Positive Feedback between RNA-binding protein HuD and transcription factor SATB1 promotes neurogenesis

(Wang et al 2015)

Supplementary Figures

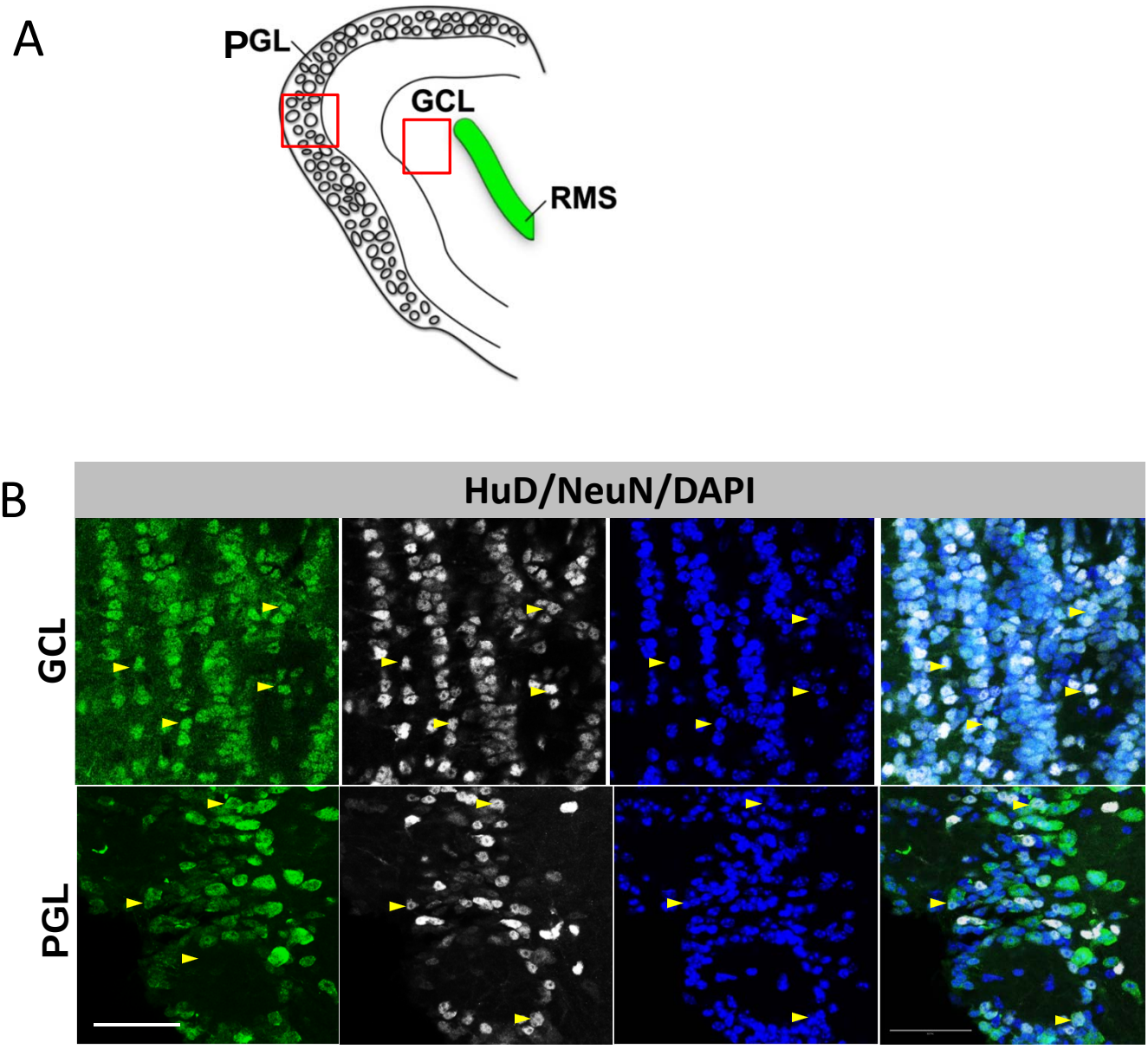


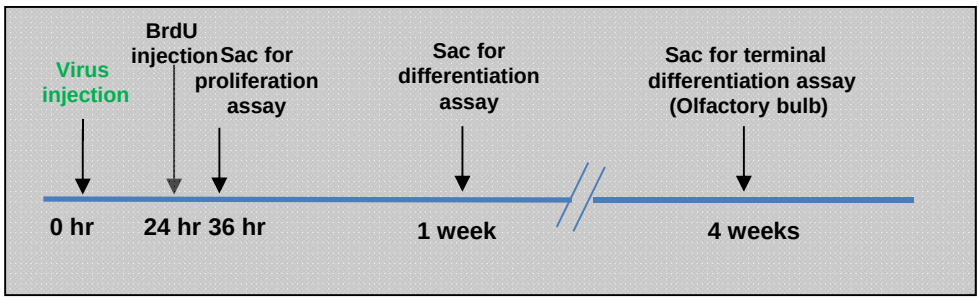
Figure S1. HuD localization in the adult olfactory bulb.

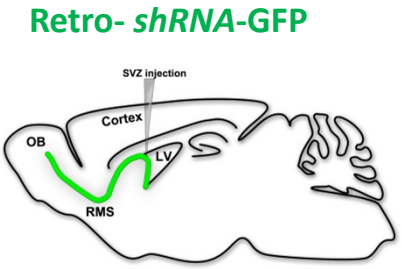
A. Schematics of the olfactory bulb structure. Boxed regions indicates where the images were taken from for B. PGL: Periglomerular layer; GCL: granule cell layer; RMS: the end of rostral migratory stream.

B. Brain section containing the olfactory bulb from adult mice were co-stained with antibodies for HuD and for a neuronal marker NeuN. Images were taken from PGL and GCL of the Olfactory bulb. Arrows indicated the colocalized cell. HuD: Green; NeuN: Gray; DAPI, Blue. Scale bar, 50 μm

A

B





C

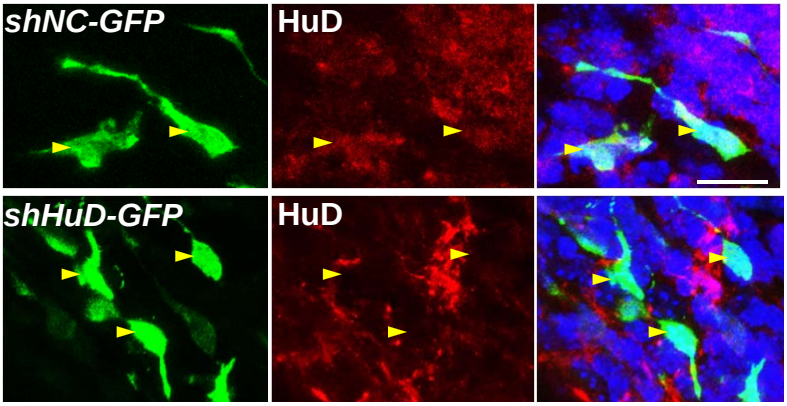


Figure S2. Strategy for investigating the role of HuD in adult SVZ neurogenesis using retrovirus targeting.

A Schematic drawing of the retrovirus expressing shRNA and GFP.

B. Experimental scheme for analyzing proliferation of retrovirus infected NPCs in the adult SVZ.

C Mice were injected with retro *shNC*-GFP or retro-*shHuD*-GFP and stained with HuD antibodies (G-2). At 1 weeks post-viral injection, Retro-*shHuD*-GFP infected cells in the OB exhibit significantly reduced HuD expression compared to control shNC virus infected cells. Arrowheads point to viral transfected GFP-positive cells in RMS. Scale bar: 20 μm

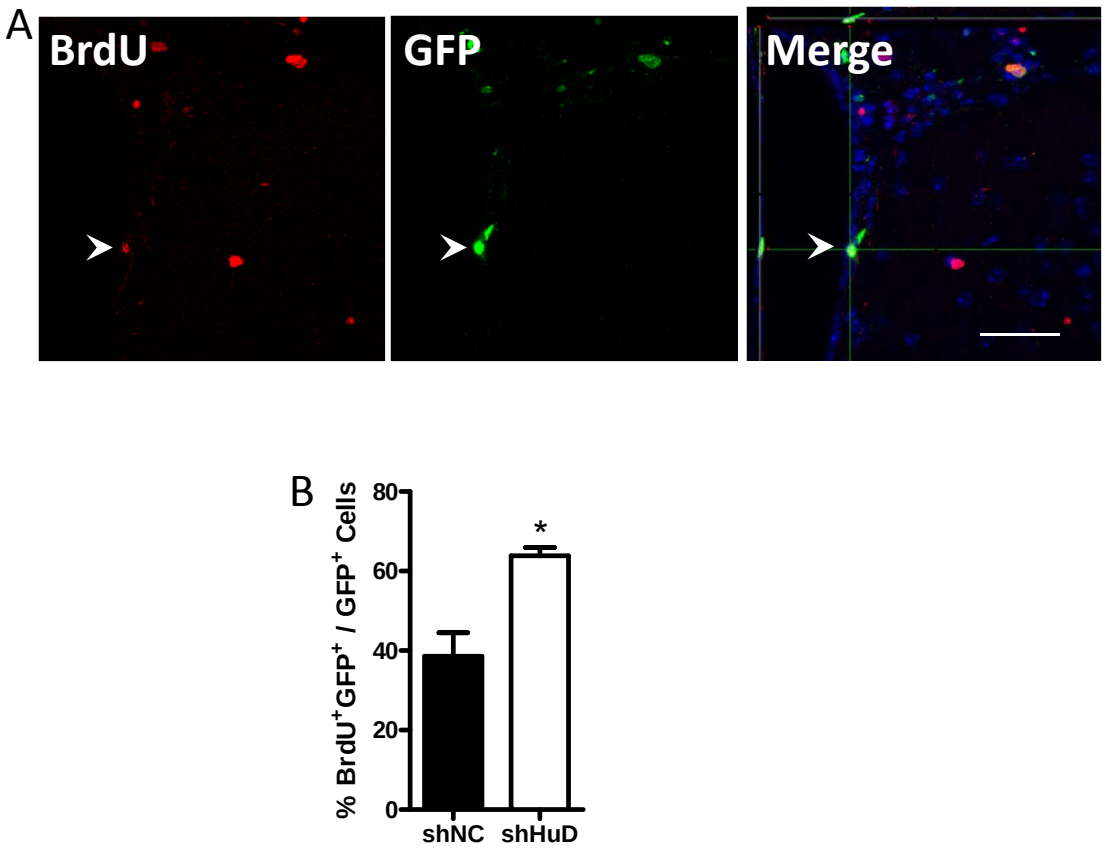
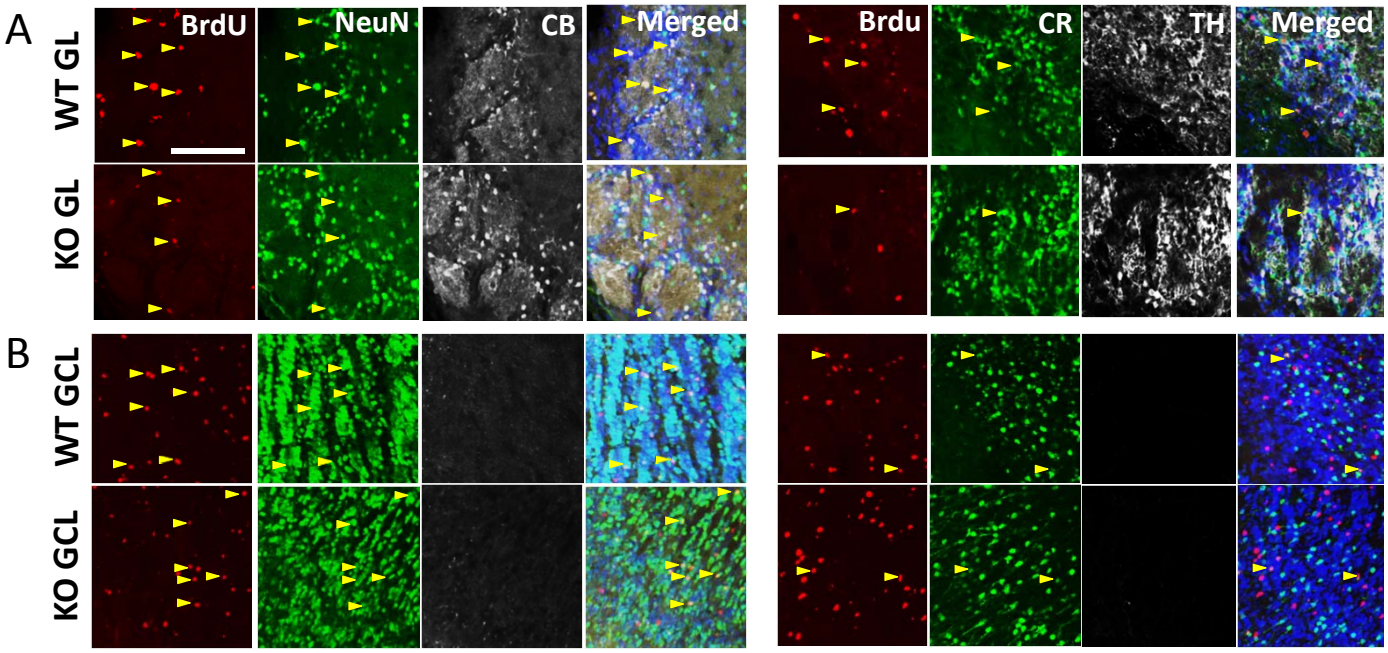


Figure S3. Acute knockdown of HuD increased the proliferation of adult SVZ NSCs.

