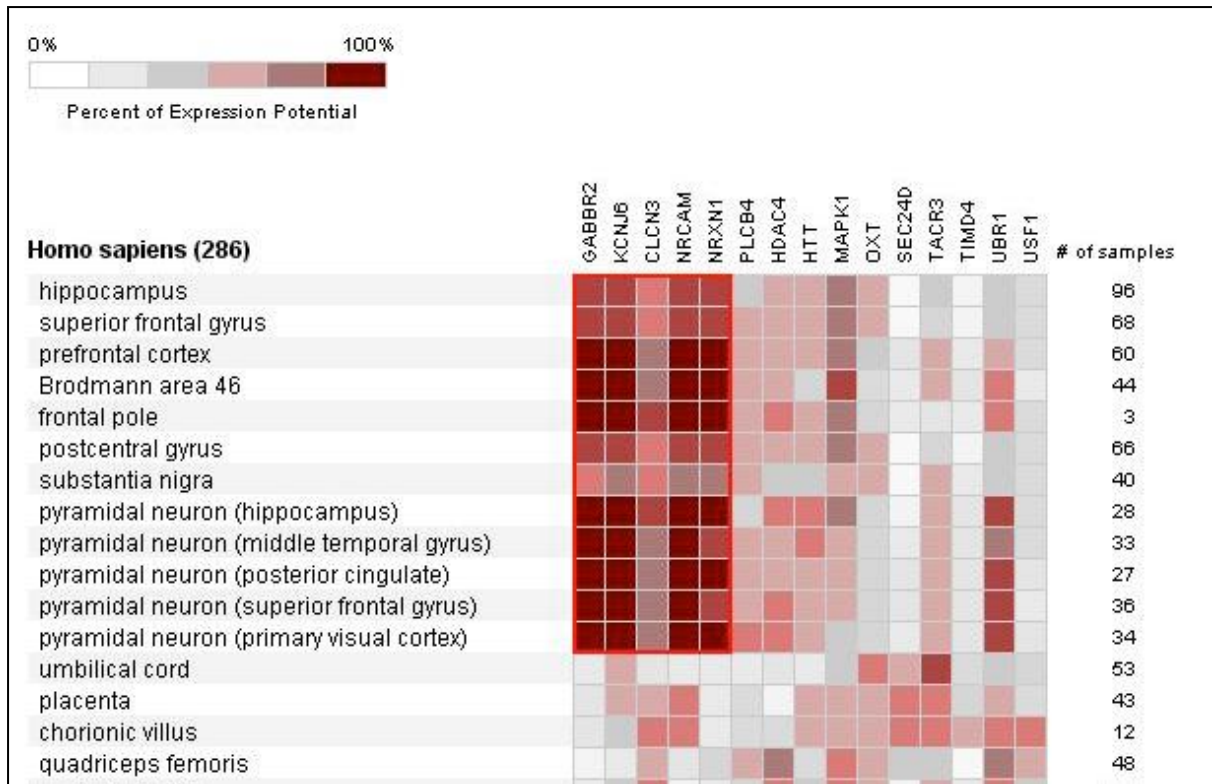


Supplementary Fig S1. A network reconstructed from genes with three and more different intragenic SVA insertions. The initial networks, which were reconstructed automatically by IPA software, associated a number of highly linked genes (white blocks) to the uploaded dataset (dark red) and have been refined by deletion of the low-connected or redundant network nodes. Genes containing less than three SVA insertions are presented in pink. X-chromosome fragility gene FMR1 and the KRAB-family ZNF680 of genes are highlighted in blue and green, respectively. The meaning of the shapes is explained in the legend. Linked text labels correspond to gene-attributed functions and diseases. Solid lines reflect experimentally validated interactions and dashed lines correspond to indicative interactions (such as physical protein binding).



Supplementary Fig S2. Anatomical gene expression heatmap produced by means of Geneinvestigator for neural system genes associated with SVA_A and/or SVA_B elements. Colour intensities correspond to the relative arithmetic mean of the detected level of expression of a gene (columns) in each listed tissue/cell type (rows).

Supplementary Table S1. Genes with neuronal function and their corresponding SVA insertion location.

Symbol	Entrez Gene Name	Gene SVA-insertion location			Location	Molecular function	Entrez Gene ID for Human	Entrez Gene ID for Mouse	Entrez Gene ID for Rat
		Within	Up str. ea m	Down str.					
VAMP1	Vesicle-Associated Membrane Protein 1 (Synaptobrevin 1)	--	VA MP1	--	Vesicle membrane	other	6843	22317	25624
FUS	Fus fused in sarcoma RNA binding protein	--	FUS	--	Cytoplasm	other	2521	233908	317385
AARS2	alanyl-tRNA synthetase 2, mitochondrial	--	AAR S2	--	Cytoplasm	enzyme	57505	224805	301254
ABCA1	ATP-binding cassette, sub-family A (ABC1), member 1	ABCA1	--	--	Plasma Membrane	transporter	19	11303	313210

ABHD12	abhydrolase domain containing 12	ABHD12	--	--	Other	enzyme	26090	76192	499913
ABL2	ABL proto-oncogene 2, non-receptor tyrosine kinase	ABL2	--	--	Cytoplasm	kinase	27	11352	304883
ACKR2	atypical chemokine receptor 2	--	--	CCB P2	Plasma Membrane	G-protein coupled receptor	1238	59289	140473
ACOT11	acyl-CoA thioesterase 11	ACOT11	--	--	Cytoplasm	enzyme	26027	329910	100363074
ACSL4	acyl-CoA synthetase long-chain family member 4	ACSL4	--	--	Cytoplasm	enzyme	2182	50790	113976
ADAM19	ADAM metalloproteinase domain 19	ADAM19	--	--	Plasma Membrane	peptidase	8728	11492	303068
ADCY10	adenylate cyclase 10 (soluble)	--	--	ADC Y10	Cytoplasm	enzyme	55811	271639	59320
ADGRV1	adhesion G protein-coupled receptor V1	GPR98	--	--	Plasma Membrane	G-protein coupled receptor	84059	110789	100362255
ADIPOQ	adiponectin, C1Q and collagen domain containing	--	--	ADI POQ	Extracellular Space	other	9370	11450	246253
ADORA3	Adenosine A3 Receptor	ADORA3	--	--	Plasma Membrane	G-protein coupled receptor	121933	562	25370
AGTPBP1	ATP/GTP binding protein 1	AGTPBP1	--	--	Nucleus	peptidase	23287	67269	290986
AHI1	Abelson helper integration site 1	AHI1	--	--	Cytoplasm	other	54806	52906	308923
AIMP1	aminoacyl tRNA synthetase complex-interacting multifunctional protein 1	AIMP1	--	--	Extracellular Space	cytokine	9255	13722	114632
AIP	aryl hydrocarbon receptor interacting protein	--	AIP	--	Nucleus	transcription regulator	9049	11632	282827
AKAP9	A kinase (PRKA) anchor protein 9	AKAP9	--	--	Other	other	10142	100986	246150
ALDH7A1	aldehyde dehydrogenase 7 family, member A1	ALDH7A1	--	--	Cytoplasm	enzyme	501	110695	291450
ALOX5	arachidonate 5-lipoxygenase	ALOX5	--	--	Cytoplasm	enzyme	240	11689	25290
ALPL	alkaline phosphatase, liver/bone/kidney	--	ALPL	--	Plasma Membrane	phosphatase	249	11647	25586
ANK2	ankyrin 2, neuronal	ANK2	--	--	Plasma Membrane	other	287	109676	362036
ANKRD11	ankyrin repeat domain 11	ANKRD11	--	--	Nucleus	other	29123	77087	365023
ANXA2	annexin A2	ANXA2	--	--	Plasma Membrane	other	302	12306	56611
APAF1	apoptotic peptidase activating factor 1	APAF1	--	--	Cytoplasm	other	317	11783	78963
APBB2	amyloid beta (A4) precursor protein-binding, family B, member 2	APBB2	--	--	Cytoplasm	other	323	11787	305338
APLP2	amyloid beta (A4) precursor-like protein 2	APLP2	--	--	Cytoplasm	other	334	11804	64312
ARHGAP5	Rho GTPase activating protein 5	ARHGAP5	--	--	Cytoplasm	enzyme	394	11855	299012
ARHGAP35	Rho GTPase activating protein 35	--	--	ARHGAP35	Nucleus	transcription regulator	2909	232906	306400

ARL13B	ADP-ribosylation factor-like 13B aryl hydrocarbon receptor nuclear translocator	ARL13B	--	--	Extracellular Space	other	200894	68146	304037
ARNT		ARNT	--	--	Nucleus	transcription regulator	405	11863	25242
ASPA	aspartoacylase activating transcription factor 2	--	ASP A	--	Cytoplasm	enzyme	443	11484	79251
ATF2		ATF2	--	ATF 2	Nucleus	transcription regulator	1386	11909	81647
ATG7	autophagy related 7 ATPase, Ca++ transporting, type 2C, member 1	ATG7	--	--	Cytoplasm	enzyme	10533	74244	312647
ATP2C1	ATPase, Cu++ transporting, alpha polypeptide	ATP2C1	--	--	Cytoplasm	transporter	27032	235574	170699
ATP7A	ATPase, aminophospholipid transporter, class I, type 8A, member 2	ATP7A	--	--	Plasma Membrane	transporter	538	11977	24941
ATP8A2	alpha thalassemia/mental retardation syndrome X-linked	ATP8A2	--	--	Plasma Membrane	transporter	51761	50769	691889
ATRX		ATRX	--	--	Nucleus	transcription regulator	546	22589	246284
ATXN2	ataxin 2 Bardet-Biedl syndrome 5	ATXN2	--	ATX N2	Nucleus	other	6311	20239	288663
BBS5		BBS5	--	--	Cytoplasm	other	129880	72569	362142
BBS9	Bardet-Biedl syndrome 9 B-Raf proto-oncogene, serine/threonine kinase	BBS9	--	--	Extracellular Space	other	27241	319845	315484
BRAF	BRCA1-associated ATM activator 1 breast cancer 1, early onset	BRAF	--	--	Cytoplasm	enzyme	673	109880	114486
BRAT1	bromodomain and WD repeat domain containing 3	--	--	BRA T1	Nucleus	other	221927	231841	498150
BRCA1		BRCA1	--	--	Nucleus	transcription regulator	672	12189	497672
BRWD3	complement component 9	BRWD3	--	--	Other	other	254065	382236	317213
C9	C2 calcium-dependent domain containing 3 calcium channel, voltage-dependent, alpha 2/delta subunit 4	C9	--	--	Extracellular Space	other	735	12279	117512
C2CD3	calcium channel, voltage-dependent, beta 4 subunit	C2CD3	--	--	Cytoplasm	other	26005	277939	293148
CACNA2D4	calcium channel, voltage-dependent, calcium/calmodulin-dependent protein kinase ID	CACNA2D4	CAC NA2 D4	--	Plasma Membrane	ion channel	93589	466912	312668
CACNB4	calmodulin binding transcription activator 1	CACNB4	--	--	Plasma Membrane	ion channel	785	12298	58942
CAMK1D	calcium/calmodulin-dependent serine protein kinase (MAGUK family)	CAMK1D	--	--	Cytoplasm	kinase	57118	227541	307124
CAMTA1	caspase 6, apoptosis-related cysteine peptidase	CAMTA1	--	--	Other	other	23261	100072	362665
CASK	caspase 8, apoptosis-related cysteine peptidase	CASK	--	--	Plasma Membrane	kinase	8573	12361	29647
CASP6		--	--	CAS P6	Cytoplasm	peptidase	839	12368	83584
CASP8		CASP8	--	CAS P8	Nucleus	peptidase	841	12370	64044