A. A representative image of BrdU and GFP double-labeled cells in that adult SVZ. Scale bar: 50 μm.

B. Quantification of the percentage of $BrdU^+$ cells among cells with HuD acute knockdown (shHuD) compared to control (shNC) cells. n=4 mice/ condition. *, $p < 0.05$. Student's *t* test. Data are expressed as mean ± SEM.

Wang_Fig.S4


A
WT GL
KO GL
BrdU
NeuN
CB
Merged
Brdu
CR
TH
Merged
B
WT GCL
KO GCL

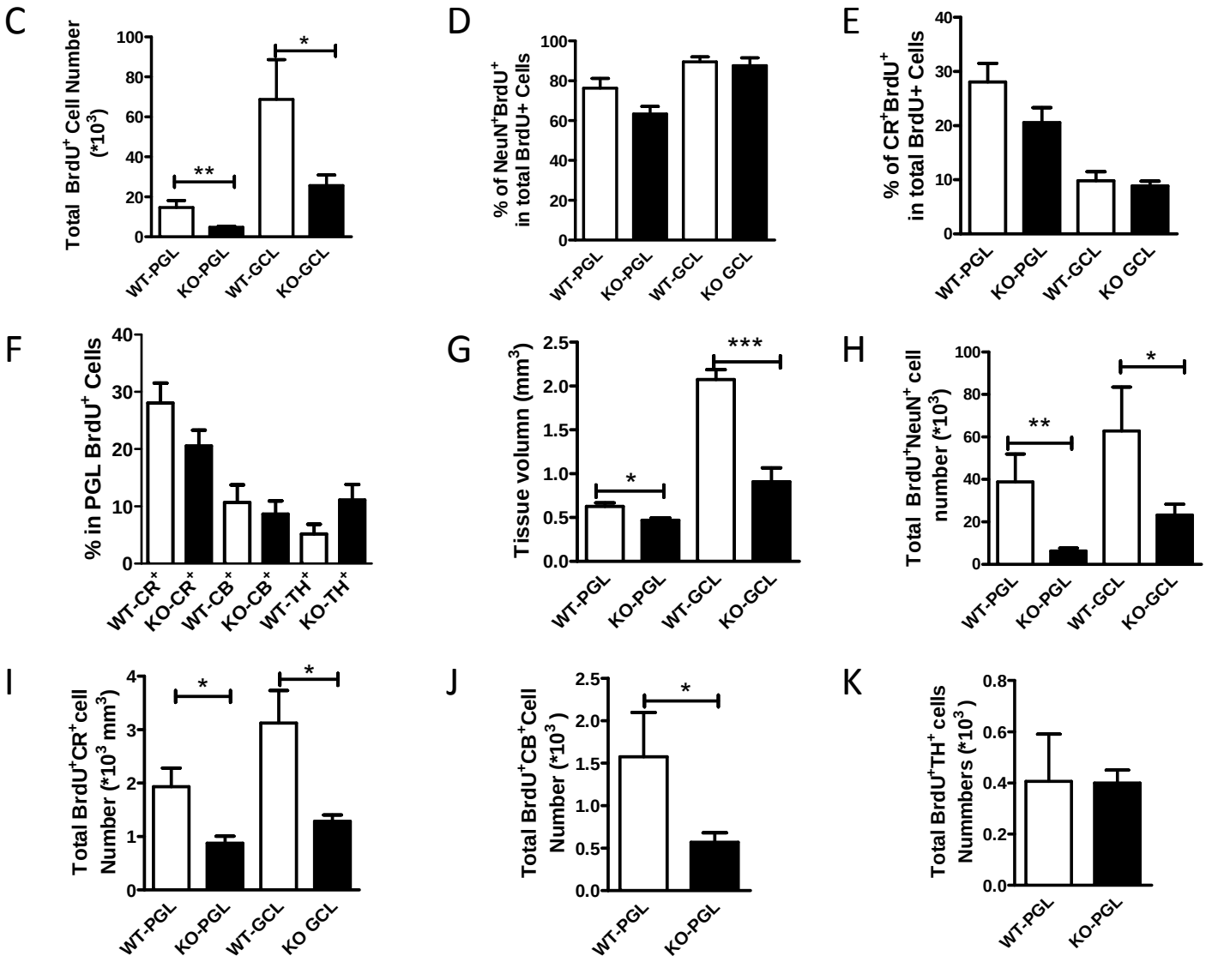

C
Total BrdU+ Cell Number (*10^3)
WT-PGL
KO-PGL
WT-GCL
KO-GCL
D
% of NeuN+BrdU+ in total BrdU+ Cells
E
% of CR+BrdU+ in total BrdU+ Cells
F
% in PGL BrdU+ Cells
WT-CR+
KO-CR+
WT-CB+
KO-CB+
WT-TH+
KO-TH+
G
Tissue volumn (mm3)
H
Total BrdU+NeuN+ cell number (*10^3)
I
Total BrdU+CR+cell Number (*10^3 mm^3)
J
Total BrdU+CB+Cell Number (*10^3)
K
Total BrdU+TH+ cells Nummbers (*10^3)

Figure S4. HuD mutant mice exhibit reduced production of adult-born new neurons in the olfactory bulb.

A-B. Sample confocal images showing the expression patterns of various neuronal markers, NeuN (pan-neuronal marker), calbindin (CB), Tyrosine hydroxylse (TH), and calretinin (CR) among BrdU- labeled new neurons in the periglomerular layer (PGL) and granule cell layer (GCL) of olfactory bulb of both HuD WT and KO mice. NeuN, pan-neuronal marker;. z-stack projections of confocal series. Yellow arrows point to double-labelled cells (Merge, yellow). BrdU, Red; TH and CB, Grey; NeuN and CR, green; DAPI, blue. Scale bar : 50 µm.

C. Quantitative results of the total number of $BrdU^+$ cells in the PGL and GCL of HuD KO (n=7) and WT (n=4) mice.

D-G. Quantitative results of the percentage of NeuN (D), CR (E), TH and CB (F) positive cells among total $BrdU^+$ cells in the GL or GCL of HuD KO (n=7) and WT (n=4) mice. Note, same data for CR cells were used in E and F for comparisons with other data. WT *vs* KO, *, $p < 0.05$; ***, $p < 0.001$. Student's *t* test. Data are expressed as mean ± SEM.

G. Quantification of the volumes of the GL and GCL in HuD KO (n=7) and WT (n=4) mice.

H-K. Quantitative results of the total number of $BrdU^+$ cells co-expressing NeuN (H), CR (I), CB (J), and TH (K) in the GL or GCL of HuD KO (n=7) and WT (n=4) mice.

Wang_Fig. S5

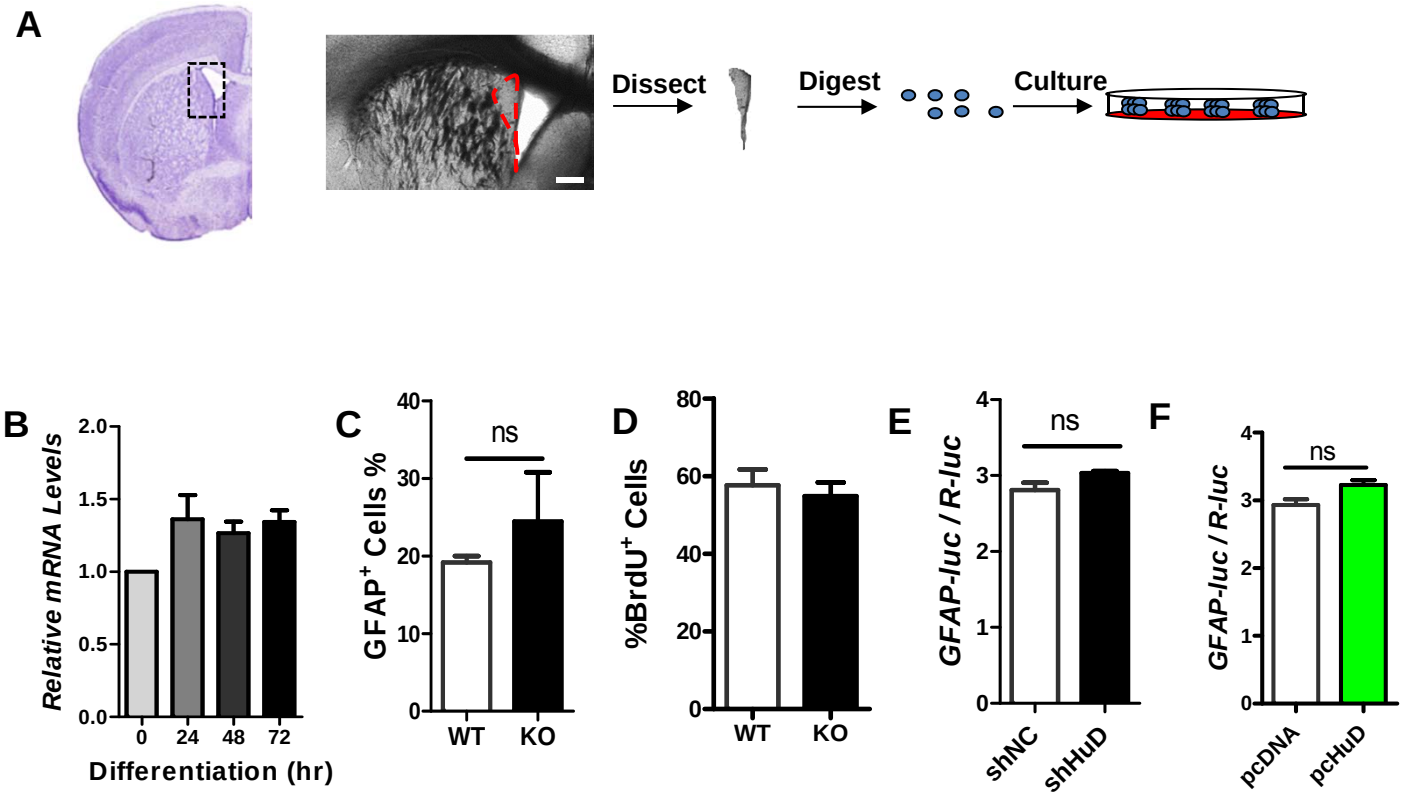


Figure S5. HuD deficiency has no significant effect on glia differentiation

A Schematic drawing showing the isolation of adult SVZ-NSCs.

B Quantitative RT-PCR analysis for HuD mRNA expression at different time points of differentiation; GAPDH mRNA was used as a control. n=3. RM-ANOVA. $p < 0.05$.

C Quantitative analysis showing no significant change in the percentage of HuD KO aNSCs differentiated $GFAP^+$ positive astrocytes as compared with WT control cells (n=6).

D Quantitative analysis showing no significant difference in BrdU incorporation between HuD KO and WT control aNSCs (n = 5; p = 0.6). Data are expressed as mean ± SEM.

E-F Quantitative analyses showing that, under differentiation conditions, HuD knockdown by shRNA (E) or overexpression by pc-HuD (F) has no significant effect on the promoter activity of transfected GFAP promoter-driven firefly luciferase (GFAP-Luc) construct (n = 3).

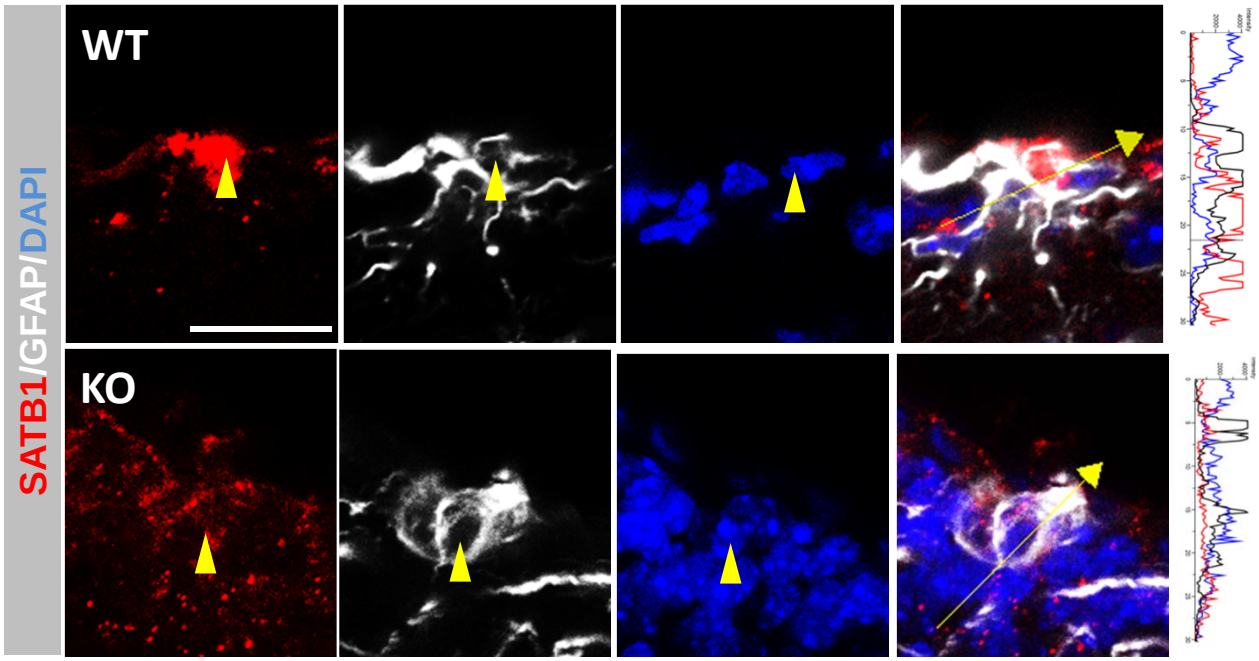


Figure S6. Reduced SATB1 levels in HuD-deficient cells.