CCM2	cerebral cavernous malformation 2	--	CCM2	--	Cytoplasm	other	83605	216527	305505
CDK5RAP2	CDK5 regulatory subunit associated protein 2	CDK5RAP2	--	--	Cytoplasm	other	55755	214444	286919
CECR2	cat eye syndrome chromosome region, candidate 2	--	--	CECR2	Nucleus	other	27443	330409	500308
CFB	complement factor B	CFB	--	--	Space	peptidase	629	14962	294257
CFLAR	CASP8 and FADD-like apoptosis regulator	CFLAR	--	CFLAR	Cytoplasm	other	8837	12633	117279
CLCN3	chloride channel, voltage-sensitive 3	CLCN3	--	--	Plasma Membrane	ion channel	1182	12725	84360
CLIC4	chloride intracellular channel 4	CLIC4	--	CLIC4	Plasma Membrane	ion channel	25932	29876	83718
CLN6	ceroid-lipofuscinosis, neuronal 6, late infantile, variant	CLN6	--	--	Cytoplasm	other	54982	76524	315746
CNTN4	contactin 4	CNTN4	--	--	Plasma Membrane	enzyme	152330	269784	116658
CNTNAP2	contactin associated protein-like 2	CNTNAP2	--	--	Plasma Membrane	other	26047	66797	500105
CPA6	carboxypeptidase A6	CPA6	--	--	Extracellular Space	peptidase	57094	329093	312913
CRB1	crumbs family member 1, photoreceptor morphogenesis associated	CRB1	--	--	Plasma Membrane	other	23418	170788	304825
CREB1	cAMP responsive element binding protein 1	--	--	CREB1	Nucleus	transcription regulator	1385	12912	81646
CTSS	cathepsin S	--	--	CTSS	Cytoplasm	peptidase	1520	13040	50654
CYP19A1	cytochrome P450, family 19, subfamily A, polypeptide 1	CYP19A1	--	--	Cytoplasm	enzyme	1588	13075	25147
CYP7B1	cytochrome P450, family 7, subfamily B, polypeptide 1	CYP7B1	--	--	Cytoplasm	enzyme	9420	13123	25429
CYSLTR1	cysteinyl leukotriene receptor 1	--	--	CYSLTR1	Plasma Membrane	G-protein coupled receptor	10800	58861	114099
DCLK1	doublecortin-like kinase 1	DCLK1	--	--	Other	kinase	9201	13175	83825
DDIT3	DNA-damage-inducible transcript 3	--	--	DDIT3	Nucleus	transcription regulator	1649	13198	29467
DIXDC1	DIX domain containing 1	--	--	DIXDC1	Cytoplasm	other	85458	330938	363062
DNAJC1	DnaJ (Hsp40) homolog, subfamily C, member 1	DNAJC1	--	--	Cytoplasm	other	64215	13418	100360412
DST	dystonin	DST	--	--	Plasma Membrane	other	667	13518	316313
DYSF	dysferlin	DYSF	--	--	Plasma Membrane	other	8291	26903	312492
DYX1C1	dyslexia susceptibility 1 candidate 1	DYX1C1	--	--	Nucleus	other	161582	67685	363096
EDEM2	ER degradation enhancer, mannosidase alpha-like 2	--	EDEM2	--	Cytoplasm	enzyme	55741	108687	296304

EIF2B3	eukaryotic translation initiation factor 2B, subunit 3 gamma, 58kDa	EIF2B3	--	--	Cytoplasm	other	8891	108067	171145
EIF2B4	eukaryotic translation initiation factor 2B, subunit 4 delta, 67kDa	--	--	EIF2B4	Cytoplasm	other	8890	13667	117019
EIF4G3	eukaryotic translation initiation factor 4 gamma, 3	EIF4G3	--	--	Cytoplasm	translation regulator	8672	230861	298573
ELMO1	engulfment and cell motility 1	ELMO1	--	--	Cytoplasm	other	9844	140580	361251
ENTPD1	ectonucleoside triphosphate diphosphohydrolase 1	ENTPD1	--	--	Plasma Membrane	enzyme	953	12495	64519
ERBB3	erb-b2 receptor tyrosine kinase 3	--	ERBB3	--	Plasma Membrane	kinase	2065	13867	29496
ERBB2IP	erb2 interacting protein	ERBB2IP	--	--	Plasma Membrane	other ligand-dependent nuclear receptor	55914	59079	365661
ESR1	estrogen receptor 1	ESR1	--	--	Nucleus	G-protein coupled receptor	2099	13982	24890
F2RL1	coagulation factor II (thrombin) receptor-like 1	--	F2RL1	--	Plasma Membrane	receptor	2150	14063	116677
FAF1	Fas (TNFRSF6) associated factor 1	FAF1	--	--	Nucleus	other	11124	14084	140657
FAIM2	Fas apoptotic inhibitory molecule 2	--	--	FAIM2	Plasma Membrane	other	23017	72393	246274
FBXL20	F-box and leucine-rich repeat protein 20	FBXL20	--	--	Cytoplasm	other	84961	72194	64039
FER	fer (fps/fes related) tyrosine kinase	FER	--	--	Cytoplasm	kinase	2241	14158	301737
FGD4	FYVE, RhoGEF and PH domain containing 4	FGD4	--	--	Cytoplasm	other	121512	224014	246174
FGF12	fibroblast growth factor 12	FGF12	--	--	Extracellular Space	other	2257	14167	170630
FSTL1	follistatin-like 1	FSTL1	--	--	Extracellular Space	other	11167	14314	79210
FTO	fat mass and obesity associated	--	FTO	--	Nucleus	other	79068	26383	291905
FUCA1	fucosidase, alpha-L- 1, tissue	FUCA1	--	FUCA1	Cytoplasm	enzyme	2517	71665	24375
FXN	frataxin	--	--	FXN	Cytoplasm	kinase	2395	14297	499335
GABBR2	gamma-aminobutyric acid (GABA) B receptor, 2	GABBR2	--	--	Plasma Membrane	G-protein coupled receptor	9568	242425	83633
GABRA2	gamma-aminobutyric acid (GABA) A receptor, alpha 2	GABRA2	--	--	Plasma Membrane	ion channel	2555	14395	289606
GABRG3	gamma-aminobutyric acid (GABA) A receptor, gamma 3	GABRG3	--	--	Plasma Membrane	ion channel	2567	14407	79211
GFRA2	GDNF family receptor alpha 2	GFRA2	--	--	Plasma Membrane	transmembrane receptor	2675	14586	25136
GLRA3	glycine receptor, alpha 3	GLRA3	--	--	Plasma Membrane	ion channel	8001	110304	114516
GNAQ	guanine nucleotide binding protein (G protein), q polypeptide	GNAQ	--	--	Plasma Membrane	enzyme	2776	14682	81666

GOLPH3	golgi phosphoprotein 3 (coat-protein)	GOLPH3	--	--	Cytoplasm	other	64083	66629	78961
GPHN	gephyrin	GPHN	--	--	Plasma Membrane	enzyme	10243	268566	64845
GRID1	glutamate receptor, ionotropic, delta 1	GRID1	--	--	Plasma Membrane	G-protein coupled receptor	2894	14803	24408
HDAC2	histone deacetylase 2	--	--	HDA C2	Nucleus	transcription regulator	3066	15182	84577
HDAC4	histone deacetylase 4	--	--	HDA C4	Nucleus	transcription regulator	9759	208727	363287 363481 10091 1968
HDAC8	histone deacetylase 8 hes-related family bHLH transcription factor with YRPW motif 2	HDAC8	--	HDA C8	Nucleus	transcription regulator	55869	70315	
HEY2	major histocompatibility complex, class II, DR beta 1	--	--	HEY 2	Nucleus	transcription regulator	23493	15214	155430
HLA-DRB1	major histocompatibility complex, class I, E	HLA-DRB1	--	--	Other Plasma Membrane	other transmembrane receptor	3123		
HLA-E	homeobox containing 1	--	--	HLA-E			3133	667803 15040	294228
HMBOX1	5-hydroxytryptamine (serotonin) receptor 1E, G protein-coupled	--	--	HM BOX 1	Nucleus Plasma Membrane	transcription regulator G-protein coupled receptor	79618	219150	305968
HTR1E	huntingtin	HTR1E	--	--	Cytoplasm	transcription regulator	3354	107927	
HTT	HECT, UBA and WWE domain containing 1, E3 ubiquitin protein ligase	HTT	--	--			3064	15194	29424
HUWE1	hypoxia up-regulated 1	HUWE1	--	--	Nucleus	transcription regulator	10075	59026	
HYOU1	intraflagellar transport 140	--	--	HYO U1	Cytoplasm Extracellular Space	other	10525	12282	192235
IFT140	immunoglobulin (CD79A) binding protein 1	IFT140	--	--			9742	106633	100362 124
IGBP1	interleukin 1 receptor accessory protein-like 1	--	--	IGBP 1	Cytoplasm Plasma Membrane	phosphatase transmembrane receptor	3476	18518	58845
IL1RAPL1	interleukin 1 receptor antagonist	IL1RAPL1	--	--	Extracellular Space	cytokine transcription regulator	11141	331461	317553
IL1RN	jumonji, AT rich	--	--	IL1RN			3557	16181	60582
JARID2	interactive domain 2	JARID2	--	--	Nucleus	transcription regulator	3720	16468	681740
KALRN	kalirin, RhoGEF kinase	KALRN	--	--	Cytoplasm Plasma Membrane	kinase	8997	545156	84009
KCNJ6	potassium channel, inwardly rectifying subfamily J, member 6	KCNJ6	--	--	Plasma Membrane	ion channel	3763	16522	25743 100310
KDM6A	lysine (K)-specific demethylase 6A	KDM6A	--	--	Nucleus	other	7403	22289	845
KIF15	kinesin family member 15	KIF15	--	--	Nucleus Extracellular Space	other	56992	209737	353302
LAMA2	laminin, alpha 2	LAMA2	--	--			3908	16773	309368
LEF1	lymphoid enhancer-binding factor 1	LEF1	--	--	Nucleus Plasma Membrane	transcription regulator transmembrane receptor	51176	16842	161452
LEPR	leptin receptor	LEPR	--	--	Plasma Membrane	receptor	3953	16847	24536