A. SATB1 protein expression in SVZ type A Cell of HuD KO and WT mice were detected by using antibodies against SATB1 (red) and GFAP (grey) (Dapi in blue) followed by confocal imaging. Scale bar: 20 μm.

B. Fluorescence intensity profiles for red (SATB1), Grey (GFAP) and Blue (DAPI) channels measured along yellow lines shown in the merged channel. Arrows indicated the $GFAP^+$ cells.

Wang_Fig. S7

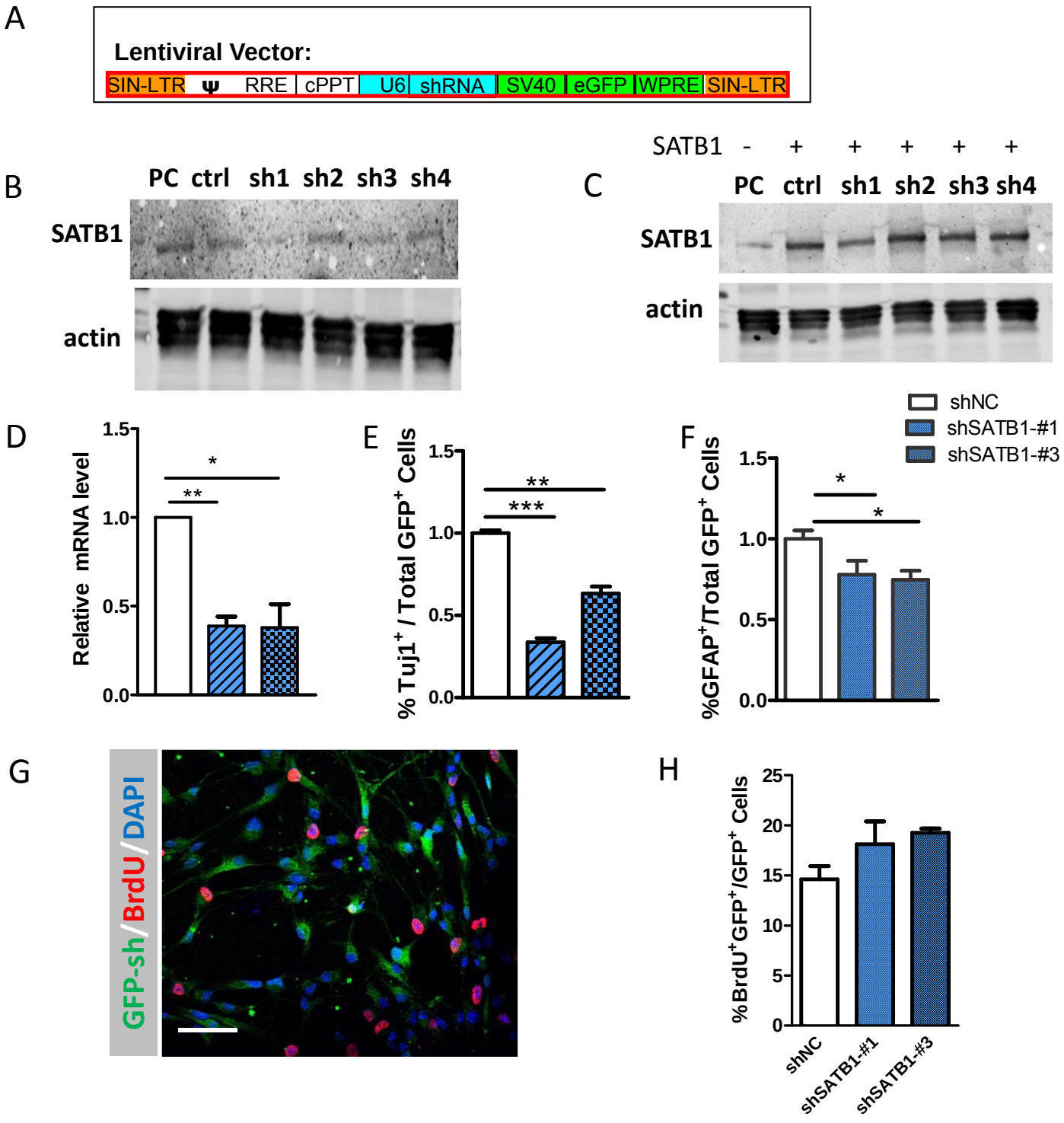

A
Lentiviral Vector:
SIN-LTR
Ψ
RRE
cPPT
U6
shRNA
SV40
eGFP
WPRE
SIN-LTR
B
PC ctrl sh1 sh2 sh3 sh4
SATB1
actin
C
SATB1 - + + + + +
PC ctrl sh1 sh2 sh3 sh4
SATB1
actin
D
Relative mRNA level
1.5
1.0
0.5
0.0
*
**
E
% Tuj1+ / Total GFP+ Cells
1.5
1.0
0.5
0.0
**
***
F
shNC
shSATB1-#1
shSATB1-#3
%GFAP+/Total GFP+ Cells
1.5
1.0
0.5
0.0
*
*
G
GFP-sh/BrdU/DAPI
H
%BrdU+GFP+/GFP+ Cells
25
20
15
10
5
0
shNC
shSATB1-#1
shSATB1-#3

Figure S7: SATB1 deficiency does not affect NSC Proliferation or astrocyte differentiation

A. Lentiviral vector expressing shRNA also expressed eGFP.

B-C. Selection of shRNA against SATB1 (*shSATB1*): Neuro-2a cells (B) or HEK293 cells (C) were transfected with indicated four different *shSATB1* (sh1, sh2, sh3, sh4) and control (Ctrl). Cells were lysed 48 hours after transfection and the protein level of SATB1 was analyzed by Western blotting with SATB1 antibodies. β-Actin was used as a loading control.

D. NSCs infected with Lentivirus *shNC* or *shSATB1* ($1^{\#}$ and $3^{\#}$) were collected 60 hours later. RT-PCR identified the SATB1 knockdown efficiency from three independent experiments. *Paired t*-test. **, $p < 0.01$.

E-F . High-content image analysis by Operetta indicated that Lenti-sh*SATB1* (1# and 3#) infected WT aNSCs differentiated into fewer neurons (E) and astrocytes (F).

G-H. Lenti-*shSATB1*-infected cells exhibit no difference in proliferation. (G) Representative images used for quantification (BrdU in red, DAPI in blue, GFP, Green). Bars: 50 μm. The results were normalized to control. (H) Quantitative analysis showing no significant change in the percentage of Lenti-*shSATB1*-infected aNSCs incorporating BrdU compared with Lenti-*shNC*-infected aNSCs (n = 3). *shSATB1* vs *shNC.* *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$. Student's *t* test. Data are expressed as mean ± SEM.

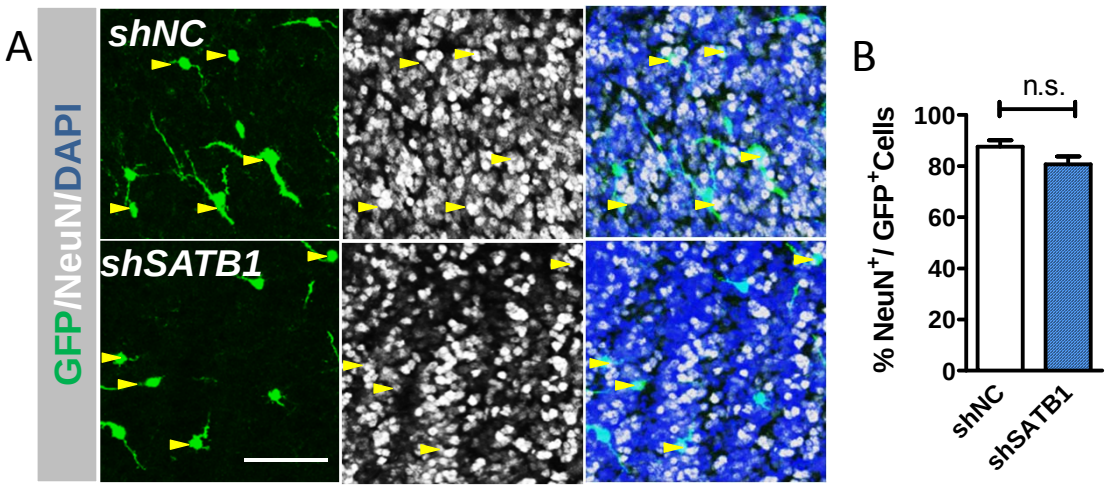


Figure S8: SATB1 deficiency does not affect SVZ NSC terminal differentiation
(A) Representative confocal images of immunohistological analysis showing that *Retrovirus*-infected cells in the granule cell layer (GCL) of olfactory bulb differentiated into NeuN$^+$ neurons at 4 weeks post-virus injection. GFP, Green; NeuN, Gray; DAPI, Blue. Arrows indicate cells that were positive for both *shRNA* (GFP) and NeuN. Scale bar, 50 μm. (B) Quantitative analyses show that acute knockdown of SATB1 in adult SVZ NSCs had no effect on the terminal differentiated into NeuN$^+$ mature neurons (n = 5 for *shNC*, n=4 for *shSATB1,* Student's *t*-test.). Data are expressed as mean ± SEM. (*), p = 0.12, student t-test.

Wang_Fig. S9

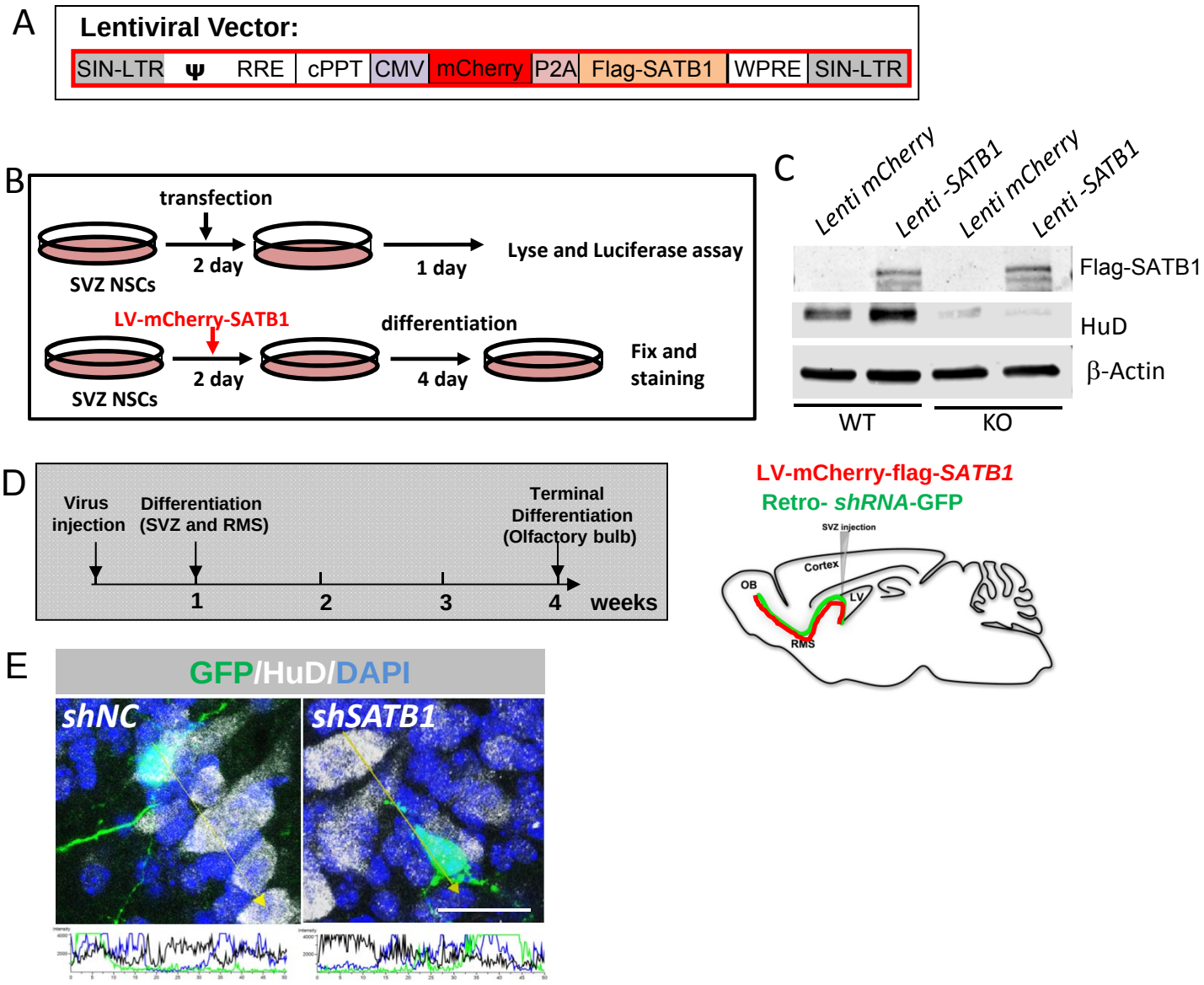


Figure S9. Overexpression and knockdown of SATB1 in adult NSCs from SVZ.