LFNG	LFNG O-fucosylpeptide 3-beta-N-acetylglucosaminyltransferase leukocyte immunoglobulin-like receptor, subfamily B (with TM and ITIM domains), 3	--	--	LFNG	Cytoplasm	enzyme	3955	16848	170905
LILRB3	glutamate receptor, metabotropic 5	--	--	LILRB3	Plasma Membrane	transmembrane receptor	11025	1146	18733 18726 18729 18725 18722 100038909 10004
LOC440040	pseudogene	LOC440040	--	--	Other Plasma Membrane	other	440040		683463 690955
LPAR4	lysophosphatidic acid receptor 4	--	--	LPAR4	Plasma Membrane	other phosphatase	2846	78134	302378
LPIN1	lipin 1	LPIN1	--	--	Nucleus Plasma Membrane		23175	14245	313977
LRP2	low density lipoprotein receptor-related protein 2	LRP2	--	--	Extracellular Space	transporter	4036	14725	29216
LRP4	low density lipoprotein receptor-related protein 4	LRP4	--	--	Plasma Membrane	transmembrane receptor	4038	228357	83469
LRPAP1	low density lipoprotein receptor-associated protein 1	--	--	LRPAP1	Plasma Membrane	other	4043	16976	116565
LRRC4C	leucine rich repeat containing 4C	LRRC4C	--	--	Cytoplasm	kinase	57689	241568	311236
LRRK2	leucine-rich repeat kinase 2	LRRK2	--	--	Cytoplasm	kinase	120892	66725	300160
MAPK1	mitogen-activated protein kinase 1	MAPK1	--	--	Cytoplasm	kinase	5594	26413	116590
MFN2	mitofusin 2	MFN2	--	--	Cytoplasm	enzyme	9927	170731	100911
MKKS	McKusick-Kaufman syndrome megakaryoblastic leukemia	--	--	MKKS	Cytoplasm	other	8195	59030	485 64476
MKL1	(translocation) 1	MKL1	--	--	Nucleus Cytoplasm	transcription regulator	57591	223701	315151
MKS1	Meckel syndrome, type 1	MKS1	--	--	Cytoplasm	other	54903	380718	287612
MOS	v-mos Moloney murine sarcoma viral oncogene homolog membrane-spanning 4-domains, subfamily A, member 1	--	--	MOS	Cytoplasm Plasma Membrane	kinase	4342	17451	24559
MS4A1	mutS homolog 2	--	--	MS4A1	Plasma Membrane	other	931	12482	309217
MSH2	mechanistic target of rapamycin (serine/threonine kinase)	MSH2	--	--	Nucleus	enzyme	4436	17685	81709
MTOR	myosin, heavy chain 9, non-muscle	MTOR	--	--	Nucleus Cytoplasm	kinase	2475	56717	56718
MYH9	myosin, heavy chain 10, non-muscle	--	--	MYH9	Cytoplasm	other	4627	17886	100911
MYH10	myosin IB	MYH10	--	--	Cytoplasm	other	4628	77579	597
MYO1B	myosin VA (heavy chain 12, myoxin) neuroblastoma	--	--	MYO1B	Cytoplasm	other	4430	17912	79433
MYO5A	amplified sequence nuclear receptor corepressor 1	MYO5A	--	--	Cytoplasm	enzyme	4644	17918	117057
NBAS	NADH dehydrogenase (ubiquinone) 1 alpha subcomplex, 9, 39kDa	NBAS	--	--	Nucleus	other transcription regulator	51594	71169	25017
NCOR1		NCOR1	--	--	Nucleus	transcription regulator	9611	20185	690073
NDUFA9		--	--	NDUFA9	Cytoplasm	enzyme	4704	66108	54299

NEU1	sialidase 1 (lysosomal sialidase)	--	--	NEU1	Cytoplasm	enzyme	4758	18010	24591
NFATC3	nuclear factor of activated T-cells, cytoplasmic, calcineurin-dependent 3	NFATC3	--	--	Nucleus	transcription regulator	4775	18021	361400
NIPBL	Nipped-B homolog (Drosophila)	NIPBL	--	--	Nucleus	transcription regulator	25836	71175	294787
NPEPPS	aminopeptidase puromycin sensitive nucleophosmin (nucleolar phosphoprotein B23, numatrin)	NPEPPS	--	--	Cytoplasm	peptidase	9520	19155	50558
NPM1		NPM1	--	--	Nucleus	transcription regulator ligand-dependent nuclear receptor	4869	18148	25498
NR1H2	nuclear receptor subfamily 1, group H, member 2	--	--	NR1H2	Nucleus		7376	22260	58851
NRCAM	neuronal cell adhesion molecule	NRCAM	--	--	Plasma Membrane	other	4897	319504	497815
NRXN1	neurexin 1	NRXN1	--	--	Plasma Membrane	transporter	9378	18189	60391
NRXN2	neurexin 2	NRXN2	--	--	Plasma Membrane	transporter	9379	18190	116595
NUSAP1	nucleolar and spindle associated protein 1	--	--	NUSAP1	Nucleus	other	51203	108907	311336
OCLN	occludin	OCLN	--	--	Plasma Membrane	enzyme	10050	18260	83497
OMP	olfactory marker protein	--	OMP	--	Cytoplasm	other	6658	18378	24612
OPHN1	oligophrenin 1	OPHN1	--	--	Cytoplasm	other	4975	18378	24612
ORC6	origin recognition complex, subunit 6	ORC6	--	--	Nucleus	other	4983	94190	312108
OTOGL	otogelin-like	OTOGL	--	--	Other Extracellular	other	23594	56452	291927
OXT	oxytocin/neurophysin I prepropeptide	--	OXT	--	Space Plasma Membrane	other	283310	628870	685868
PARD3	par-3 family cell polarity regulator	PARD3	--	--	Plasma Membrane	other	5020	18429	25504
PARG	glycohydrolase parkin RBR E3 ubiquitin protein ligase	PARG	PAR	--	Cytoplasm	enzyme	56288	93742	81918
PARK2		PARK2	--	--	Cytoplasm	enzyme	8505	26430	83507
PARK7	parkinson protein 7 poly (ADP-ribose)	--	PAR	--	Nucleus	enzyme	5071	50873	56816
PARP1	polymerase 1 pre-B-cell leukemia	PARP1	--	--	Nucleus	enzyme	11315	57320	117287
PBX3	homeobox 3 protein-L-isoaspartate (D-aspartate) O-methyltransferase	PBX3	--	--	Nucleus	enzyme transcription regulator	142	11545	25591
PCMT1		PCMT1	--	--	Cytoplasm	enzyme	5090	18516	311876
PCSK5	proprotein convertase subtilisin/kexin type 5 phosphodiesterase	PCSK5	--	--	Extracellular	peptidase	5110	18537	25604
PDE11A	11A phosphodiesterase	PDE11A	--	--	Space Cytoplasm	enzyme	5125	18552	116548
PDE4D	4D, cAMP-specific phosphodiesterase	PDE4D	--	--	Cytoplasm	enzyme	50940	241489	140928
PDE9A	phosphodiesterase 9A	--	--	PDE9A	Other Cytoplasm	enzyme	5144	238871	24627
							5152	18585	191569

PDGFRA	platelet-derived growth factor receptor, alpha polypeptide	PDGFRA	--	--	Plasma Membrane	kinase	5156	18595	25267
PDS5B	PDS5 cohesin associated factor B	PDS5B	--	--	Nucleus	other	23047	100710	304218
PDXDC2P	pyridoxal-dependent decarboxylase domain containing 2, pseudogene	--	PDXDC2P	--	Other	other transmembrane	283970		
PEX5	peroxisomal biogenesis factor 5	PEX5	--	--	Cytoplasm	receptor transcription regulator	5830	19305	312703
PHB	prohibitin polyhomeotic homolog 2	--	PHB	--	Nucleus		5245	18673	25344
PHC2	(Drosophila)	--	PHC2	--	Nucleus	other	1912	54383	313038
PHF8	PHD finger protein 8	PHF8	--	--	Nucleus	enzyme	23133	320595	317425
PIGL	phosphatidylinositol glycan anchor biosynthesis, class L	PIGL	--	--	Cytoplasm	enzyme	9487	327942	192263
PIGV	phosphatidylinositol glycan anchor biosynthesis, class V	--	--	PIGV	Cytoplasm	enzyme	55650	230801	366478
PLCB4	phospholipase C, beta 4	PLCB4	--	--	Cytoplasm	enzyme	5332	18798	25031
PNKD	paroxysmal nonkinesigenic dyskinesia	--	--	PNKD	Nucleus	other	25953	56695	100188944
PNPT1	polyribonucleotide nucleotidyltransferase 1	PNPT1	--	--	Cytoplasm	enzyme	87178	71701	360992
POLA1	polymerase (DNA directed), alpha 1, catalytic subunit	POLA1	--	--	Nucleus	enzyme	5422	18968	85241
POR	P450 (cytochrome) oxidoreductase	POR	--	--	Cytoplasm	enzyme	5447	18984	29441
PPARD	peroxisome proliferator-activated receptor delta	PPARD	PPARD	--	Nucleus	receptor	5467	19015	25682
PRKG1	protein kinase, cGMP-dependent, type I	PRKG1	--	--	Cytoplasm	kinase	5592	19091	54286
PRPH2	peripherin 2 (retinal degeneration, slow)	--	--	PRPH2	Plasma Membrane	receptor	5961	19133	25534
PSEN1	presenilin 1	PSEN1	--	PSEN1	Plasma Membrane	peptidase	5663	19164	29192
PTPN9	protein tyrosine phosphatase, non-receptor type 9	PTPN9	--	--	Cytoplasm	phosphatase	5780	56294	266611
PTPN12	protein tyrosine phosphatase, non-receptor type 12	--	PTPN12	--	Cytoplasm	phosphatase	5782	19248	117255
PTPRD	protein tyrosine phosphatase, receptor type, D	PTPRD	--	--	Plasma Membrane	phosphatase	5789	19266	313278
PUS1	pseudouridylate synthase 1	--	PUS1	--	Nucleus	enzyme	80324	56361	304567
RAB7A	RAB7A, member RAS oncogene family	RAB7A	--	RAB7A	Cytoplasm	enzyme	7879	19349	29448
RAD54L	RAD54-like (S. cerevisiae)	--	RAD54L	--	Nucleus	enzyme	8438	19366	298429
RANBP2	RAN binding protein 2	RANBP2	--	--	Other	other	5903	19386	294429
RBL1	retinoblastoma-like 1 receptor accessory protein 1	RBL1	--	RBL1	Nucleus	transcription regulator	5933	19650	680111
REEP1	receptor accessory protein 1	--	REEP1	--	Cytoplasm	other	65055	52250	362384

RGS11	regulator of G-protein signaling 11	--	--	RGS11	Plasma Membrane	enzyme	8786	50782	54291
RLBP1	retinaldehyde binding protein 1	--	--	RLBP1	Cytoplasm	transporter	6017	19771	293049
RMND1	required for meiotic nuclear division 1 homolog (S. cerevisiae)	RMND1	RMND1	--	Cytoplasm	other	55005	66084	292268
RNF135	ring finger protein 135 roundabout, axon guidance receptor, homolog 2	RNF135	--	--	Cytoplasm	enzyme	84282	71956	303350
ROBO2	(Drosophila)	ROBO2	--	--	Plasma Membrane	transmembrane receptor ligand-dependent nuclear	6092	268902	84409
RORA	RAR-related orphan receptor A	RORA	--	--	Nucleus	receptor	6095	19883	300807
RPGRIP1L	RPGRIP1-like	RPGRIP1L	--	--	Cytoplasm	other	23322	244585	307724
RTTN	rotatin	RTTN	--	--	Other	other	25914	246102	291377
SCN8A	sodium channel, voltage gated, type VIII alpha subunit	SCN8A	--	--	Plasma Membrane	ion channel	6334	20273	29710
SEC24D	SEC24 family member D	SEC24D	--	SEC24D	Cytoplasm	transporter	9871	69608	310843
SERAC1	serine active site containing 1	SERAC1	--	--	Extracellular Space	other	84947	321007	499015
SHANK2	SH3 and multiple ankyrin repeat domains 2	SHANK2	--	--	Plasma Membrane	other	22941	210274	171093
SIL1	SIL1 nucleotide exchange factor	SIL1	--	--	Cytoplasm	transporter	64374	81500	291673
SLC16A2	solute carrier family 16, member 2 (thyroid hormone transporter)	--	SLC16A2	--	Plasma Membrane	transporter	6567	20502	259248
SLC17A5	solute carrier family 17 (acidic sugar transporter), member 5	SLC17A5	SLC17A5	--	Plasma Membrane	transporter	26503	235504	363103
SLC25A12	solute carrier family 25 (aspartate/glutamate carrier), member 12	SLC25A12	SLC25A12	SLC25A12	Cytoplasm	transporter	8604	78830	362145
SLC30A10	solute carrier family 30, member 10	SLC30A10	--	--	Other	transporter	55532	226781	289353
SLMAP	sarcolemma associated protein	--	SLMAP	--	Plasma Membrane	other	7871	83997	290533
SMAD2	SMAD family member 2	--	--	SMA D2	Nucleus	transcription regulator	4087	17126	29357
SMO	smoothened, frizzled class receptor	--	--	SMO	Plasma Membrane	G-protein coupled receptor	6608	319757	25273
SNTB2	syntrophin, beta 2 (dystrophin-associated protein A1, 59kDa, basic component 2)	SNTB2	--	--	Plasma Membrane	other	6645	20650	689421
SNX2	shadow of prion protein homolog	SNX2	--	--	Cytoplasm	transporter	6643	67804	291464
SPRN	(zebrafish)	--	--	SPRN	Other	other	503542	212518	541462
SPTBN1	spectrin, beta, non-erythrocytic 1	SPTBN1	--	--	Plasma Membrane	other	6711	20742	305614
SPTLC1	serine palmitoyltransferase,	SPTLC1	--	--	Cytoplasm	enzyme	10558	268656	361213