A.Schematic diagram of the Lentiviral vector used for overexpression of Flag-SATB1 and mCherry.

B.Experimental scheme for assessing the effect of exogenous SATB1 on NSCs differentiation in vitro using both promoter reporter assays and neuronal lineage gene expression analysis.

C.Western blotting showing Flag-SATB1 protein in HuD KO and WT aNSCs at 48 hours after virus infection. β-Actin was used as the loading control.

D. Experimental scheme for assessing the effects of exogenous SATB1 on NSC differentiation in vivo by using retrovirus and Lentivirus co-grafting into the adult SVZ

E. Acute knockdown of SATB1 using shRNA (ShSATB1) led to reduced HuD protein levels compared to neurons infected with a control shRNA (shNC). Fluorescence intensity profiles for Green (shRNA) , Grey (HuD) and Blue (DAPI) channels measured along yellow lines shown. Scale bar: 20 μm.

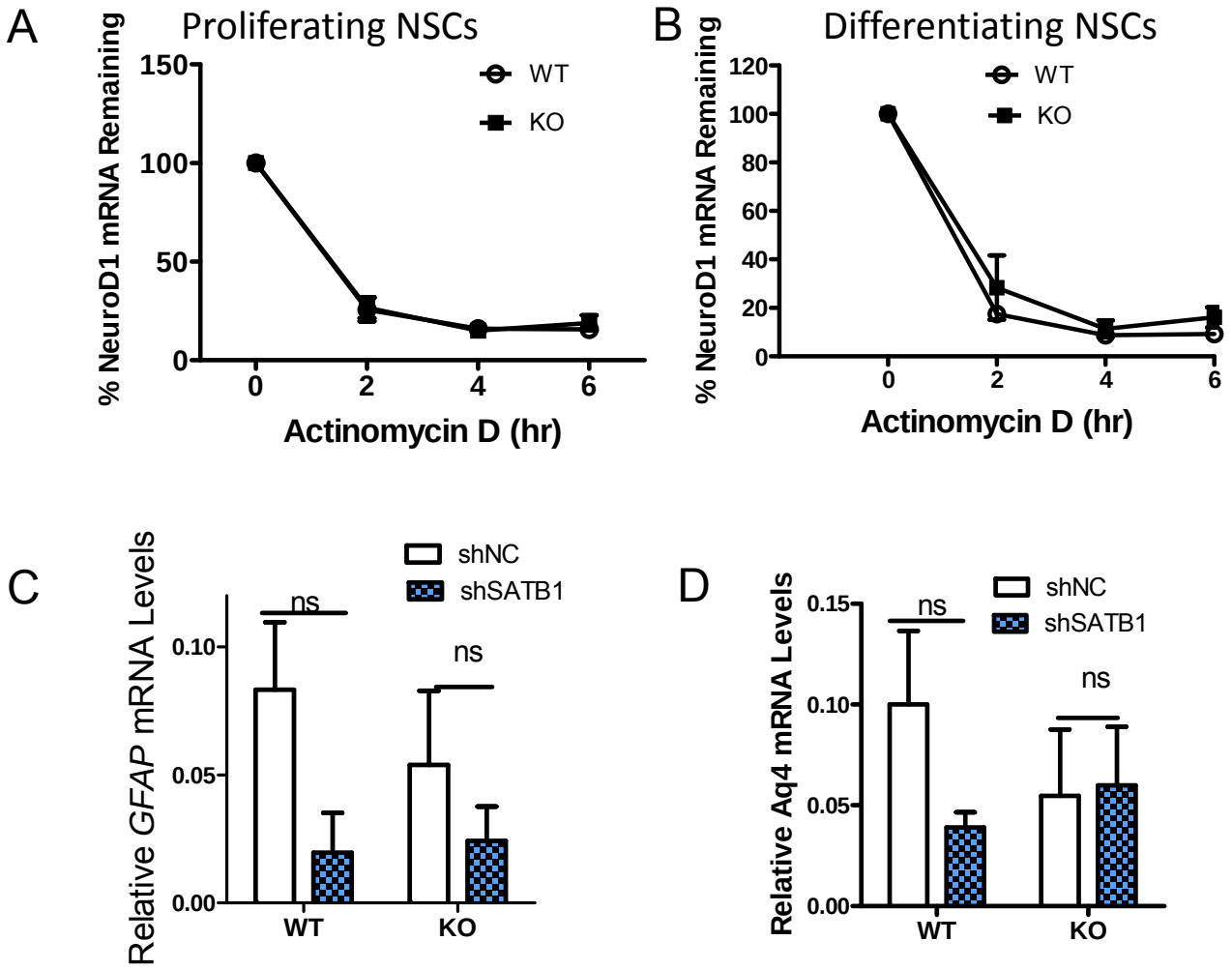


Figure S10. NeuroD1 mRNA is not a direct target of HuD

A-B. Adult HuD KO and WT NSCs in proliferating (A) and differentiating (B) conditions were treated with actinomycin D to inhibit gene transcription. The percentage of NeuroD1 mRNA in aNSCs was quantified using real-time PCR at the indicated time points (n = 3). HuD deficiency had no significant effect on NeuroD1 mRNA stability in HuD KO cells compared to WT cells. Two-way ANOVA, Bonferroni post-hoc test.

C-D. Acute knockdown of SATB1 using a Lenti-*shSATB1* virus had no effect on astrocyte differentiation as assessed by GFAP (C) and Aquaporin 4 (D, Aq4) mRNA levels in differentiating cells. n = 3. Two-way ANOVA, Bonferroni post-hoc test. Data are expressed as mean ± SEM.

Table S1 **Predicted HuD binding sites in SATB1 3'UTR**

>ENSMUSG00000023927|ENSMUST00000144331 mouse **SATB1**

```
   1 GAGAACAGTATTCTTTTCAGCCACACCACCGGTATTTCCTAACAACATGAGAAGTCCACC
  61 TTGTGTTCACTCAGACAAACCTTCATTGTTTATTGTTTGGCCAATGAATCTTCGGAAACT
 121 TGCACAAACAGGAAGGAAGTTGGAAGGACAGGACAGCCAGCACTCAAGGTTTTACTGTGT
 181 TTTACAAAACTGCTTGGCAGCCCCGGGTGAAGCGTCAAGGACTGTTTGGTAGAATTTGTG
 241 TTCAAGGGCTGCACCCAGGTGTTGTACCCTGTCAGCATGATACCAGAAATTGGTTTTCCT
 301 TTTGATTATTATTATTCTGGAGCCTCAAATAAGCATTATAACTTCTGTGGTTATGATTGC
 361 CTTTTCTTTAGTAATTCTTCTGTAACCCGCCACACTAGTCTTTGGAAACTGGCCCCTTAT
 421 TTTAAAGAGAAAAAGAAAAAAAAAAAGAGAGAGAGAGAGTTTGTTACTCGATTGTATGTT
 481 AAAAAAAAGAACTATAGACTGTGGAATGCAGTTTAAAGATGACATATGCCAACAAATGCC
 541 TTGTATTGTATGGCACTGCCGTAATTAAAATTTGTTTTTTTATTTTGGAAATAAAAGTTC
 601 ACTGTAATTTTTTTCATCCTCATTATTACATGATTTTTTTTTTAAGGAAAAGAAAATGTG
 661 AAACACAATTTAGTCCTTGTTATTTATTTGTAGCTCCTGCAGCATCATGTCATAATTAAG
 721 TTTTTTGGAGATTTCTGTTAAATGTAATGTTGCTTTCCCATCCTGATTTCCTTTCTATTT
 781 ATAACTGTATTTTGATGGGCAGTAAAACAAAGTGTCTTAAAAGTTTTAAATAGAGAAAAA
 841 TGTGCTTTACACAGTTGCCTATAAAAAGTCTATGTTATCCAAGCAATTCACTCTAGAAGC
 901 TTCGGTCTCGTTGTTGTATGCAATTTTTACTATCATGCAAATAAGCTTAGGTAAATAAAA
 961 CTAATAGATCACCTTAGAAAATTATGCAATTAATGTGAAAATAATTGATGTTTGCAATGT
1021 GTCTTCCTTTGGTTTACAATCAATTTTAAAGCGACATCTGTATAAAGTTTCTGTATAAAG
1081 GTGTATTTCTTTTTTATGAGTTTATGGCTATGAAAACACCAGCTATTTTGTTACAGCTGC
1141 TGTTTTTATAAGTGTATCACAGTTTTCTTTATGCAGAAATGTGCTGATTAGGAGTGGTTA
1201 TTGACTGTAAGTACACGATTAAAATTGTTTGTATGGTATGACATGGCAGGGTTTGTCTGC
1261 TTATGTGAAGTAACTTGAGCCAGGCTCAAGGACGGCTGTCATGTAGGTGCATGCTCACGC
1321 TTTCTTGGTGATAGCTTGTGGGTTCTGAAAAGCAACTGAACACTCCCTGAGATACTCAAT
1381 TCAAGCTACACATATGCTCAGTTTTCAATAGTTATGGAATTCCACAATGCAGATGATAAT
1441 CTGCTTTTGCTTATTACACCAGACAGTCAAAGACTCCAGCAGAAATATTACTGTAGCAGT
1501 TAAGTACTTGAGATGGCCATATCTGCTTTTTCTGTACAATCCTCCAGTTAGGGCAATATT
1561 TTCTTCAAGCTAGGGTACATTTTTTTTAAAAGCCATCAATAGCAGCATGAACAAGGGAAC
1621 GCATGGGCCTTCCGTGCGAGAATCCTTTGCAGGAAACAGTTTAGGGGAGGGGCTTGTTTG
1681 CTGGTGATTTGTTTTACAAGTCATAGGTAGGCAAGGTGAACATGGACTGCCTTTGTCAAA
1741 ACTGAGAACCACATGAAGATAGTAGGAGGCAGAGCCCTGGACTCCAAGTCTAAACTGCTG
1801 CATCATGGCCCAGGCTGGTGTGCTGTGGCTGGCTCCAGAGAAACTTTCGTAGGCTGTGTT
1861 TTTCTGTCTTTTGTATCCCTTTGTTAGGGTTCCCGTGTTGATGGGGATATTTAGGTTTGT
1921 GGAGCCAGGCTCTGTAGCTACTGTCTTCCGGGGGAGCATTTCCTCAGGCCTGGGCAGCTC
1981 CATTCTGGTGGCTGCAGGGCTTTCCTGGTGGTCTAAATGGGCTCCTTGAAAACTCCACTG
2041 AGGGATTTACTTCGAAGCACAGCTGAGCACCTTGGAAGGCTGCTGTTCTGCTGCAAACTA
2101 ATTTCTGATTCTTAAGTGAGAGAGAAAACAATGCAAACTTTCTTGTTCGCTGGAGTTGAG
2161 CAAAGTAATTACTTGAGCCAAAGGCATTTGAACGGAGATAATGCAAGCTAATTTTAAATG
2221 TTAAAAACAACAACAACAACAAAACCCCCAAAACAAGTAACATGCTGCTAACCACAGATT
2281 ATCATCTGTGGCCTCCTTTTCCCAGATTTAAGAATGGATGGAGCATCATGTAGAATTGAT
2341 GCCTTTTTTATTTAAAACAGCCCAACACTTAAGATATCAGATAGGTGTAAAATTCAATAG
2401 TTATTTAGAAGGAGGAAGATTTTTCCTGTTCCTAACAGTCTGAGTTATTTTGAATTGATG
2461 TATCCAAGGAAATGAGTGTGTTGGAAAGCAACACCATTGTGCCAGCAAAATTATCAGATT
2521 TTTAAAATTTCAGGTCAGCATGGTTTTGTTACTTTAGAATAAAGCACATGTTTGCAAGCC
2581 ACGATGGTCACAATGGAGTGGGCAAAACTGTTGAAGACAGCGTATTTCAGAAGATTTCCC
2641 CTAGTGATCCACATTGTCCCCAGCTCCCAACGTCATTGTCACCCATGTGTCTCTGGTTGC
2701 CTATGGCTGTTGGTAAAATTCCTTTAACAAGCTTCATTGTGTCCCAGCGTTTCGGCTGGG
2761 CATGACATAGTGCTTTGTGCTGTTAGAACCTTAGCAGAGTCAGGTAATTTCCGGGTAGTA
2821 GTCAGTTGTGTGCATCTGAGTCTGTCATAGCATCCTACACTCAGCACTTTGCCACTAATT
2881 TGTATTACACTCTGTGGCCATATAATACCTGCACATTATGCAAAAAATGTTGTTGACAGT
2941 ATCTTCTTGCCACACAATATGCAGAGTTGACACATAACCTTTGAAAACAAAGGTGACTAG
3001 TATGTGTGCCCTACCTGTGTGGCACTTAGTAACAAAGTCTGTACATATGTATAAAATGCG
3061 TATTGACTGGCATTTAGTACTATGAAATTCTGAGCTTAAGCGTCTGCCCCTAGTAGTATC
3121 TATAGTTAACAATGCATATTGAAAATACATAGCTTAAATAAAAAAAAAATTTAAATGGTTC
3181 AGAAGTGATTGGAAATGAGTGTCCCACACCTGCTATTATTAAATTCTTCCCTGGTCCCAG
3241 TTGTTCACATTTGGCTAACAAGGTCCTTGATTGTCACAGTATTTTCAATAAATGAGCTAT
3301 TATGAACTGCCTGGTGATATTTTCAGCAAGAGCAACTAAAATGTGTATGGCCTGTGCTAT
3361 ATAGCCATGGAGGAGATGGGACTGTGCTAAAGCCAGCCAGAAATGTGGATGGCAGTGTGG
3421 GAACCCAGCAGCTCCATAGCCATCAAAAAACGGTCATAGAAAGAAGTCTCTCAAGGGCCT
3481 ATTCTTGGATTCAGTGTTCCCTCAGAAGCAATCCTTTAAATGTAAATAGTGAATACTTGC
3541 ATGTCTTTGGACAAAAGCTGAGCTACAATCTATTAAAATGCACAATTTTTGATAAAATAT
3601 AAAGTGCCCTCTAACAAAATGTGGTGGAAGGTGTGTGTTAAGAATACTATACCTGTTTAA
3661 CAATACCATATGCTAAATAAAAATAGTTTGGAATTAATGTTTAAAACATGA
```

ARE and HuD binding motifs:

AUUUA	667	681	776	1908	2044	2305	2349	2402	3071	3167				
ARED														
U-RICH	293	564	565	566	567	568	569	570	622	623	1083	1085	1854	1856
GRE														
MOTIF 1	2290													
MOTIF 2														
MOTIF 3	1578	2343	2344											

Table S2 Neurogenesis Pathway Array Analysis

well	UniGene	RefSeq	Description	Gene Name	Ct WT-NC	Ct WT *shSATB1* -1	Ct WT *shSATB1* -3	Ct HuD KO-NC	Ct HuD *shSATB1* -1	Ct HuD *shSATB1* -3
A01	Mm.489229	NM_009599	Ache	Acetylcholinesterase	27.90345383	27.93815422	27.9196701	26.88892937	26.89079666	26.89170074
A02	Mm.298908	NM_001008533	Adora1	Adenosine A1 receptor	26.90132141	26.89261627	26.87787628	25.87396812	25.87826347	26.88079071
A03	Mm.333734	NM_009630	Adora2a	Adenosine A2a receptor	30.88825989	30.89371681	30.8926506	30.8999958	29.88829041	30.88368034
A04	Mm.311854	NM_007439	Alk	Anaplastic lymphoma kinase	34.94376373	32.90607452	33.9318924	31.91064262	33.91202927	32.91744995
A05	Mm.490092	NM_009685	Apbb1	Amyloid beta (A4) precursor protein-binding, family B, member 1	27.9100914	27.95727921	27.91971397	26.94914436	27.94820976	26.89941025
A06	Mm.305152	NM_009696	Apoe	Apolipoprotein E	23.90409851	24.88652802	24.88489151	23.90422058	23.88722801	23.88778496
A07	Mm.38594	NM_007488	App	Amyloid beta (A4) precursor protein	22.87862587	22.86969757	23.86856461	22.87172699	22.88491249	23.87265205
A08	Mm.56897	NM_009711	Artn	Artemin	33.89748383	31.88915253	31.90715599	30.90592194	32.88489914	32.88909149
A09	Mm.136217	NM_008553	Ascl1	Achaete-scute complex homolog 1 (Drosophila)	26.89448547	26.89171791	26.88903427	26.89629745	26.88881874	27.91994476
A10	Mm.43133	NM_174991	Bcl2	B-cell leukemia/lymphoma 2	27.90400696	27.88281441	27.87897301	26.88977814	26.87964058	27.88003731
A11	Mm.1442	NM_007540	Bdnf	Brain derived neurotrophic factor	27.92092133	26.8907814	26.88463211	26.89100647	26.89339828	26.88539886
A12	Mm.42160	NM_009757	Bmp2	Bone morphogenetic protein 2	31.93306923	30.90365028	30.882864	30.91160965	30.9012928	31.88921165
B01	Mm.103205	NM_007553	Bmp4	Bone morphogenetic protein 4	31.89161491	31.8870945	32.92511368	30.89529037	31.88655472	31.91690445
B02	Mm.6813	NM_007554	Bmp8b	Bone morphogenetic protein 8b	32.9097023	31.89691162	31.89102936	31.90106201	31.88669968	31.91465378
B03	Mm.439764	NM_007559	Cdk5r1	Cyclin-dependent kinase 5, regulatory subunit 1 (p35)	31.90408707	30.89971542	30.88034439	30.89199638	30.88786316	30.89988327
B04	Mm.474282	NM_009871	Cdk5rap2	CDK5 regulatory subunit associated protein 2	28.92544174	28.92141724	29.92201233	28.91614342	28.92321205	28.91771507
B05	Mm.289427	NM_025876	Chrm2	Cholinergic receptor, muscarinic 2, cardiac	32.90487289	32.90282822	32.90312958	31.88671875	32.89252472	31.88369751
B06	Mm.379344	NM_145990	Creb1	CAMP responsive element binding protein 1	26.87447548	26.86423111	26.86115646	26.89428329	26.89138031	27.89889336
B07	Mm.28297	NM_030248	Cxcl1	Chemokine (C-X-C motif) ligand 1	32.87202835	32.86526489	31.87809944	31.86631393	31.86868858	31.88101959
B08	Mm.448632	NM_203491	Dcx	Doublecortin	31.88793373	31.88602829	31.88768578	31.8977108	32.90001297	31.8847065
B09	Mm.21013	NM_008176	Dlg4	Discs, large homolog 4 (Drosophila)	27.89653397	27.91285324	27.87984848	27.89746666	26.87721825	27.884655
B10	Mm.27256	NM_007864	Dll1	Delta-like 1 (Drosophila)	28.87696838	29.88098717	29.87809944	29.87141418	29.87615585	30.88532639
B11	Mm.4875	NM_007865	Drd2	Dopamine receptor D2	32.89770508	32.8829422	31.87721252	31.88339424	32.89422226	30.89233971
B12	Mm.41970	NM_010077	Dvl3	Dishevelled 3, dsh homolog (Drosophila)	26.90777588	26.8992939	26.88876343	26.90452766	26.93175125	26.88354874
C01	Mm.167154	NM_013503	Efnb1	Ephrin B1	28.95910263	27.89653969	28.94184685	27.89834785	27.90935516	28.92549324
C02	Mm.272443	NM_007889	Egf	Epidermal growth factor	31.93475151	31.93272018	31.94205475	31.94110489	30.91928673	30.95841026
C03	Mm.3374	NM_010110	Ep300	E1A binding protein p300	26.89498138	26.90033913	27.9131546	27.92102623	26.89182472	27.89821815
C04	Mm.252481	NM_010113	Erbb2	V-erb-b2 erythroblastic leukemia viral oncogene homolog 2, neuro/glioblastoma derived oncogene homolog (avian)	29.89756966	29.92782784	30.97426605	29.8801384	29.90661049	30.93889236
C05	Mm.258397	NM_177821	Fgf2	Fibroblast growth factor 2	32.91116333	31.88054848	31.88004875	31.88695717	31.88539124	31.88087845
C06	Mm.290822	NM_001003817	Flna	Filamin, alpha	23.87636566	23.88304901	24.88204575	23.89210129	23.87967491	23.88017273
C07	Mm.5264	NM_183171	Gdnf	Glial cell line derived neurotrophic factor	33.87715149	32.87593842	32.88297272	31.87543106	32.87644196	32.88038635
C08	Mm.7995	NM_010200	Gpi1	Glucose phosphate isomerase 1	22.92717361	22.93139267	22.8992424	21.87841988	21.88324928	21.88695335
C09	Mm.473689	NM_008006	Grin1	Glutamate receptor, ionotropic, NMDA1 (zeta 1)	30.93754578	30.90067291	30.92127037	30.88683891	31.96121025	30.89663887
C10	Mm.295533	NM_010227	Hdac4	Histone deacetylase 4	26.93867874	26.9149971	26.90995026	25.89623833	25.89413643	25.89572144
C11	Mm.4679	NM_010275	Hes1	Hairy and enhancer of split 1 (Drosophila)	26.90190315	26.89678001	26.89422226	25.89785194	25.90530014	26.89334297
C12	Mm.251445	NM_010308	Hey1	Hairy/enhancer-of-split related with YRPW motif 1	27.97978783	27.94579315	27.92302132	27.95269775	27.92761993	27.89291763
D01	Mm.589	NM_008155	Hey2	Hairy/enhancer-of-split related with YRPW motif 2	36.99052811	36.99128342	37.03574371	36.98303604	37.02524948	37.00408554
D02	Mm.278672	NM_008169	Heyl	Hairy/enhancer-of-split related with YRPW motif-like	33.9117012	32.88592529	33.92979813	32.91477966	32.89339066	32.89118195
D03	Mm.318567	NM_207225	Il3	Interleukin 3	34.88872147	33.92816544	33.91020966	33.89620209	34.90974808	32.89600372
D04	Mm.384027	NM_019572	Mdk	Midkine	27.8790226	27.87671852	27.87769699	28.90209579	27.87232971	28.91036415
D05	Mm.390859	NM_008235	Mef2c	Myocyte enhancer factor 2C	26.89280128	27.89439774	27.88311958	26.8907795	26.8799572	27.88485146
D06	Mm.29581	NM_010423	Mll1	Myeloid/lymphoid or mixed-lineage leukemia 1	27.91326332	27.89599609	27.90416527	27.91281319	27.93081665	28.95409012
D07	Mm.103573	NM_013904	Mtap2	Microtubule-associated protein 2	23.88782692	23.89211273	24.88895035	23.88988495	23.89306068	25.90122795
D08	Mm.103615	NM_013905	Ndn	Necdin	26.88747597	26.88993454	26.89224052	27.90651321	26.90249062	27.89109802
D09	Mm.983	NM_010556	Ndp	Norrie disease (pseudoglioma) (human)	26.8966198	27.8885498	27.88119316	26.89194489	26.88352585	27.88710022
D10	Mm.8042	NM_008380	Neurod1	Neurogenic differentiation 1	28.88212013	29.88816071	29.87861443	28.88020325	29.87856293	29.88238335
D11	Mm.906	NM_010784	Neurog1	Neurogenin 1	34.93247604	32.891819	32.88395309	32.92961121	33.92582321	33.90214157
D12	Mm.451574	NM_025282	Neurog2	Neurogenin 2	32.8987999	32.91126633	33.888134	31.89035225	33.89188385	33.89168549
E01	Mm.2389	NM_001081049	Nf1	Neurofibromatosis 1	26.92449379	27.9929924	27.98999405	26.93790054	26.93145561	27.94079018
E02	Mm.27592	NM_019825	Nog	Noggin	30.87839508	30.90065384	30.88191032	30.88883018	30.8810482	30.8765583
E03	Mm.400253	NM_010882	Notch1	Notch gene homolog 1 (Drosophila)	26.88169861	27.89078331	27.90075493	26.89097404	26.87436104	28.90551758
E04	Mm.5014	NM_010883	Notch2	Notch gene homolog 2 (Drosophila)	28.89273262	28.88833427	29.89209175	28.90156364	28.88658142	29.88562202
E05	Mm.4636	NM_010894	Nr2e3	Nuclear receptor subfamily 2, group E, member 3	33.91773987	33.9227562	33.91111755	32.90468597	32.91175842	32.90325928
E06	Mm.135266	NM_008711	Nrcam	Neuron-glia-CAM-related cell adhesion molecule	24.89736366	24.89759636	24.89584541	24.91637039	24.91705322	24.90917969
E07	Mm.485843	NM_010928	Nrg1	Neuregulin 1	29.88864899	29.88679314	29.90759468	30.94728661	29.89093018	29.88064384
E08	Mm.5142	NM_008730	Nrp1	Neuropilin 1	26.8856411	26.88546371	26.88559914	26.89659119	26.90850639	26.91086388
E09	Mm.208439	NM_176930	Nrp2	Neuropilin 2	31.91174126	30.88805389	30.94654274	31.94632912	31.96251488	29.88660622
E10	Mm.460675	NM_178591	Ntf3	Neurotrophin 3	32.87808228	31.88474274	32.86970139	31.8754406	32.88114166	32.88039017
E11	Mm.271745	NM_008737	Ntn1	Netrin 1	25.87339211	25.88557243	26.86993408	25.86923599	25.87121773	27.87223816
E12	Mm.266341	NM_010939	Odz1	Odd Oz/ten-m homolog 1 (Drosophila)	32.89930725	31.89559555	29.90012932	31.88899231	31.88502312	29.89035797
F01	Mm.39095	NM_008744	Olig2	Oligodendrocyte transcription factor 2	23.90414429	23.91029167	24.90898514	23.91785812	22.89581871	24.91768646
F02	Mm.327698	NM_011855	Pafah1b1	Platelet-activating factor acetylhydrolase, isoform 1b, subunit 1	22.86847687	23.91185188	22.87950897	22.89749336	22.8698349	22.86783791
F03	Mm.397111	NM_013625	Pard3	Par-3 (partitioning defective 3) homolog (C. elegans)	27.88473701	27.88202667	27.88882256	27.88817215	27.9035778	28.89541245
F04	Mm.299254	NM_033620	Pax3	Paired box gene 3	32.88978577	31.88302803	31.88188553	31.89182663	32.88740158	31.88298988
F05	Mm.292834	NM_021409	Pax5	Paired box gene 5	30.95951843	30.96647072	30.96140671	29.94478035	29.94786263	29.95008278
F06	Mm.1371	NM_008781	Pax6	Paired box gene 6	26.87854195	26.88171768	27.89595604	26.88462257	26.87879562	27.88476753
F07	Mm.439659	NM_008782	Pou3f3	POU domain, class 3, transcription factor 3	25.8883934	25.89196396	26.89520454	25.88150787	25.88366318	26.88512802
F08	Mm.33870	NM_013627	Pou4f1	POU domain, class 4, transcription factor 1	33.90747452	32.88600159	31.89272499	33.91841888	32.8948288	31.89966965
F09	Mm.489878	NM_008900	Ptn	Pleiotrophin	20.90063667	20.89711189	20.89113045	20.94184303	19.89422607	20.89543915
F10	Mm.246550	NM_011143	Rac1	RAS-related C3 botulinum substrate 1	21.88007736	21.87465096	21.87893677	21.88352394	21.88032722	21.87764931
F11	Mm.279690	NM_008973	Robo1	Roundabout homolog 1 (Drosophila)	24.87206078	24.8859005	24.86756516	23.87114525	23.86772728	24.86894798
F12	Mm.469963	NM_009007	Rtn4	Reticulon 4	23.87704468	23.87850761	24.89391136	23.87594414	23.88164139	24.87765503
G01	Mm.310772	NM_019413	S100a6	S100 calcium binding protein A6 (calcyclin)	33.91831589	32.89329529	32.9148674	32.89700317	32.90357208	32.90316391
G02	Mm.440639	NM_194053	S100b	S100 protein, beta polypeptide, neural	25.89877129	25.93798256	25.93667603	25.96302986	24.88745308	24.88054466
G03	Mm.100144	NM_011313	Shh	Sonic hedgehog	33.97539902	32.93756485	32.9509201	32.94202423	32.91247559	31.90182495
G04	Mm.235998	NM_009115	Slit2	Slit homolog 2 (Drosophila)	29.87127113	29.86270714	29.89193916	29.86724281	29.88904953	30.86909485
G05	Mm.33903	NM_013660	Sod1	Superoxide dismutase 1, soluble	25.90285301	25.89770508	26.90199089	25.89764595	25.89888	25.89497185
G06	Mm.57202	NM_009170	Sox2	SRY-box containing gene 2	23.8975544	24.92878532	24.90265083	23.89250946	23.88902283	24.89590073
G07	Mm.289739	NM_178804	Sox3	SRY-box containing gene 3	28.90122032	29.8885746	29.89537048	29.88994408	29.90054893	29.90096664
G08	Mm.35784	NM_009237	Stat3	Signal transducer and activator of transcription 3	25.93358231	25.96151733	24.8737011	24.87660217	24.91127586	24.88930893
G09	Mm.249934	NM_011486	Tgfb1	Transforming growth factor, beta 1	31.92411423	30.89751816	30.90085411	30.89900017	30.89112282	30.91303062
G10	Mm.483249	NM_022312	Th	Tyrosine hydroxylase	31.90711975	31.88982582	31.89233398	30.89546967	31.88956833	30.90519333
G11	Mm.282184	NM_009505	Tnr	Tenascin R	32.8908844	31.88919067	31.87783241	31.87913322	31.88543701	31.8763504
G12	Mm.332314	NM_011738	Vegfa	Vascular endothelial growth factor A	26.91632462	26.90437889	26.9052887	26.94756126	25.9080143	26.89387321
H01	Mm.3317	NM_010368	Actb	Actin, beta	19.87062073	20.8976059	20.87646484	19.88553047	19.87856865	20.88313293
H02	Mm.299381	NM_013556	B2m	Beta-2 microglobulin	22.87195778	22.8662529	22.88234138	22.87187767	22.8785553	22.87582588
H03	Mm.2180	NM_008302	Gapdh	Glyceraldehyde-3-phosphate dehydrogenase	20.98473167	20.97604942	20.91680336	19.92015839	19.9172802	20.9684906
H04	Mm.304088	NM_008084	Gusb	Glucuronidase, beta	26.89107323	26.90002632	27.92186356	26.92300797	26.92694092	26.89189911
H05	Mm.391967	NM_007393	Hsp90ab1	Heat shock protein 90 alpha (cytosolic), class B member 1	20.8865509	20.88435173	21.87800598	20.87779617	20.8768692	21.89959526