STAR	long chain base subunit 1 steroidogenic acute regulatory protein	--	--	STAR	Cytoplasm	transporter	6770	20845	25557
SV2C	synaptic vesicle glycoprotein 2C spectrin repeat containing, nuclear envelope 2	SV2C	--	--	Plasma Membrane	other	22987	75209	29643
SYNE2		SYNE2	--	--	Nucleus	other	23224	319565	366669
SYTL4	synaptotagmin-like 4 transforming, acidic coiled-coil containing protein 2	SYTL4	--	--	Cytoplasm	transporter	94121	27359	140594
TACC2		TACC2	--	--	Nucleus	other	10579	57752	309025
TACR3	tachykinin receptor 3	--	TACR3	--	Plasma Membrane	G-protein coupled receptor	6870	21338	24808
TAF1	TAF1 RNA polymerase II, TATA box binding protein (TBP)-associated factor, 250kDa	TAF1	TAF1	TAF1	Nucleus	transcription regulator	6872	270627	317256
TAOK1	TAO kinase 1 tudor domain containing 7	TAOK1	--	--	Cytoplasm	kinase	57551	216965	286993
TDRD7	teneurin transmembrane protein 4	--	--	TDRD7	Cytoplasm	other	23424	100121	85425
TENM4	transcription factor AP-2 beta (activating enhancer binding protein 2 beta)	TENM4	--	TENM4	Plasma Membrane	other	26011	23966	308831
TFAP2B	T-cell immunoglobulin and mucin domain containing 4	--	TFA2B	--	Nucleus	transcription regulator	7021	21419	301285
TIMD4		TIMD4	--	--	Plasma Membrane	other	91937	276891	497891
TMC1	transmembrane channel-like 1	TMC1	--	TMC1	Plasma Membrane	ion channel	11753	13409	361739
TRA	T cell receptor alpha locus	TRA	--	--	Plasma Membrane	transmembrane receptor	6955	21473	
TRIOBP	TRIO and F-actin binding protein	--	--	TRIOBP	Nucleus	other	11078	110253	362956
TRPM6	transient receptor potential cation channel, subfamily M, member 6	TRPM6	--	--	Plasma Membrane	kinase	140803	225997	293874
TRPV1	transient receptor potential cation channel, subfamily V, member 1	--	--	TRPV1	Plasma Membrane	ion channel	7442	193034	83810
TRPV3	transient receptor potential cation channel, subfamily V, member 3	--	TRPV3	--	Plasma Membrane	ion channel	162514	246788	497948
UBE4B	ubiquitination factor E4B	--	UBE4B	--	Cytoplasm	other	10277	63958	298652
UBR1	ubiquitin protein ligase E3 component n-recognin 1	UBR1	--	UBR1	Cytoplasm	enzyme	197131	22222	499877
UBR2	ubiquitin protein ligase E3 component n-recognin 2	UBR2	--	UBR2	Nucleus	other	23304	224826	363188
UGT1A3	UDP glucuronosyltransferase 1 family, polypeptide A3	--	UGT1A3	--	Cytoplasm	enzyme	54659	22236	396527
ULK1	unc-51 like autophagy activating kinase 1	--	--	ULK1	Cytoplasm	kinase	8408	22241	360827

ULK4	unc-51 like kinase 4 unc-13 homolog B (C. elegans)	ULK4	--	--	Other	kinase	54986	209012	363167
UNC13B	upstream transcription factor 1	UNC13B	--	--	Cytoplasm	other	10497	22249	64830
USF1	transcription factor 1	--	--	1	Nucleus	transcription regulator	7391	22278	83586
UTRN	utrophin	UTRN	--	--	Plasma Membrane	transmembrane receptor	7402	22288	25600
VAMP7	vesicle-associated membrane protein 7	VAMP7	--	--	Cytoplasm	transporter	6845	20955	85491
VAPB	(vesicle-associated membrane protein)-associated protein B and C	VAPB	--	--	Plasma Membrane	other	9217	56491	60431
VAV2	vav 2 guanine nucleotide exchange factor	VAV2	--	--	Cytoplasm	transcription regulator	7410	22325	296603
VEZT	vezatin, adherens junctions transmembrane protein	VEZT	--	--	Plasma Membrane	other	55591	215008	299738
VPS35	vacuolar protein sorting 35 homolog (S. cerevisiae)	--	VPS 35	VPS 35	Cytoplasm	transporter	55737	65114	25479
WDR62	WD repeat domain 62	WDR62	--	WD R62	Nucleus	other	28440	233064	100911
XK	X-linked Kx blood group tyrosyl-tRNA synthetase	XK	--	--	Plasma Membrane	transporter	7504	22439	863 30
YARS	tyrosine 3-monooxygenase/tryptophan 5-monooxygenase activation protein, epsilon	YARS	--	--	Cytoplasm	enzyme	8565	107271	8492
YWHAE	zinc finger, DHHC-type containing 9	--	YW HAE	--	Cytoplasm	other	7531	22627	29753
ZDHHC9	zinc finger, DHHC-type containing 15	--	ZDH HC9	--	Cytoplasm	enzyme	51114	208884	302808
ZDHHC15	zinc finger E-box binding homeobox 1	ZDHHC15	--	--	Cytoplasm	enzyme	15886	108672	317235
ZEB1		ZEB1	--	--	Nucleus	transcription regulator	6	6935	25705

Supplementary Table S2a. Enrichment of SVA-containing gene functions in Canonical pathways (IPA analysis). Functional groups directly attributed to neuronal function are highlighted.

Ingenuity Canonical Pathways	-log Ratio	p-value	Molecules
Cardiac β -adrenergic Signaling	3.88E00	1.04E-01	CACNA1D,PDE3A,PPP2R3B,CACNA1C,AKAP6,PPP1R3A,PDE4B,PPP1R14B,PDE4D,PPP2R5A,AKAP13,ADCY1,PDE8B,GNG2,PPP2R5E,GNG12

Synaptic Long Term Potentiation	3.39E00	1.14E-01	MAPK1,GRM1,GRM3,CACNA1C,PPP1R3A,GRM4,CREB5,PPP1R14B,ADCY1,PRKCE,PRKD3,CAMK2B,GRIA3
Synaptic Long Term Depression	3.02E00	9.46E-02	NOS1,GRID1,MAPK1,GRM3,GRM1,PLA2R1,GUCY2F,PRKCE,PPP2R3B,PPP2R5E,GRM4,PRKD3,PPP2R5A,GRIA3
Axonal Guidance Signaling	2.99E00	6.98E-02	FYN,LRRC4C,GLI2,MAPK1,EPHB2,NFATC3,PIK3R1,SEMA4F,WNT2,EIF4E,EPHB1,WASL,SRGAP1,UNC5D,PRKCE,ROBO2,SHANK2,PRKD3,GNG12,GLIS1,ITGB1,SEMA3E,SRGAP3,SEMA6D,FZD3,PIK3CB,GNG2,SEMA4B,WNT5A,NRP1
Neuropathic Pain Signaling In Dorsal Horn Neurons	2.86E00	1.07E-01	CAMK1D,MAPK1,GRM1,GRM3,PIK3R1,PRKCE,KCNQ3,PIK3CB,GRM4,PRKD3,GRIA3,CAMK2B
CREB Signaling in Neurons	2.64E00	7.96E-02	MAPK1,GRM1,GRM3,PIK3R1,GRIK3,GRM4,CREB5,GRID1,ADCY1,PRKCE,PIK3CB,GNG2,PRKD3,GNG12,CAMK2B,GRIA3
Amyotrophic Lateral Sclerosis Signaling	2.54E00	9.17E-02	CAPN5,NOS1,CACNA1D,GRID1,HECW1,PIK3R1,GRIK3,CACNA1C,PIK3CB,NAIP,GRIA3
TR/RXR Activation	2.54E00	1.04E-01	RAB3B,AKR1C1/AKR1C2,SLC2A1,PIK3R1,NCOA1,THRA,PIK3CB,THRB,NCOA3,PPARGC1A
Hypoxia Signaling in the Cardiovascular System	2.29E00	1.23E-01	BIRC6,UBE2V2,UBE2E2,UBE2E3,CREB5,UBE2E1,PTEN,ARNT
Breast Cancer Regulation by Stathmin1	2.15E00	7.69E-02	CAMK1D,MAPK1,PIK3R1,PPP2R3B,PPP1R3A,TRPC5,PPP1R14B,PPP2R5A,ADCY1,PRKCE,PIK3CB,GNG2,PPP2R5E,PRKD3,GNG12,CAMK2B

Renal Cell Carcinoma Signaling	2.06E00	1.08E-01	MET,ETS1,SLC2A1,MAPK1,CUL2,PIK3R1,PIK3CB,ARNT
PKC θ Signaling in T Lymphocytes	2.05E00	7.75E-02	MAP3K15,FYN,POU2F1,MAPK1,NFATC3,VAV3,PIK3R1,CD86,PIK3CB,CARD11,CAMK2B
Dopamine-DARPP32 Feedback in cAMP Signaling	2.03E00	7.49E-02	NOS1,CACNA1D,CSNK1G3,CACNA1C,PPP2R3B,PPP1R3A,CREB5,PPP1R14B,PPP2R5A,ADCY1,PRKCE,KCNJ6,PPP2R5E,PRKD3
Glutamate Receptor Signaling	2.02E00	1.01E-01	GRID1,GRM1,GRM3,GRIK3,GRM4,GNG2,GRIA3
AMPK Signaling	2.02E00	7.23E-02	PFKFB3,KAT2B,ACACB,MAPK1,PIK3R1,PRKAA2,PPP2R3B,PIK3CB,CFTR,PPP2R5E,AK2,PPP2R5A
Actin Cytoskeleton Signaling	2.01E00	7.05E-02	ITGB1,MPRIIP,MAPK1,PIK3R1,FGF14,TRIO,WASL,PIP5K1C,VAV3,DIAPH2,PIK3CB,WASF2,SSH2,NCKAP1L,ARHGAP24,GNG12,IQGAP3
Clathrin-mediated Endocytosis Signaling	1.97E00	7.69E-02	ITGB1,MYO6,AP2B1,APOB,EPH2,EPHB2,PIK3R1,FGF14,ITGB8,HIP1,MET,WASL,PIP5K1C,PIK3CB,MYO1E
ERK/MAPK Signaling	1.97E00	7.35E-02	PPARG,ITGB1,ETS1,FYN,MAPK1,PIK3R1,PPP2R3B,PPP1R3A,CREB5,PPP1R14B,PPP2R5A,EIF4E,PRKCE,PIK3CB,PPP2R5E
Virus Entry via Endocytic Pathways	1.88E00	9E-02	ITGB1,FLNB,AP2B1,FYN,PIK3R1,PRKCE,PIK3CB,ITGB8,PRKD3
Fcy Receptor-mediated Phagocytosis in Macrophages and Monocytes	1.79E00	8.82E-02	FYN,MAPK1,VAV3,PIK3R1,DGKB,PRKCE,FYB,PRKD3,PTEN

Antiproliferative Role of Somatostatin Receptor 2	1.79E00	9.86E-02	NOS1,MAPK1,PIK3R1,GUCY2F,PIK3CB,GNG2,GNG12
cAMP-mediated signaling	1.75E00	7.31E-02	MAPK1,CAMK1D,GRM3,PDE3A,AKAP6,PDE4B,GRM4,CREB5,PDE4D,CNGA1,AKAP13,FSHR,ADCY1,P2RY12,PDE8B,CAMK2B
Production of Nitric Oxide and Reactive Oxygen Species in Macrophages	1.74E00	6.67E-02	MAP3K15,APOB,MAPK1,PIK3R1,PPP2R3B,PPP1R3A,NCF4,PPP1R14B,PPP2R5A,RHOT1,PRKCE,PIK3CB,PPP2R5E,PRKD3
Glioma Signaling	1.74E00	8.04E-02	CAMK1D,MAPK1,PIK3R1,PRKCE,PIK3CB,RBL1,PRKD3,PTEN,CAMK2B
DNA Double-Strand Break Repair by Homologous Recombination	1.72E00	1.76E-01	ATRX,RAD52,BRCA1
Semaphorin Signaling in Neurons	1.67E00	1.15E-01	ITGB1,MET,FYN,MAPK1,RHOT1,NRP1
Macropinocytosis Signaling	1.63E00	9.21E-02	ITGB1,MET,PIK3R1,PRKCE,PIK3CB,ITGB8,PRKD3
Relaxin Signaling	1.61E00	7.01E-02	MAPK1,PDE3A,PIK3R1,ADCY1,GUCY2F,PDE8B,PIK3CB,PDE4B,GNG2,PDE4D,GNG12
Rac Signaling	1.54E00	7.38E-02	ITGB1,NOX4,MAPK1,PIP5K1C,PIK3R1,PIK3CB,PARD3,IQGAP3,ANK1
CDK5 Signaling	1.53E00	8.51E-02	ITGB1,MAPK1,ADCY1,PPP2R3B,PPP1R3A,PPP2R5E,PPP1R14B,PPP2R5A

Supplementary Table S2b. Enrichment of functions of SVA-containing genes in Functional Networks (IPA analysis). Functional categories directly attributed to neuronal function are highlighted.

ID	Top Diseases and Functions	Molecules in Network	Score	Focus Molecules
1	Connective Tissue Development and Function, Embryonic Development, Organ Development	ADAMTS9, ANO3, BIRC6, BRE, CADPS2, EDAR, ERC1, GCOM1, HIVEP3, IPO11, IRAK1BP1, KCND3, LCA5, MYO1E, NFkB (complex), PCLO, PHC1, PHC2, RELT, RNF185, RNF144A, SCM H1, SENP6, SIAH1, TBC1D1, TBL1X, TPMT, TRAFD1, TRIM5, UBE2, UBE2E1, UBE2E2, UBE2E3, UBE2V2, VSNL1	52	33
2	Cell Cycle, DNA Replication, Recombination, and Repair, Cell Morphology	ANTXR1, APLF, ATRX, BACH1, BARX2, BRCA1, CREB5, DIAPH2, DMXL1, GINS2, GRHL1, GRHL2, HELLS, ITGB8, KDM1A, KIF20B, KLF8, MCPH1 (includes EG:244329), Mhc class ii, MTA3, NOX4, PARP, PARP1, PARP4, PARP14, PARP16, PRIM 2, RAD52 (includes EG:19365), TBC1D8, TFCP2L1, Tnf, UBP1 (includes EG:100136855), Vegf, WNT2, ZEB1	45	31
3	Cellular Development, Hematological System Development and Function, Hematopoiesis	AKAP6, Alpha tubulin, Arp2/3, ASAP2, ATAD5, BRD4, BRPF3, Calbindin, CBF A2T2, CSMD2, DYSF, EHMT2, F Actin, FYN, GAS2L3, HCN1, IgG2a, LRBA, LRRTM4, MPRIP, MYR IP, NKAIN2, PCDH15, PIK3R1, PTPRT, REST, SCARF2, SHROOM 3, SNX8, SPEN, TCF12, THSD7A, WDYHV1, XKR4, ZNF652	44	30
4	Cell Morphology, Cellular Assembly and Organization, Cellular Development	Actin, Akt, Alpha Actinin, Alpha catenin, ANK1, ANKS1B, Cadherin, CDH4, CDH12, CDH18, CEL F1, CNKSR2, CTNNA2, CTNNBL1, CTNND2, DAP3, EIF4G3, EXO SC7, Integrin β , IP6K1, IPP, LRRC7, MAGI2, MAP4, MTMR3, PLX NA4, PYGO1, SEMA6D, SEPT7, SEPT9, SNX27, Spectrin, SPTBN 1, TJP1 (includes EG:21872), TSPAN8	39	27
5	Cellular Assembly and Organization, Cellular Function and Maintenance,	Adaptor protein 2, Ap2 alpha, AP2B1, ARHGAP8/PRR5- ARHGAP8, Beta adaptin, BTBD9, Clathrin, CPSF3, Dynamin, EPS15, ERK, FBLN2, FBN1, FIP1L1, GABAR- A, GABRA2, GABRB1, GABRR1, HERC1, HIP1 (includes EG:176224), MADD, MYO6, NCF4, NCKAP1L, OSBPL9, OSBPL1	39	28

	Infectious Disease	0,PACSIN2,PAQR3,PDK4,PIP5K1C,STON1-GTF2A1L,SYMPK,WASF2,WASL,WWOX		
6	Infectious Disease, Cardiovascular Disease, Dermatological Diseases and Conditions	3',5'-cyclic-nucleotide phosphodiesterase,ALCAM,ART3,ATG7,Cdc2,CDCA7L,CDK14,Cyclin E,DAPK2,DHX30,DOCK3,E2f,EEA1,FAM3B,Filamin,FLNB,Ig h (family),Jnk,KLHL5,MAD1L1,MAP1LC3B,MAP4K3,MYBL2,NINL,PDE3A,PDE4B,PDE4D,PDE8B,POU2F2,Rb,RBL1,STBD1,STK4,TPO,TSPAN7	37	27
7	Nervous System Development and Function, Tissue Development, Digestive System Development and Function	ACAC,ACACB,ADCY1,alcohol group acceptor phosphotransferase,ARHGAP32,CFTR,CPT1,CTH,endothelin receptor,Ephb,EPHB1,EPHB2,FDPS,GRAMD3,KCNJ6,MAPK1,MINOS1,MTORC1,MX2,NMDA Receptor,OCRL,PPARGC1B,PRKAA,PRKAA2,PRMT8,Rab5,S HANK2,SKAP1,SLC2A1,SLC4A7,SLC9A3 (includes EG:105243),ST5,TFEB,TTK,VPS45	35	26
8	Cellular Function and Maintenance, Antigen Presentation, Humoral Immune Response	ADCY,AIG1,C9,C4B (includes others),Calmodulin,CAMK1D,CAMK2B,CAMTA1,CDKAL1,C LIC4,creatine kinase,CSMD1,DBC1,DMD,DPP6,EIF2C3,EPB41L4B,Fibrinogen,GALNT9,GPIIB-IIIa,HDL,HDL-cholesterol,KCNQ3,KCNQ5,KPNA6,LYPLA2,MYO1B,Nos,N OVA1,PHF12,SGCD,SGCZ,STRN,Talin,TNRC6B	34	26
9	Cell Signaling, Molecular Transport, Vitamin and Mineral Metabolism	AKAP13,ARFGEF1,ARFGEF2,BMPR1A,C3orf15,Dgk,DGKB, DGKI,DGKK,DPY30,ENG,ERK1/2,KIDINS220,L-type Calcium Channel,MPZL1,MYCBP,Pki,PP1/PP2A,PPP1R14B,PPP1R3 A,Ppp2c,PPP2R3B,PPP2R5A,PPP2R5E,PRKAC,PTPN5,Rab11,SHC4,SMAD1/5,SPRED2,STIM1,TRP,TRPC5,TRPC6,ZHX2	33	25
10	Connective Tissue Disorders, Dermatological Diseases and Conditions, Gastrointestinal Disease	ADAR,ANKH,AUTS2,CD86,COL19A1 (includes EG:12823),COL21A1,COL22A1,COL24A1,collagen,Collagen Alpha1,DUB,EFCAB6,GBP1,Hsp27,IFN alpha/beta,Ifn gamma,IL-1R,IL1RAPL1,Interferon alpha,IRG,IRGM,LDL-cholesterol,LZTFL1,MARCH1,MYD88,NCR2,P38 MAPK,PCDH7,RRBP1,Tgf beta,USP18,USP26,USP34,USP36,USP48	29	23

11	Inflammatory Disease, Reproductive System Disease, DNA Replication, Recombination, and Repair	14-3-3, ABR, Ap1, ARHGAP6, ATP7A, CASC3, Ck2, Creb, ELMOD1, estrogen receptor, ETS1, GTPASE, Hsp90, Insulin, KLC3, p70 S6k, PAM, PARD3, POLDIP3, Rac, RNA polymerase II, RP2, SLC2A9, SLC30A8, SREK1, SRGAP3, SRSF11, STRAP, TCR, THRB, TK2, TOP2B, TSH, tyrosine kinase, VAV3	25	21
12	Cell Cycle, Cellular Response to Therapeutics, Cancer	ARHGAP24, caspase, CD3, CHD6, Cyclin A, EIF4E, ERBB2IP, FRMD6, Histone h3, Holo RNA polymerase II, Ikb, ITCH, MAP2K1/2, MGMT, MICA, Mlc, NAIP, Notch, OGDH, PHF16, POLD3, PSG1, PTEN, Ras homolog, RHOT1, Rock, RUNX3, Smad2/3, ST7, TAF15, TAF1 (includes EG:270627), Tnf receptor, TRAK1, TRIM16, ZFYVE9	23	22
13	Cellular Movement, Connective Tissue Development and Function, Embryonic Development	ABCC9, Alp, ALPL, ALT, ARNT, ASIP, CALCOCO1, CLOCK, Collagen type I, Collagen type IV, Collagen(s), CRYZ, CUZD1, DNAJC2, ECE1, ESR2, Focal adhesion kinase, Growth hormone, hCG, HMGA2, ITGB1, JINK1/2, Lh, NDUFS4, PCSK6, Pdgf (complex), PDGF BB, PRKCE, Proinsulin, PTPRD, Smad, SOX6, TCF/LEF, trypsin, WNT5A	22	19
14	Cellular Movement, Nervous System Development and Function, Organ Morphology	c-Src, COBLL1, Cofilin, DAAM1, DAB1, FHIT, Iga, Igm, Integrin, Integrin alpha 3 beta 1, KHDRBS1, KIF2A, Laminin, Mek, MET, Nfat (family), NPAS3, NRP1 (includes EG:18186), PGGT1B, PI3K (family), PIK3CB, Ptk, PTK7, PTPN12, PTPRJ, Rap1, Ras, RASGRP2, RELN, Rsk, SEMA3E, Sos, SSH2, TRIO, TXK	19	20
15	Cardiovascular System Development and Function, Organismal Development, Tissue Morphology	AKR1C1/AKR1C2, ANKRD11, Ctbp, Eotaxin, ETV6, GC-GCR dimer, GK, HESX1, IL4R, IRS, JAK, KAT2B, LCOR, Ncor, NCOA, NCOA1, NCOA3, NPAS2, OSMR, p160, PEPCK, PI3K (complex), Pias, PLB1 (includes EG:151056), RAB3B, Rar, RPH3AL, Rxr, SGK3, SLCO1B3, STAT5a/b, SWI-SNF, T3-TR-RXR, thymidine kinase, thyroid hormone receptor	18	17
16	Hereditary Disorder, Neurological	ANAPC1/LOC100286979, ANXA1, ASB4, ATP8A2, BCR (complex), CARD11, Cpla2, CUL2, CUL5, E3 RING, FAF1 (includes EG:11124), Fc gamma	18	17