well	AVG ΔC_t (Ct(GOI) - Ave Ct (HKG)) WT-NC	WT *shSATB1* -1	WT *shSATB1* -3	HuD KO-NC	HuD *shSATB1* -1	HuD *shSATB1* -3	$2^{-\Delta Ct}$ WT-NC	WT *shSATB1* -1	WT *shSATB1* -3	HuD KO-NC	HuD *shSATB1* -1	HuD *shSATB1* -3
A01	5.602466965	5.228935623	5.02457428	4.793255234	4.795153809	4.187911987	0.020582086	0.026664505	0.030722208	0.036065038	0.036017608	0.054867209
A02	4.600334549	4.185269737	3.982780457	3.778293991	3.782620621	4.177001953	0.041225061	0.054967789	0.06325045	0.072881982	0.072663737	0.055283702
A03	8.587273026	8.193207169	7.997554779	8.804321671	7.792647552	8.179891586	0.002599999	0.003416637	0.003912876	0.002236841	0.004510029	0.003448318
A04	12.64277687	10.71900692	11.03679657	9.814968491	11.81638641	10.21366119	0.000156367	0.000593277	0.000475985	0.001110197	0.000277277	0.000842135
A05	5.609104538	5.23852005	5.024618149	4.85347023	5.85256691	4.19562149	0.020487609	0.026487949	0.030721274	0.034590742	0.017306204	0.054574791
A06	1.603111649	2.185733223	1.989795685	1.808546448	1.791585159	1.183996201	0.329166256	0.219800531	0.251774541	0.285478411	0.288854493	0.440130666
A07	0.577639008	0.669154549	0.973468781	0.776052856	0.789269638	1.168863297	0.670059443	0.628875114	0.509280089	0.583962302	0.578636952	0.444771639
A08	11.59649696	9.198177719	9.012060165	8.810247803	10.78925629	10.18530273	0.00032929	0.001702443	0.001936866	0.002227671	0.00056508	0.000858852
A09	4.593498611	4.190399551	3.993938446	4.800623322	4.793175888	5.216156006	0.041420862	0.054772686	0.062763149	0.035881318	0.036067022	0.026901753
A10	5.603020096	5.180917168	4.983877182	4.794104004	4.783997726	5.17624855	0.020574197	0.027566938	0.031601193	0.036043827	0.036297205	0.02765629
A11	5.619934464	4.187730217	3.989536285	4.795332336	4.797755432	4.181610107	0.02033439	0.054874123	0.062954954	0.036013151	0.035952716	0.055107401
A12	9.632082367	8.193280602	7.987768173	8.815935516	8.805649948	9.185422897	0.001260243	0.003416463	0.00393951	0.002218906	0.002234782	0.001717561
B01	9.590628052	9.706127548	10.03001785	8.799616241	9.790911865	9.213115692	0.00129698	0.001197194	0.000956453	0.002244148	0.001128865	0.001684907
B02	10.60871544	9.19399395	8.995933533	9.805387878	9.791056824	9.210865021	0.00064041	0.001707387	0.001958638	0.001117594	0.001128751	0.001687537
B03	9.603100204	8.190053368	7.985248566	8.79632225	8.792220306	8.196094513	0.001285816	0.003424114	0.003946396	0.002249278	0.002255682	0.003409806
B04	6.62445488	6.721738243	7.026916504	6.820469284	6.827569199	6.213926315	0.010135388	0.009474475	0.007668093	0.008847777	0.008804341	0.013471681
B05	10.60388603	10.20300236	10.00803375	9.791044617	10.79688187	9.179908752	0.000642558	0.00084838	0.00097114	0.001128761	0.000562101	0.001724138
B06	4.573488617	4.162717247	3.966060638	4.798609161	4.795737457	5.195104599	0.041999367	0.055833808	0.063987742	0.035931447	0.03600304	0.027297174
B07	10.57104149	9.671705627	8.983003616	9.770639801	9.773045731	9.177230835	0.000657354	0.001226102	0.001976271	0.001144839	0.001142931	0.001727342
B08	9.586946869	9.186880493	8.992589951	9.802036667	10.80437012	9.18091774	0.001300294	0.001715827	0.001963183	0.001120193	0.000559191	0.001722933
B09	5.595547104	5.196374321	4.984752655	5.801792526	4.781575394	5.180866241	0.020681045	0.02727316	0.031582022	0.017926125	0.0363582	0.027567911
B10	6.575981522	7.179566765	6.983003616	7.775740051	7.780513	8.181537628	0.010481714	0.006898188	0.007905083	0.004563195	0.004548123	0.003444386
B11	10.59671822	9.680100822	8.982116699	9.787720108	10.79857941	8.188550949	0.000645758	0.001218988	0.001977486	0.001131365	0.00056144	0.003427682
B12	4.606789017	4.194052124	3.993667603	4.808853531	4.836108398	4.179759979	0.041041037	0.05463419	0.062774933	0.035677207	0.035009532	0.055178116
C01	6.658115768	5.719216728	6.046751022	5.802673721	5.813712311	6.221704483	0.009901647	0.018982098	0.015126783	0.017915179	0.017778627	0.013399245
C02	9.633764648	9.237410927	9.046958923	9.845430756	8.823643875	8.254621506	0.001258774	0.00165677	0.00189575	0.001087001	0.002207082	0.003274246
C03	4.593994522	4.706770325	5.018058777	5.825352097	4.79618187	5.194429398	0.041406627	0.038293137	0.03086127	0.017635764	0.035991951	0.027309952
C04	7.596582794	7.751070404	8.079170227	7.784464264	7.810967636	8.235103607	0.005166551	0.004641895	0.003697664	0.004535684	0.00445312	0.003318844
C05	10.61017647	9.180322075	8.984952927	9.791283035	9.789748383	9.177089691	0.000639762	0.001723644	0.001973602	0.001128574	0.001129775	0.001727511
C06	1.575378799	1.682570839	1.986949921	1.796427155	1.784032059	1.176383972	0.33555501	0.311527011	0.252271665	0.28788666	0.29037073	0.442459106
C07	11.57616463	10.17947903	9.987876892	9.779756927	10.7807991	10.1765976	0.000327512	0.000862326	0.000984803	0.001137627	0.000568403	0.00086405
C08	0.626186752	0.215340996	0.004146576	-0.217254257	-0.21239357	-0.816835403	0.64788661	0.861342548	0.997129939	1.162518969	1.158608834	1.761537764
C09	8.636558914	8.210995102	8.026174545	8.79116478	9.865567398	8.192850113	0.002512677	0.00337477	0.003836019	0.002257333	0.001071935	0.003417483
C10	4.637691879	4.212497139	4.014854431	3.800564194	3.798493576	3.191932678	0.040171277	0.053940132	0.061859782	0.071765576	0.071868651	0.109429022
C11	4.60091629	4.195524597	3.999126434	3.802177811	3.809657288	4.189554214	0.041208441	0.054578456	0.062537856	0.071685353	0.071314671	0.054804789
C12	5.678800964	5.234430695	5.027925491	5.857023621	5.831977081	5.189128876	0.019521382	0.026563136	0.030650927	0.017252825	0.017554965	0.027410475
D01	12.69901314	12.30002346	12.10490417	12.90432587	12.90435715	12.29621124	0.000150389	0.000198301	0.000227018	0.00013044	0.000130437	0.000198825
D02	11.61071434	10.70788517	11.0347023	10.81910553	10.7977478	10.18739319	0.000319762	0.000597868	0.000476676	0.000553509	0.000561764	0.000857608
D03	12.5877346	11.21921101	11.01511383	11.80052795	12.81410522	10.19221497	0.000162448	0.000419451	0.000483193	0.000280341	0.000138858	0.000854747
D04	5.578035736	5.177231216	4.982601166	6.806421661	5.776686859	6.206575394	0.0209336	0.027637459	0.031629155	0.008934349	0.018240804	0.013540498
D05	4.591814423	5.18878212	4.988023758	4.795105362	4.784314346	5.181062698	0.041469245	0.027417064	0.031510495	0.036018818	0.03628924	0.027564157
D06	5.612276459	5.200104141	5.009069443	5.817139053	5.835173798	6.250301361	0.020442615	0.027202741	0.031054164	0.017736448	0.01751611	0.013136262
D07	1.586840057	1.690555	1.993854523	1.794210815	1.797417831	3.197439194	0.332899808	0.30980772	0.251067201	0.288329266	0.287689041	0.109012147
D08	4.586489105	4.191110992	3.997144699	5.810839081	4.806847763	5.187309265	0.0416226	0.054745683	0.062623819	0.017814069	0.035726843	0.027445068
D09	4.595632935	5.184894943	4.986097336	4.796270752	4.787882996	5.183311462	0.041359629	0.027491035	0.031552599	0.035989734	0.036199586	0.027521226
D10	6.58113327	7.183411026	6.9835186	6.784529114	7.782920074	7.178594589	0.010444352	0.006879832	0.007902262	0.00907096	0.004540541	0.006902838
D11	12.63148918	10.18790951	9.988857269	10.83393707	11.83018036	11.19835281	0.000157595	0.000857302	0.000984134	0.000547848	0.000274638	0.000425559
D12	10.59781303	10.69972363	10.99303818	9.794678116	11.796241	11.18789673	0.000645268	0.00060126	0.000490643	0.001125921	0.000281176	0.000428655
E01	4.623506927	5.291516685	5.094898224	4.84222641	4.835812759	5.237001419	0.040568199	0.025532583	0.029260572	0.034861382	0.035016707	0.026515846
E02	8.577408218	8.191305542	7.986814499	8.793156052	8.78540535	8.172769547	0.002617838	0.003421144	0.003942115	0.00225422	0.002266363	0.003465383
E03	4.580711746	5.19579258	5.005659103	4.795299911	4.778718185	6.201728821	0.041789614	0.02728416	0.031127659	0.036013961	0.036430278	0.013586062
E04	6.591745758	6.690236473	6.996995926	6.805889511	6.790938568	7.181833267	0.010367805	0.009683629	0.007828785	0.008937645	0.009030749	0.00688736
E05	11.61675301	11.21696033	11.01602173	10.80901184	10.81611557	10.19947052	0.000318426	0.000420106	0.000482889	0.000557395	0.000554657	0.000850459
E06	2.596376801	2.196744347	2.000749588	2.820696259	2.82141037	2.20539093	0.165353238	0.218129327	0.24987014	0.14154216	0.141472116	0.21682591
E07	7.587662125	7.197217369	7.012498856	8.851612473	7.795287323	7.176855087	0.005198596	0.006814307	0.007745108	0.002164707	0.004501784	0.006911166
E08	4.584654236	4.185554886	3.990503311	4.800917053	4.812863541	4.207075119	0.041675571	0.054956926	0.06291277	0.035874013	0.035578178	0.054143234
E09	9.610754395	8.217321777	8.051446915	9.850654984	9.866872025	7.182817459	0.001279012	0.003360003	0.003769406	0.001083072	0.001070966	0.006882663
E10	10.57709541	9.677245522	9.97460556	9.779766464	10.78549881	10.17660141	0.000654602	0.001221403	0.000993904	0.001137619	0.000566554	0.000864048
E11	3.572405243	3.677776718	3.974838257	3.773561859	3.775574875	5.168449402	0.084061835	0.078140987	0.063599611	0.073121432	0.073019476	0.027806204
E12	10.59832039	8.197885895	7.005033493	9.793318176	9.789380264	7.186569214	0.000645042	0.003405575	0.00778529	0.001126983	0.001130064	0.006864788
F01	1.603157425	1.709661865	2.013889313	1.82218399	0.800175858	2.213897705	0.329155812	0.305731718	0.247604714	0.282792548	0.574279171	0.215551169
F02	0.567490005	0.695703888	-0.015586853	0.801819229	0.774192047	0.164049149	0.674789764	0.617408013	1.010862557	0.573625383	0.584715991	0.892516565
F03	5.583750153	5.185448074	4.99372673	5.792498016	5.807934952	6.191623688	0.020850848	0.027480497	0.03138618	0.018041986	0.017849965	0.013681558
F04	10.5887989	9.18248024	8.986789703	9.796152496	10.79175873	9.179201126	0.000649313	0.001721068	0.001971091	0.001124771	0.000564101	0.001724984
F05	8.65853157	8.263962173	8.066310883	7.849106216	7.852219772	7.246294022	0.002474698	0.003253116	0.00373077	0.004336942	0.004327592	0.006586401
F06	4.577555084	4.688860321	5.000860214	4.788948441	4.783152771	5.180978775	0.041881151	0.038771482	0.031231373	0.036172862	0.03631847	0.027565761
F07	3.58740654	3.693607712	4.000108719	3.78583374	3.788020325	4.181339264	0.08319228	0.077288217	0.06249529	0.072502083	0.072392281	0.055117747
F08	11.60648766	9.689386749	8.997629166	11.82274475	10.79918594	9.19588089	0.0003207	0.001211167	0.001956337	0.000276057	0.000561204	0.001705156
F09	-1.400350189	-1.80585537	-2.003965378	-1.1538311	-2.201416779	-1.808349609	2.639656475	3.496363953	4.011009485	2.225039736	4.599307889	3.502413959
F10	-0.4209095	-0.823182678	-1.016159058	-0.212150192	-0.215315628	-0.82613945	1.338771274	1.769304891	2.022527134	1.158413397	1.160957877	1.772934761
F11	2.571073914	2.176756287	1.97246933	1.775471115	1.772084427	2.165159225	0.168278887	0.221172468	0.254816512	0.292098911	0.292785411	0.222957521
F12	1.576057816	1.686232948	1.998815536	1.780270004	1.785998535	2.173866272	0.335397115	0.310737239	0.250205336	0.291128906	0.289975208	0.221615966
G01	11.61732903	10.2041048	10.01977158	10.80132904	10.80792923	10.19937515	0.000318299	0.000847732	0.00096327	0.000560371	0.000557814	0.000850515
G02	3.597784424	3.237352753	3.0415802	3.867355728	2.791810226	2.176755905	0.082595991	0.106037557	0.121448771	0.068518827	0.144404717	0.221172527
G03	11.67441216	10.24426594	10.05582428	10.8463501	10.81683273	9.198036194	0.000305951	0.000824458	0.000939497	0.000543154	0.000554382	0.00170261
G04	7.570284271	7.177346611	6.996843338	7.77156868	7.793406677	8.165306091	0.005261594	0.006908812	0.007829613	0.004576408	0.004507657	0.003483357
G05	3.60186615	3.699871445	4.006895065	3.801971817	3.803237152	3.19118309	0.082362638	0.076953383	0.062202007	0.07169559	0.071632736	0.109485894
G06	1.596567535	2.215741539	2.007555008	1.796835327	1.793379974	2.192111969	0.330662756	0.215275861	0.248694239	0.287805222	0.288495361	0.218830848
G07	6.600233459	7.191996002	7.000274658	7.794269943	7.804906082	7.197177887	0.010306988	0.006839014	0.007811013	0.00450496	0.00447187	0.006814493
G08	3.632595444	2.717632675	1.97860527	2.78092804	2.815633011	2.185520172	0.080626872	0.152023612	0.253735051	0.145498074	0.142039785	0.219832993
G09	9.623127365	8.199209595	8.005758286	8.803326035	8.795479965	8.209241867	0.00126809	0.003402452	0.00389069	0.002238385	0.002250592	0.003378874
G10	9.606132889	9.191103363	8.997238159	8.799795532	9.793925476	8.201404572	0.001283116	0.001710812	0.001956868	0.002243869	0.001126509	0.003397279
G11	10.58989754	9.183535004	8.982736588	9.783459091	9.789794159	9.172561646	0.000648818	0.00171981	0.001976637	0.001134711	0.001129739	0.001732941
G12	4.615337753	4.204857254	4.010192871	4.851887131	3.812371445	4.190084457	0.040798566	0.054226533	0.062059984	0.03462872	0.071180632	0.05478465
H01	-2.430366135	-1.81294117	-2.018630981	-2.210143661	-2.217074203	-1.820655823	5.390302113	3.513578593	4.051991033	4.627213484	4.649495566	3.532417393
H02	0.570970917	0.174320602	-0.01275444	0.776203537	0.782912445	0.172037125	0.673163605	0.886184745	1.008879899	0.583901314	0.581192324	0.887588497
H03	-1.316255188	-1.753550148	-1.978292465	-2.175515747	-2.178362656	-1.735298157	2.490188903	3.371872881	3.940264467	4.517472276	4.526395525	3.32948296
H04	4.590086365	4.710968399	5.026767731	4.827333832	4.831298065	4.188110352	0.041518946	0.038181871	0.030675534	0.035223112	0.035126458	0.054859666
H05	-1.414435959	-1.318797684	-1.017089844	-1.21787796	-1.218773651	-0.804193497	2.665555016	2.494581292	2.023832432	2.326043311	2.327487873	1.746169366