	Disease , Cell Morphology	receptor,Fcer1,Fgf,FGF14,FYB,Gi-coupled receptor,Gm-csf,Ige,IgG1,Igg3,KLHDC10,Mapk,NPLOC4,PFKFB3,PLA2,PLA2R1,PLAA,PLC gamma,Profilin,SEMA4B,SVIP,SYK/ZAP,Tenascin,VAV		
17	Neurological Disease, Psychological Disorders , Lipid Metabolism	26s Proteasome,A1CF,ACLY,AMPK,APBB2,APOB,CASP8,CTPS,CYP39A1,Cytochrome c,EIF2AK3,FSH,GOT,Gsk3,Hsp70,Ifn,IFN Beta,IgG,IL1,IL12 (complex),Immunoglobulin,LDL,LRP1 (includes EG:16971),MACF1,MHC Class II (complex),NXN,PON2,POU2F1,PPARG,Pro-inflammatory Cytokine,RORA,SIGLEC5,SLC2A13,Tlr,Ubiquitin	18	17
18	Gene Expression, Organ Morphology, Skeletal and Muscular System Development and Function	ACADM,Calcineurin A,Cbp/p300,CK1,CSNK1G3,EPC1,Esr1-Esr1-estrogen-estrogen,Gcn5l,Gli,GLI2,GLIS1,Hdac,HISTONE,Histone h4,HMG CoA synthase,KCNC2,KDM4A,MED12L,mediator,MEF2,MEF2A,NFAT (complex),NFATC3,Pde,PIAS1,Pka,PKHD1,Pmca,PPARGC1A,ROBO2,SUPT3H,THRA (includes EG:21833),TIP60,Wnt,ZNF219	17	17
19	Cellular Assembly and Organization, DNA Replication, Recombination, and Repair, Cell Cycle	ASTN2,BAIAP2L1,CCDC8,CHD8,COL14A1,CPEB1,CYLC2,DS C3 (includes EG:13507),FAT3,FOXJ3,HYDIN,IKBIP,KIAA0430,MACROD2,MLL5,MTHFSD,MUS81,NMT2,NOC2L,PCDH7,PCDH9,PPP1CA,PPP1R10,PPP1R13B,PPP1R13L,PQLC3,PVT1,REV3L,RYK ,SNRK,TERF2,TMEM132D,TOX4,TP53,ZNF292	17	17
20	Cellular Assembly and Organization, Cellular Function and Maintenance, Nucleic Acid Metabolism	AGPAT2,ALMS1,AP1AR,ARHGAP23,ATP5A1,ATP5B,ATPAF1,CGRRF1,CREB3,EDEM2,EXOC6B,EXPH5,FILIP1,GGA1 (includes EG:106039),HSF1,JMJD6,MEPCE,MSTO1,NR1H3,PHRF1,RAB27A,RAD23A,RAE1,RALA,RPAP1,RPS3A,S100BPB,SLC30A9,SMAD9,UBC,VKORC1L1,WDR5,WDR48,WDR59,WDR70	17	16
21	Cell Cycle, Hereditary Disorder,	AKAP11,CCHCR1,CNOT8,DEGS1,EIF5,ESF1,FAM21A,IQGA P3,KIAA0196,KIAA1033,KLHDC4,KNTC1,LEPRE1,NBAS,POLD2,PRR12,PUM1,RINT1,SCFD2,SEC61A1,SEC61A2,SEC61G	17	16

	Neurological Disease	,SERPINA12,SLC39A14,STT3A,TSSC1,TUSC3,TXNDC12,UBC,USP3,WASH1/WASH5P,WBTC1,YTHDF2,ZW10,ZWILCH		
22	Lipid Metabolism, Nucleic Acid Metabolism, Small Molecule Biochemistry	ACAD9,ACAD10,ACADSB,AGPAT3,AGPAT4,AGPAT5,AGPAT6,CLPP,DDX46,DDX47,EFTUD1,FRYL,GFM2,GPR107,GPR108,GPR119,GPR155,GPR158,GPR176,GPR179,GPR89A/GPR89B,GPR89C,GPRC5C,HECW1,ITFG1,LGR4,NTSR1,OLA1,PCNX,SCAF11,SH2D4A,SUCLG2,TRAPPC12,UBC,ZNF277	17	16
23	Organ Morphology, Reproductive System Development and Function, Tissue Morphology	ADAMTS19,ALDH5A1,AQP8,AR,CRISP1,CUX2,DMRT1,DMRTC2,DMRTC1/DMRTC1B,EPB41L4B,FAM110B,FGFR2,GLCCI1,GLIPR1,GPR65,GUCY2F,HOXD1,HS6ST2,KBTD11,KLK11,KLK14,MED12L,MSMB,MTL5,NLRP10,NR3C1,PATZ1,PHF3,RAD54L2,RBMS3,SAR1B,SEMA5B,SPINLW1,TGFB1 (includes EG:21803),TPST2	17	16

Supplementary Table S2c Enrichment of functions of SVA-containing genes in ‘Diseases and Functions’ categories (IPA analysis). Functional categories directly attributed to neuronal function are highlighted.

Categories	Diseases or Functions Annotation	p-Value	Molecules
Cardiovascular Disease	coronary artery disease	1.77E-06	AGPAT5,AKAP13,ASTN2,CACNA1C,CACNA1D,CACNA2D1,CAMTA1,CNTN5,CSMD1,CSMD2,CTNBL1,EIF4G3,ESR2,GABRA2,GABRB1,KDM1A,KIAA0319L,LRP1 (includes EG:16971),MEF2A,OGDH,P2RY12,PDE3A,PDE4B,PDE4D,PPARG,SGCD,TMEM163,WWOX
Endocrine System Development and Function	glucose tolerance	1.42E-05	ABCC9,ARNT,CACNA1D,CADPS2,CASP8,CREB5,EIF2AK3,FAM3B,LRP1 (includes EG:16971),MGAT4A,NOS1,PAM,PKD4,PIK3CB,PIK3R1,PPARG,PPARGC1A,PPP1R3A,PRKAA2,PTEN,RPH3AL,SERPIN

			A12,SGK3,SLC30A8,THRA (includes EG:21833)
Cell Morphology, Cellular Assembly and Organization, Cellular Development, Cellular Function and Maintenance, Embryonic Development, Nervous System Development and Function , Tissue Development, Tissue Morphology	morphology of dendritic spines	1.93E-05	CTNNA2,EPHB1,EPHB2,LRRRC7,MAGI2,OPHN1
Cellular Movement, Nervous System Development and Function	guidance of axons	6.93E-05	ALCAM,APBB2,CDH4,CNTN4,EPHB1,EPHB2,FEZ2,GLI2,LRRRC4C,MAPK1,NRP1 (includes EG:18186),OPHN1,PLXNA4,RELN,ROBO2,RUNX3,SEMA4F,VAV3
Cellular Function and Maintenance	function of enterocytes	7.37E-05	ESR2,MYD88,THRA (includes EG:21833)
Connective Tissue Disorders	Dupuytren contracture	1.69E-04	ADAMTS16,ADAMTS18,ADAMTS19,ADAMTS3,ADAMTS6,ADAMTS9,COL14A1,COL19A1 (includes EG:12823),COL21A1,COL22A1,COL24A1
Nervous System Development and Function	development of central nervous system	1.70E-04	ABR,APBB2,ATG7,ATRX,CDCA7L,CTNNA2,DAB1,EPHB2,ESR2,FOXJ3,FYN,FZD3,GLI2,HESX1,IL1RAPL1,IL1RAPL2,KHDRBS1,KIF2A,MAPK1,MCPH1 (includes

			EG:244329),MET,NDST3,NDUFS4,NPAS2,NPAS3,PARD3,PCSK6,PLXNA4,PPARG,PTEN,RBL1,RELN,REST,ROBO2,RORA,SHROOM4,SLC4A7,SOX6,SPTBN1,ST8SIA4,STK4,THRA (includes EG:21833),TOP2B,TRIO,VSNL1,WASF2,WNT5A,ZEB1
Cardiovascular Disease, Organismal Injury and Abnormalities	variant angina	1.88E-04	CACNA1C,CACNA1D,CACNA2D1,SGCD
Cell-To-Cell Signaling and Interaction	synaptic depression	2.24E-04	ADCY1,CAMK2B,EPHB1,EPHB2,GRIA3,GRM1,GRM3,HIP1 (includes EG:176224),LRRC7,PCLO,PIP5K1C,ST8SIA4,SYN3
Neurological Disease	radiculopathy	2.85E-04	CACNA2D1,CACNA2D2,CACNA2D3
Organismal Survival	organismal death	3.14E-04	ABCC9,ACLY,ADAR,ANKH,ANXA1,APBB2,APOB,ARNT,ATG7,BIRC6,BMPR1A,BRCA1,BRD4,C4B (includes others),CACNA2D2,CASP8,CELF1,CFT R,CLIC4,CUZD1,DAB1,DMD,EHMT2,EIFF2AK3,ENG,EPHB2,ESR2,ETS1,ETV6,FBN1,FLNB,FYN,GABRA2,GPR98,HIP1 (includes EG:176224),HMGA2,IL4R,IRGM,ITGB1,ITGB8,KAT2B,KCNJ6,KIDINS220,LRRC7,MAD1L1,MADD,MAGI2,MAPK1,MC PH1 (includes EG:244329),MEF2A,MET,MGMT,MYBL2,MYD88,NCOA1,NCOA3,NDUFS4,NFATC3,NOS1,NOVA1,NRP1 (includes EG:18186),OPHN1,PARP1,PCLO,PCSK6,PHC1,PHC2,PIK3CB,PIK3R1,PIP5K1C,POU2F1,PPARG,PPARGC1A,PPARGC1B,PTEN,PTPRJ,RAB3B,RAD52 (includes EG:19365),RBL1,REST,REV3L,SGCD,SI AH1,SLC2A1,SPEN,SPRED2,SPTBN1,ST8SIA4,STK4,TCF12,TFCP2L1,TFEB,THRA (includes

			EG:21833),THRB, TOP2B, TPMT, TRAFD1, TRIM54, TRIO, UBP1 (includes EG:100136855), USP18, VAV3, WASF2, WASL, WWOX, ZEB1
Cellular Function and Maintenance, Nervous System Development and Function	function of outer hair cells	3.27E-04	CACNA1D, GPR98, THRA (includes EG:21833), THRB
Cancer, Hereditary Disorder, Reproductive System Disease	tumorigenesis of prostatic carcinoma	3.27E-04	HIP1 (includes EG:176224), PPARG, PRKCE, PTEN
DNA Replication, Recombination, and Repair	breakage of DNA	3.66E-04	BRCA1, NOS1, PARP1, PTEN, RAD52 (includes EG:19365), REV3L, TOP2B
Cardiovascular Disease, Organismal Injury and Abnormalities	angina pectoris	4.31E-04	CACNA1C, CACNA1D, CACNA2D1, P2RY12, PDE3A, PDE4B, PDE4D, PPARG, SGCD
Cellular Assembly and Organization, Cellular Function and Maintenance	organization of cytoplasm	4.49E-04	ABR, ADCY1, ALMS1, ANTXR1, ARHGAP24, ARHGAP32, ARHGAP6, ARHGAP8/PRR5-ARHGAP8, ATG7, ATP7A, CAMK1D, CDH4, CNTN4, CTNNA2, CTNND2, DAB1, DIAPH2, EIF2AK3, ENG, EPHB1, EPHB2, FHIT, FLNB, FYN, GRM4, HYDIN, ITGB1, ITGB8, KIDINS220, KIF20B, KIF2A, LRP1 (includes EG:16971), LRRC4C, LRRC7, MAGI2, MAP4, MAPK1, MET, MPRIP, MSTO1, MYD88, MYO6, NCKAP1L, NOS1, NPLOC4, NRP1 (includes EG:18186), OPHN1, PACSIN2, PAM, PARD3, PCDH15, PCLO, PIK3R1, PIP5K1C, PKHD1, PLXNA4, PPARG, PPARGC1A, PPAR

			GC1B,PRKCE,PTEN,PTPRQ,RALB,RELN,ROBO2,RRBP1,RUNX3,SEC16B,SEMA3E,SEMA4F,SEPT7,SEPT9,SHROOM3,SHROOM4,SIAH1,SSH2,STRN,TFCP2L1,TOPO2B,TRIM54,TRIO,TTK,VAV3,VPS54,WASF2,WASL,WNT5A
Nervous System Development and Function	morphology of nervous system	5.03E-04	ABR,ADCY1,ALPL,APBB2,APOB,BRCA1,CACNA1D,CACNA2D2,CADPS2,CD86,CLIC4,CNTN4,CTNNA2,CUX2,DAB1,ECE1,EPHB1,EPHB2,ERBB2IP,ESR2,FAT3,FSHR,FYN,GLI2,GRID1,HESX1,IL1RAPL1,IL4R,ITGB1,ITGB8,KIDINS220,KIF2A,LRRC7,MADD,MAGI2,MCPH1 (includes EG:244329),MET,NCOA1,NDST3,NDUFS4,NFATC3,NOS1,NPAS3,NRP1 (includes EG:18186),OPHN1,PCSK6,PLXNA4,PPARGC1A,PTEN,RBL1,RELN,ROBO2,SEMA5B,ST8SIA4,THRA (includes EG:21833),THRB,TOPO2B,TRIO,VAV3,WNT5A
Molecular Transport	transport of Mg ²⁺	5.28E-04	MAGT1,NIPAL1,TUSC3,ZDHHC17
Neurological Disease	hydrocephalus	5.75E-04	APOB,DAB1,ENG,GLI2,ITGB8,OPHN1,PTEN,RELN,ST8SIA4,USP18
Cellular Assembly and Organization, Cellular Function and Maintenance	organization of cytoskeleton	5.85E-04	ABR,ADCY1,ALMS1,ANTXR1,ARHGAP24,ARHGAP32,ARHGAP6,ARHGAP8/PPP5-ARHGAP8,ATG7,ATP7A,CAMK1D,CDH4,CNTN4,CTNNA2,CTNND2,DAB1,DIAPH2,ENG,EPHB1,EPHB2,FHIT,FLNB,FYN,GRM4,HYDIN,ITGB1,ITGB8,KIDINS220,KIF20B,KIF2A,LRP1 (includes EG:16971),LRRC4C,LRRC7,MAGI2,MAP4,MAPK1,MET,MPRIIP,MYD88,MYO6,NCKAP1L,NOS1,NRP1 (includes EG:18186),OPHN1,PACSIN2,PAM,PAR3,PCDH15,PCLO,PIK3R1,PIP5K1C,PKHD1,PLXNA4,PPARG,PPARGC1B,PRKCE,PTEN,PTPRQ,RALB,RELN,ROBO2,RRBP1,RUNX3,SEMA3E,SEMA4F,SEPT7,S

			EPT9,SHROOM3,SHROOM4,SSH2,STRN, TOP2B,TRIM54,TRIO,VAV3,VPS54,WASF2,WASL,WNT5A
Cell Cycle, Cellular Movement	cytokinesis of tumor cell lines	5.86E-04	BRD4,KIF20B,MASTL,NEDD4L,SEPT7,S EPT9,SIAH1,VAV3
Cardiovascular System Development and Function	abnormal morphology of vasculature	6.59E-04	ARNT,BIRC6,CLIC4,FBN1,ITGB8,MAPK1,NDUFS4,NFATC3,NPAS3,PPARG,PTE N,SLC4A7,STK4,UBP1 (includes EG:100136855),WASF2,WNT2
Cardiovascular System Development and Function, Embryonic Development, Organismal Development, Tissue Development	vascularization of yolk sac	8.02E-04	ARNT,ITGB8,NRP1 (includes EG:18186),STK4
Cell Cycle, DNA Replication, Recombination, and Repair	abnormal morphology of chromosomes	9.14E-04	BRCA1,HELLS,MCPH1 (includes EG:244329),PARP1,RAD52 (includes EG:19365)
Infectious Disease	infection by Retroviridae	1.07E-03	ACACB,AKAP13,ANKRD30A,ARHGAP32,ATG7,BRCA1,CACNA2D1,CACNA2D2,CACNA2D3,CALCOCO1,CAMK1D,CD86,CFTR,CLOCK,DAPK2,DMXL1,DYSF,E IF2C3,FDPS,GABRB1,HCP5,IL4R,KHDR BS1,KIAA0922,MAP4,NDUFAF2,PCSK6 ,PDE3A,PDE4B,PDE4D,PHF12,PHF3,PI P5K1C,PPARG,PPP2R5E,PTPRJ,PVT1,R ALB,RANBP17,RNF170,SEMA5B,SLC2A1,SLC2A13,SLC4A7,SPEN,SPTBN1,ST3GAL3,SUCLG2,TATDN1,TMEM163,T OP2B,TRIM5,UBE2E1,USP26,WBTC1, XKR4,ZNF292
Developmental Disorder,	mental retardation	1.15E-03	ATP7A,ATRX,AUTS2,CTNND2,GRIA3,IL1RAPL1,MAGT1,OPHN1,SHROOM4,TS PAN7,TUSC3,ZNF599

Neurological Disease			
Behavior	nest building behavior	1.16E-03	LRRC7,MAPK1,NDUFS4,NPAS3
Cardiovascular System Development and Function, Organ Morphology	abnormal morphology of heart	1.23E-03	ACACB,CASP8,ECE1,ESR2,ITGB8,MAPK1,NFATC3,NOX4,PHC1,PPARGC1A,PPARGC1B,SGCD,SNX27,SPTBN1,TRIM54,UBP1 (includes EG:100136855),WASF2,WASL
Digestive System Development and Function, Endocrine System Development and Function, Organ Morphology	morphology of pancreas	1.25E-03	CACNA1D,CADPS2,CFTR,EIF2AK3,ESR2,GPR39,MGMT,MYD88,NFATC3,PKHD1,PPARG,PTEN,THRA (includes EG:21833)

Supplementary Table S3. Genes grouped by associated SVA-types (a (SVA_A)-g(SVA_F1)) and the corresponding p-values of their enrichment in behavioural categories.

a.SVA_A

Diseases or Functions Annotation	p-Value	Molecules
Climbing Ability	1.22E-03	KCNJ6
Anxiety	1.89E-03	GABBR2,KCNJ6,PLCB4
Passive Avoidance Learning	4.67E-02	GABBR2

b.SVA_B

Diseases or Functions Annotation	p-Value	Molecules
Learning	1.71E-05	HDAC4,HTT,MAPK1,NRCAM,NRXN1,OXT,TACR3,UBR1
Social Behaviour	3.35E-05	HTT,MAPK1,NRXN1,OXT

Motor Learning	6.71E-05	HTT,NRCAM,NRXN1
Anxiety-Like Behaviour	1.19E-04	HTT,MAPK1,OXT
Spatial Learning	1.55E-04	HDAC4,HTT,NRCAM, TACR3,UBR1
Behaviour	1.76E-04	CLCN3,HDAC4,HTT, MAPK1,NRCAM,NRXN1, OXT,SEC24D,TACR3,UBR1,USF1
Discriminatory Learning	2.62E-04	HTT,UBR1
Olfactory Discrimination	3.26E-04	HTT,OXT
Grooming	4.83E-04	HTT,NRXN1,OXT
Emotional Behaviour	5.18E-04	HTT,MAPK1,NRXN1,OXT,TACR3
Aggressive Behaviour	6.52E-04	HTT,MAPK1,OXT
Nest Building Behaviour	7.55E-04	MAPK1,NRXN1
Invasive Behaviour	1.49E-03	NRCAM,SEC24D
Vertical Rearing	1.52E-03	HTT,NRCAM,UBR1
Circadian Rhythm	1.69E-03	HTT,MAPK1,OXT
Apathy	2.74E-03	HTT
Choreiform Movement	2.74E-03	HTT
Facial Expression	2.74E-03	HTT
Irritability Of Organism	2.74E-03	HTT
Somatosensory-Discrimination Learning	2.74E-03	HTT
Spasmodic Movement	2.74E-03	HTT

Stretching Behaviour	2.74E-03	HTT
Memory	3.53E-03	HDAC4,HTT,MAPK1,OXT
Hyperactivity	3.90E-03	HTT,TIMD4
Social Exploration	4.86E-03	NRCAM,OXT
Passive Avoidance Learning	5.11E-03	TACR3,UBR1
Climbing Behaviour	5.48E-03	HTT
Executive Functioning	5.48E-03	HTT
Barbering Behaviour	8.20E-03	USF1

c.SVA_C

Diseases or Functions Annotation	p-Value	Molecules
Grooming	5.50E-03	LRRK2,SLC16A2
Head Tossing	5.94E-03	ATF2
Mounting	7.91E-03	NPEPPS
Emotional Behaviour	1.22E-02	LRRK2,MKKS,SLC16A2
Behaviour	2.15E-02	ABHD12,ATF2,LRRK2,MKKS,NPEPPS,SLC16A2
Locomotion	3.23E-02	ABCA1,FGF12,LRRK2

d.SVA_D

Diseases Or Functions Annotation	p-Value	Molecules
Behaviour	2.01E-08	ABL2,ATP8A2,CACNB4,CNTNAP2,CYP19A1,ESR1,F2RL1,FTO,GFRA2,GNAQ,GPHN,IL1RN,LEPR,LRPAP1,MOS,MTOR,NFATC3,NRXN1,OCLN,PARK7,PRKG1,SCN8A,SHANK2,SYTL4,TRPV1,UBR1,VEZT
Cognition	3.76E-06	ABL2,CNTNAP2,CYP19A1,ESR1,IL1RN,LEPR,LRPAP1,MTOR,NIPBL,NRXN1,PARK7,SHANK2,UBR1,VEZT
Learning	1.07E-05	ABL2,CNTNAP2,CYP19A1,ESR1,IL1RN,LEPR,LRPAP1,MTOR,NRXN1,PARK7,SHANK2,UBR1,VEZT
Locomotion	4.76E-05	ABL2,AGTPBP1,ATP7A,CACNB4,CYP19A1,ESR1,FXN,NFATC3,PARK7,PBX3,SCN8A
Social Behaviour	1.19E-04	CNTNAP2,IL1RN,NFATC3,NRXN1,SHANK2
Nest Building Behaviour	1.54E-04	CNTNAP2,NRXN1,SHANK2