well	Fold change WT *shSATB1* -1 /WT-NC	WT *shSATB1* -3 /WT-NC	HuD KO-NC/WT-NC	HuD *shSATB1* -1/WT-NC	HuD *shSATB1* -3/WT-NC	Fold Up or down regulation WT shSATB1-1 /WT-NC	WT shSATB1-3 /WT-NC	HuD KO-NC/WT-NC	HuD shSATB1-1/WT-NC	HuD shSATB1-3/WT-NC
A01	1.295520048	1.492667347	1.752253773	1.749949338	2.665774926	1.12	1.49	1.75	1.75	2.67
A02	1.333358576	1.534271811	1.767904762	1.762610773	1.341021712	1.16	1.53	1.77	1.76	1.34
A03	1.314091612	1.504952806	0.860323622	1.734627003	1.326276373	1.15	1.50	-1.16	1.73	1.33
A04	3.794132208	3.044025197	7.099947615	1.773243252	5.385632086	4.73	3.04	7.10	1.77	5.39
A05	1.292876516	1.499505059	1.688373754	0.844715617	2.663794977	1.11	1.50	1.69	-1.18	2.66
A06	0.667749282	0.764885638	0.867277268	0.877533733	1.33710749	-1.72	-1.31	-1.15	-1.14	1.34
A07	0.938536305	0.760052103	0.871508204	0.863560625	0.663779377	1.16	-1.32	-1.15	-1.16	-1.51
A08	5.271886259	5.997814063	6.898339636	1.749861425	2.659572249	4.63	6.00	6.90	1.75	2.66
A09	1.322345398	1.51525454	0.866261971	0.870745323	0.649473517	1.15	1.52	-1.15	-1.15	-1.54
A10	1.339879192	1.535962415	1.751894736	1.764210085	1.344222116	1.17	1.54	1.75	1.76	1.34
A11	2.698587088	3.095984349	1.771046544	1.768074458	2.71005918	2.35	3.10	1.77	1.77	2.71
A12	2.710956127	3.125992233	1.760697238	1.773294828	1.362880878	2.35	3.13	1.76	1.77	1.36
B01	0.923062668	0.737446451	1.730287546	0.870379322	1.299099884	1.16	-1.36	1.73	-1.15	1.30
B02	2.66608262	3.058410177	1.745121592	1.762543196	2.635086678	2.32	3.06	1.75	1.76	2.64
B03	2.662989679	3.069176553	1.749300273	1.75428105	2.651861982	2.31	3.07	1.75	1.75	2.65
B04	0.934791575	0.756566277	0.872958875	0.868673349	1.329172698	1.16	-1.32	-1.15	-1.15	1.33
B05	1.320316379	1.511365169	1.756667829	0.874787291	2.683242192	1.15	1.51	1.76	-1.14	2.68
B06	1.329396416	1.523540634	0.855523539	0.857228167	0.649942511	1.16	1.52	-1.17	-1.17	-1.54
B07	1.865207145	3.006401876	1.741585967	1.738684008	2.627718357	1.16	3.01	1.74	1.74	2.63
B08	1.31956862	1.509799442	0.861492536	0.430050132	1.32503377	1.15	1.51	-1.16	-2.33	1.33
B09	1.318751544	1.527099906	0.866790098	1.758044648	1.333003772	1.14	1.53	-1.15	1.76	1.33
B10	0.658116436	0.754178488	0.435348142	0.433910235	0.328608999	-1.74	-1.33	-2.30	-2.30	-3.04
B11	1.887684153	3.062270055	1.751994332	0.869428208	5.307995939	1.16	3.06	1.75	-1.15	5.31
B12	1.331208816	1.529564997	0.869305686	0.853037233	1.344462054	1.16	1.53	-1.15	-1.17	1.34
C01	1.917064716	1.527703687	1.80931305	1.795522159	1.353233958	2.41	1.53	1.81	1.80	1.35
C02	1.316177187	1.501917663	0.86353939	1.753358217	2.601138363	1.15	1.50	-1.16	1.75	2.60
C03	0.924806984	0.745321998	0.42591647	0.869231675	0.659555114	1.15	-1.34	-2.35	-1.15	-1.52
C04	0.898451412	0.715692897	0.877893921	0.861913597	0.642371231	1.13	-1.40	-1.14	-1.16	-1.56
C05	2.694195223	3.08489961	1.764052421	1.765929912	2.700238382	2.35	3.08	1.76	1.77	2.70
C06	0.928393264	0.751804199	0.857941774	0.865344645	1.318588887	1.15	-1.33	-1.17	-1.16	1.32
C07	2.632959993	3.006922605	3.47354238	1.735517033	2.638223944	2.31	3.01	3.47	1.74	2.64
C08	1.329464963	1.539050079	1.794324733	1.788289517	2.718898238	1.15	1.54	1.79	1.79	2.72
C09	1.343097289	1.526665896	0.89837777	0.42661054	1.360096298	1.18	1.53	-1.11	-2.34	1.36
C10	1.34275374	1.539900834	1.786489811	1.789055698	2.724061361	1.17	1.54	1.79	1.79	2.72
C11	1.324448451	1.517598182	1.73957934	1.73058404	1.329940844	1.16	1.52	1.74	1.73	1.33
C12	1.360720038	1.570120706	0.883791122	0.899268527	1.404125695	1.18	1.57	-1.13	-1.11	1.40
D01	1.31858418	1.509539976	0.867350654	0.867331848	1.322073051	1.15	1.51	-1.15	-1.15	1.32
D02	1.869728987	1.490722827	1.731003702	1.756820188	2.682022149	2.35	1.49	1.73	1.76	2.68
D03	2.582061919	2.97444556	1.725729863	0.854782561	5.261665876	2.24	2.97	1.73	-1.17	5.26
D04	1.32024394	1.51092764	0.426794673	0.871364883	0.646830827	1.15	1.51	-2.34	-1.15	-1.55
D05	0.661142106	0.759852166	0.868567009	0.875088041	0.664689157	-1.74	-1.32	-1.15	-1.14	-1.50
D06	1.330687971	1.519089652	0.867621317	0.856842925	0.642592077	1.17	1.52	-1.15	-1.17	-1.56
D07	0.93063352	0.754182476	0.866114245	0.864191069	0.327462331	1.15	-1.33	-1.15	-1.16	-3.05
D08	1.315287436	1.504562884	0.427990306	0.858352021	0.659378997	1.15	1.50	-2.34	-1.17	-1.52
D09	0.66468283	0.762883994	0.870165777	0.875239612	0.665412776	-1.73	-1.31	-1.15	-1.14	-1.50
D10	0.658713145	0.756606287	0.868503854	0.434736519	0.660915933	-1.74	-1.32	-1.15	-2.30	-1.51
D11	5.439898276	6.244698471	3.47629884	1.742681382	2.700331201	4.74	6.24	3.48	1.74	2.70
D12	0.931798174	0.760370706	1.744888583	0.435749839	0.664304368	1.14	-1.32	1.74	-2.29	-1.51
E01	0.62937433	0.72126869	0.859327826	0.863156562	0.653611607	-1.82	-1.39	-1.16	-1.16	-1.53
E02	1.306858259	1.505866337	0.861099686	0.865738287	1.323757329	1.13	1.51	-1.16	-1.16	1.32
E03	0.652893311	0.744865911	0.861792134	0.871754349	0.325106189	-1.75	-1.34	-1.16	-1.15	-3.08
E04	0.934009601	0.755105344	0.862057644	0.871037774	0.664302611	1.16	-1.32	-1.16	-1.15	-1.51
E05	1.319318299	1.516485052	1.750468579	1.741870579	2.670819513	1.15	1.52	1.75	1.74	2.67
E06	1.319171791	1.511129407	0.855998719	0.855575118	1.311289171	1.15	1.51	-1.17	-1.17	1.31
E07	1.310797436	1.489846059	0.416402216	0.865961507	1.329429283	1.15	1.49	-2.40	-1.15	1.33
E08	1.318684421	1.509583882	0.860792363	0.853693852	1.299159998	1.15	1.51	-1.16	-1.17	1.30
E09	2.627029893	2.947123422	0.846803661	0.837338212	5.381233599	2.34	2.95	-1.18	-1.19	5.38
E10	1.865871834	1.518334701	1.737880579	0.865494528	1.31995981	2.29	1.52	1.74	-1.16	1.32
E11	0.929565561	0.75658128	0.869852918	0.868640045	0.330782735	1.14	-1.32	-1.15	-1.15	-3.02
E12	5.279621458	12.06944052	1.747148471	1.751923919	10.64239665	2.31	12.07	1.75	1.75	10.64
F01	0.928835849	0.75224166	0.859144935	1.74470312	0.654860592	1.15	-1.33	-1.16	1.74	-1.53
F02	0.914963513	1.498040739	0.850080149	0.866515799	1.32265872	-1.79	1.50	-1.18	-1.15	1.32
F03	1.317955883	1.505271185	0.865287902	0.85607862	0.656163143	1.15	1.51	-1.16	-1.17	-1.52
F04	2.650599438	3.035657866	1.732249102	0.868766378	2.656630859	2.31	3.04	1.73	-1.15	2.66
F05	1.314550346	1.507565503	1.752513253	1.74873514	2.661496278	1.15	1.51	1.75	1.75	2.66
F06	0.925750137	0.745714278	0.863702663	0.867179353	0.658190135	1.15	-1.34	-1.16	-1.15	-1.52
F07	0.92903112	0.751215024	0.871500139	0.870180272	0.662534403	1.15	-1.33	-1.15	-1.15	-1.51
F08	3.776633816	6.100208231	0.860795777	1.749935457	5.31697899	2.34	6.10	-1.16	1.75	5.32
F09	1.32455264	1.519519499	0.842927766	1.742388805	1.326844607	1.15	1.52	-1.19	1.74	1.33
F10	1.321588628	1.51073389	0.865281038	0.867181646	1.324299973	1.16	1.51	-1.16	-1.15	1.32
F11	1.314320959	1.51425123	1.73580249	1.739882026	1.324928667	1.14	1.51	1.74	1.74	1.32
F12	0.926475588	0.745997282	0.868012553	0.864572756	0.660756924	1.15	-1.34	-1.15	-1.16	-1.51
G01	2.663317121	3.026305116	1.760518009	1.752482206	2.672062721	2.34	3.03	1.76	1.75	2.67
G02	1.283809971	1.470395466	0.829566014	1.748325972	2.677763446	1.12	1.47	-1.21	1.75	2.68
G03	2.694740252	3.070743216	1.775299037	1.811995562	5.564977912	2.36	3.07	1.78	1.81	5.56
G04	1.313064386	1.488068494	0.869775871	0.856709264	0.662034442	1.16	1.49	-1.15	-1.17	-1.51
G05	0.934323918	0.755221156	0.870486804	0.869723667	1.329315044	1.16	-1.32	-1.15	-1.15	1.33
G06	0.651043568	0.752108407	0.870388987	0.872476127	0.661794665	-1.77	-1.33	-1.15	-1.15	-1.51
G07	0.663531774	0.757836642	0.437078257	0.433867786	0.66115277	-1.72	-1.32	-2.29	-2.30	-1.51
G08	1.885520412	3.147028346	1.804585382	1.761692874	2.726547467	1.13	3.15	1.80	1.76	2.73
G09	2.683131514	3.068150133	1.7651629	1.774788856	2.664538166	2.35	3.07	1.77	1.77	2.66
G10	1.333325964	1.525090367	1.748766121	0.877948009	2.647679173	1.17	1.53	1.75	-1.14	2.65
G11	2.650680037	3.046517336	1.748888661	1.741225892	2.670918384	2.31	3.05	1.75	1.74	2.67
G12	1.329128416	1.521131505	0.848772973	1.744684667	1.342808241	1.16	1.52	-1.18	1.74	1.34
H01	0.651833333	0.751718725	0.85843305	0.862566785	0.655328276	-1.77	-1.33	-1.16	-1.16	-1.53
H02	1.316447798	1.498714267	0.867398816	0.86337455	1.318533103	1.16	1.50	-1.15	-1.16	1.32
H03	1.35406309	1.582315487	1.814108267	1.817691629	1.337040317	1.16	1.58	1.81	1.82	1.34
H04	0.919625239	0.738832192	0.848362369	0.846034441	1.321316437	1.14	-1.35	-1.18	-1.18	1.32
H05	0.935858115	0.759253671	0.872630014	0.873171951	0.655086598	1.15	-1.32	-1.15	-1.15	-1.53