Walking	3.26E-04	AGTPBP1,CACNB4,FXN,SCN8A
Emotional Behaviour	3.68E-04	ABL2,CNTNAP2,CYP19A1,ESR1,LEPR,NRXN1,SHANK2,TRPV1
Aggressive Behaviour Toward Females	5.03E-04	CYP19A1,ESR1
Sexual Behaviour	6.05E-04	ABL2,CYP19A1,ESR1,SYTL4
Grooming	6.95E-04	CNTNAP2,CYP19A1,NRXN1,SHANK2
Sexual Receptivity Of Female Organism	7.52E-04	CYP19A1,ESR1
Vocalization	8.31E-04	CNTNAP2,GPHN,SHANK2
Aggressive Behaviour	1.02E-03	ABL2,CYP19A1,ESR1,LEPR
Parental Behaviour	1.40E-03	CYP19A1,ESR1,SHANK2
Feeding	2.39E-03	ATP8A2,ESR1,FTO,GPHN,IL1RN,LEPR,OCLN
Pup Retrieval	2.69E-03	ESR1,SHANK2
Mating Behaviour	3.37E-03	ABL2,CYP19A1,ESR1
Anxiety	3.54E-03	GABRA2,GABRG3,NFATC3,SHANK2,TRPV1,VAMP7
Mating	5.04E-03	CYP19A1,ESR1
Panic-Like Anxiety	5.74E-03	GABRA2,GABRG3
Memory	6.18E-03	ABL2,CYP19A1,ESR1,IL1RN,LEPR,MTOR
Abnormal Initiation Of Locomotion	6.50E-03	CYP19A1,NFATC3,PARK7

e. SVA_E

Diseases or Functions Annotation	p-Value	Molecules
Spatial Learning	1.27E-03	CREB1,OPHN1,UBR1
Vertical Rearing	4.16E-03	CREB1,UBR1
Discriminatory Learning	1.05E-02	UBR1
Aggressive Behaviour Toward Mice	1.51E-02	OPHN1
Anxiety	2.33E-02	CREB1,OPHN1
Short-Term Memory	2.54E-02	CREB1
Addiction Behaviour	2.76E-02	CREB1
Memory	2.88E-02	CREB1,OPHN1
Place Preference	4.34E-02	CREB1
Passive Avoidance Learning	4.46E-02	UBR1

f. SVA_F

Diseases or Functions Annotation	p-Value	Molecules
Social Behaviour	5.47E-04	KALRN,OMP,PDE11A
Long-Term Spatial Reference Memory	2.39E-03	PSEN1
Mother Preference	2.39E-03	OMP
Social Odour Recognition Memory	2.39E-03	PDE11A
Behaviour	4.52E-03	APLP2,KALRN,LEF1,MYH10,OMP,PARK2,PDE11A,PSEN1
Associative Memory	4.78E-03	PSEN1

g.SVA_F1

Diseases or Functions Annotation	p-Value	Molecules
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Behaviour	5.91E-03	ACOT11,ATG7,CYP7B1,MKL1
Limb Clasp ing	6.28E-03	ATG7
Feeding	1.31E-02	ACOT11,MKL1
Nursing	1.53E-02	MKL1
Walking	3.17E-02	ATG7

Supplementary Table S4. Genes associated with 3 and more SVA insertions. The presence of a particular SVA type in a gene or in 10kB gene proximity is indicated by '+'.

Gene	Function	SVA_A	SVA_B	SVA_C	SVA_D	SVA_E	SVA_F	SVA_F1
BCYRN1	brain cytoplasmic RNA 1	+	+	--	+	--	+	--
DLEC1	deleted in lung and esophageal cancer 1	--	+	+	--	--	--	+
EIF4G3	eukaryotic translation initiation factor 4 gamma, 3	--	--	--	+	+	+	--
TAF1	TAF1 RNA polymerase II, TATA box binding protein (TBP)-associated factor, 250kDa	+	--	--	+	--	--	--
SIMC1	SUMO-interacting motifs containing 1	--	--	--	+	--	+	--
CCDC109B	coiled-coil domain containing 109B	+	+	--	+	--	--	--
WDR70	WD repeat domain 70	+	--	+	+	--	--	--
DST	dystonin	--	+	--	+	+	--	--
UBR1	ubiquitin protein ligase E3 component n-recognin 1	--	+	--	+	+	--	--
KDM4C	lysine (K)-specific demethylase 4C	--	--	+	+	--	+	--
MAP4	microtubule-associated protein 4	--	--	+	+	--	+	--
mir-548	microRNA 548c	--	--	--	+	+	+	--
PTPN9	protein tyrosine phosphatase, non-receptor type 9	--	--	+	+	--	--	+

Supplementary Table S5 SVA-associated genes with mental retardation phenotype.

Gene	SVA	Condition	Chromosome
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HDAC4	SVA_B	Mental retardation – brachydactylic-mental retardation syndrome	2
IGBP1	SVA_B	Mental retardation - mental retardation syndrome X-linked type 28	X
RPGRIP1L	SVA_B	Mental retardation - COACH syndrome	16
ACSL4	SVA_B	X-linked mental retardation	X
HDAC8	SVA_B	X-linked mental retardation	X
ZDHHC15	SVA_B	X-linked mental retardation	X
KDM6A	SVA_C	Mental retardation – Kabuki syndrome type 2	X
PIGL	SVA_C	Mental retardation	17
SLC16A2	SVA_C	Mental retardation - monocarboxylate transporter 8 deficiency	X
ANKRD11	SVA_D	Mental retardation – KBG Syndrome	16
CAMTA1	SVA_D	Mental retardation – cerebellar ataxia, non-progressive, with mental retardation	1
PIGV	SVA_D	Mental retardation – hyperphosphatasia with mental retardation type 1	1
RPGRIP1L	SVA_D	Mental retardation – COACH syndrome	16
SCN8A	SVA_D	Mental retardation – cognitive impairment with or without cerebellar ataxia	12
ATP7A	SVA_D	X-linked mental retardation	X
ATRX	SVA_D	X-linked mental retardation	X
BRWD3	SVA_D	X-linked mental retardation	X
CASK	SVA_D	X-linked mental retardation	X
IL1RAPL1	SVA_D	X-linked mental retardation	X
PHF8	SVA_D	X-linked mental retardation	X
SCN8A	SVA_D	X-linked mental retardation	X
ZDHHC9	SVA_D	X-linked mental retardation	X

OPHN1	SVA_E	X-linked mental retardation	X
HUWE1	SVA_E	X linked mental retardation syndrome turner type	X

Supplementary Table S6. Anatomical expression profile for SVA- associated genes.

PREFACE	
1	1.1
2	2.1
3	3.1
4	4.1
5	5.1
6	6.1
7	7.1
8	8.1
9	9.1
10	10.1
11	11.1
12	12.1
13	13.1
14	14.1
15	15.1
16	16.1
17	17.1
18	18.1
19	19.1
20	20.1
21	21.1
22	22.1
23	23.1
24	24.1
25	25.1
26	26.1
27	27.1
28	28.1
29	29.1
30	30.1
31	31.1
32	32.1
33	33.1
34	34.1
35	35.1
36	36.1
37	37.1
38	38.1
39	39.1
40	40.1
41	41.1
42	42.1
43	43.1
44	44.1
45	45.1
46	46.1
47	47.1
48	48.1
49	49.1
50	50.1
51	51.1
52	52.1
53	53.1
54	54.1
55	55.1
56	56.1
57	57.1
58	58.1
59	59.1
60	60.1
61	61.1
62	62.1
63	63.1
64	64.1
65	65.1
66	66.1
67	67.1
68	68.1
69	69.1
70	70.1
71	71.1
72	72.1
73	73.1
74	74.1
75	75.1
76	76.1
77	77.1
78	78.1
79	79.1
80	80.1
81	81.1
82	82.1
83	83.1
84	84.1
85	85.1
86	86.1
87	87.1
88	88.1
89	89.1
90	90.1
91	91.1
92	92.1
93	93.1
94	94.1
95	95.1
96	96.1
97	97.1
98	98.1
99	99.1
100	100.1

Supplementary Table S7. Reproductive diseases and reproductive functional categories associated with neuronal gene data sets grouped by SVA types (a(SVA_A)-g (SVA_F1)).

a.SVA_A

Category	Diseases or Functions Annotation	p-Value	Molecules
Reproductive System Disease	rectal prolapse	3.14E-02	TRA
Reproductive System Disease	hairpin sperm flagellum	1.34E-02	ADCY10

b.SVA_B

Reproductive System Disease	atrophy of testis	1.09E-04	HTT,NR1H2,UBR2
Reproductive System Disease	Kallmann syndrome type 11	2.74E-03	TACR3
Reproductive System Disease	atrophy of seminiferous tubule	5.48E-03	HTT

c.SVA_C

Reproductive System Disease	hypoplasia of prostate gland	3.96E-03	STAR
Reproductive System Disease	hypoplasia of seminal vesicle	1.18E-02	STAR
Reproductive System Disease	infertility	4.21E-02	ABCA1,MKKS,NPEPPS
Reproductive System Development and Function	morphology of gonadal cells	8.60E-04	ABCA1,LAMA2,NPEPPS,STAR

Reproductive System Development and Function	morphology of reproductive system	1.19E-03	ABCA1,ARNT,ATF2,LAMA2,NPEPPS,STAR
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d.SVA_D

Reproductive System Disease	diminished ovarian reserve	4.66E-03	CASP8
Reproductive System Disease	prostate cancer	1.22E-02	ADIPOQ,ANXA2,CASP8,PDXDC2P
Reproductive System Disease	endometriosis	1.76E-02	ADIPOQ,CASP8,CREB1
Reproductive System Development and Function	fertility	1.38E-04	ABL2,ATXN2,CFB,CYP19A1,ESR1,IL1RN,MOS,PDE4D,POR,PRKG1,RBL1
Reproductive System Development and Function	cell viability of gonadal cell lines	1.88E-04	ATP7A,ESR1,POR
Reproductive System Development and Function	luteinization	2.28E-04	CYP19A1,PDE4D,PDGFRA
Reproductive System Development and Function	sexual receptivity of female organism	7.52E-04	CYP19A1,ESR1
Reproductive System Development and Function	development of uterus	8.31E-04	CYP19A1,ESR1,NIPBL
Reproductive System Development and function	pup retrieval	2.69E-03	ESR1,SHANK2

Reproductive System Development and Function	mating behavior	3.37E-03	ABL2,CYP19A1,ESR1
Reproductive System Development and Function	development of testis	6.24E-03	ATRX,CYP19A1,ESR1,MSH2
Reproductive System Development and Function	development of seminiferous tubule	6.47E-03	ATRX,ESR1
Reproductive System Development and Function	development of female reproductive tract	7.10E-03	CYP19A1,ESR1,LEPR,NIPBL,PDGFRA

e.SVA_E

Reproductive System Development and Function	lactation	3.41E-03	ADIPOQ,CREB1
Reproductive System Development and Function	abnormal morphology of oocytes	2.88E-02	LFNG
Reproductive System Development and Function	differentiation of breast cell lines	3.10E-02	ADIPOQ
Reproductive System Development and Function	lactation	3.41E-03	ADIPOQ,CREB1
Reproductive System Development and Function	abnormal morphology of oocytes	2.88E-02	LFNG

f.SVA_F

Reproductive System Disease	prostate cancer	8.62E-05	ALDH7A1,BRCA1,KALRN,LEF1,PDE11A,PPARD,RANBP2,RBL1,ROBO2
Reproductive System Disease	genital tumor	1.56E-04	ALDH7A1,BRCA1,ERBB3,KALRN,LEF1,LRP2,PARK2,PDE11A,PPARD,RANBP2,RBL1,ROBO2
Reproductive System Disease	prostatic carcinoma	4.65E-04	ALDH7A1,KALRN,LEF1,RANBP2,RBL1,ROBO2
Reproductive System Disease	androgen-dependent prostate tumor	2.39E-03	LEF1
Reproductive System Disease	susceptibility to familial breast-ovarian cancer type 1	2.39E-03	BRCA1,KALRN,RANBP2,ROBO2

g.SVA_F1

Reproductive System Development and Function	size of ventral prostatic lobe	1.40E-03	CYP7B1
Reproductive System Development and Function	ejection of breast milk	4.89E-03	MKL1
Reproductive System Development and Function	function of mammary gland	6.98E-03	MKL1
Reproductive System Development and Function	abnormal morphology of mammary gland	8.37E-03	MKL1
Reproductive System Development and Function	involution of mammary gland	2.01E-02	MKL1
Reproductive System Development and Function	size of ventral prostatic lobe	1.40E-03	CYP7B1

Reproductive System Development and Function	growth of mammary gland	2.08E-02	MKL1
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