Table S3 Neurogenesis Pathway Array Resutls Sorted by shSATB1

well	UniGene	RefSeq	Description	Gene Name	WT shSATB1-1 /WT-NC	WT shSATB1-3 /WT-NC	HuD KO-NC/WT-NC	HuD shSATB1-1/WT-NC	HuD shSATB1-3/WT-NC
D11	Mm.906	NM_010784	Neurog1	Neurogenin 1	4.74	6.24	3.48	1.74	2.70
A04	Mm.311854	NM_007439	Alk	Anaplastic lymphoma kinase	4.73	3.04	7.10	1.77	5.39
A08	Mm.56897	NM_009711	Artn	Artemin	4.63	6.00	6.90	1.75	2.66
C01	Mm.167154	NM_013503	Efnb1	Ephrin B1	2.41	1.53	1.81	1.80	1.35
G03	Mm.100144	NM_011313	Shh	Sonic hedgehog	2.36	3.07	1.78	1.81	5.56
C05	Mm.258397	NM_177821	Fgf2	Fibroblast growth factor 2	2.35	3.08	1.76	1.77	2.70
A11	Mm.1442	NM_007540	Bdnf	Brain derived neurotrophic factor	2.35	3.10	1.77	1.77	2.71
A12	Mm.42160	NM_009757	Bmp2	Bone morphogenetic protein 2	2.35	3.13	1.76	1.77	1.36
G09	Mm.249934	NM_011486	Tgfb1	Transforming growth factor, beta 1	2.35	3.07	1.77	1.77	2.66
D02	Mm.278672	NM_008169	Heyl	Hairy/enhancer-of-split related with YRPW motif-like	2.35	1.49	1.73	1.76	2.68
G01	Mm.310772	NM_019413	S100a6	S100 calcium binding protein A6 (calcyclin)	2.34	3.03	1.76	1.75	2.67
E09	Mm.208439	NM_176930	Nrp2	Neuropilin 2	2.34	2.95	-1.18	-1.19	5.38
F08	Mm.33870	NM_013627	Pou4f1	POU domain, class 4, transcription factor 1	2.34	6.10	-1.16	1.75	5.32
B02	Mm.6813	NM_007554	Bmp8b	Bone morphogenetic protein 8b	2.32	3.06	1.75	1.76	2.64
F04	Mm.299254	NM_033620	Pax3	Paired box gene 3	2.31	3.04	1.73	-1.15	2.66
B03	Mm.439764	NM_007559	Cdk5r1	Cyclin-dependent kinase 5, regulatory subunit 1 (p35)	2.31	3.07	1.75	1.75	2.65
E12	Mm.266341	NM_010939	Odz1	Odd Oz/ten-m homolog 1 (Drosophila)	2.31	12.07	1.75	1.75	10.64
G11	Mm.282184	NM_009505	Tnr	Tenascin R	2.31	3.05	1.75	1.74	2.67
C07	Mm.5264	NM_183171	Gdnf	Glial cell line derived neurotrophic factor	2.31	3.01	3.47	1.74	2.64
E10	Mm.460675	NM_178591	Ntf3	Neurotrophin 3	2.29	1.52	1.74	-1.16	1.32
D03	Mm.318567	NM_207225	Il3	Interleukin 3	2.24	2.97	1.73	-1.17	5.26
C09	Mm.473689	NM_008006	Grin1	Glutamate receptor, ionotropic, NMDA1 (zeta 1)	1.18	1.53	-1.11	-2.34	1.36
C12	Mm.251445	NM_010308	Hey1	Hairy/enhancer-of-split related with YRPW motif 1	1.18	1.57	-1.13	-1.11	1.40
C10	Mm.295533	NM_010227	Hdac4	Histone deacetylase 4	1.17	1.54	1.79	1.79	2.72
A10	Mm.43133	NM_174991	Bcl2	B-cell leukemia/lymphoma 2	1.17	1.54	1.75	1.76	1.34
G10	Mm.483249	NM_022312	Th	Tyrosine hydroxylase	1.17	1.53	1.75	-1.14	2.65
D06	Mm.29581	NM_010423	Mll1	Myeloid/lymphoid or mixed-lineage leukemia 1	1.17	1.52	-1.15	-1.17	-1.56
B11	Mm.4875	NM_007865	Drd2	Dopamine receptor D2	1.16	3.06	1.75	-1.15	5.31
G12	Mm.332314	NM_011738	Vegfa	Vascular endothelial growth factor A	1.16	1.52	-1.18	1.74	1.34
B06	Mm.379344	NM_145990	Creb1	CAMP responsive element binding protein 1	1.16	1.52	-1.17	-1.17	-1.54
A07	Mm.38594	NM_007488	App	Amyloid beta (A4) precursor protein	1.16	-1.32	-1.15	-1.16	-1.51
A02	Mm.298908	NM_001008533	Adora1	Adenosine A1 receptor	1.16	1.53	1.77	1.76	1.34
G04	Mm.235998	NM_009115	Slit2	Slit homolog 2 (Drosophila)	1.16	1.49	-1.15	-1.17	-1.51
B12	Mm.41970	NM_010077	Dvl3	Dishevelled 3, dsh homolog (Drosophila)	1.16	1.53	-1.15	-1.17	1.34
B07	Mm.28297	NM_030248	Cxcl1	Chemokine (C-X-C motif) ligand 1	1.16	3.01	1.74	1.74	2.63
F10	Mm.246550	NM_011143	Rac1	RAS-related C3 botulinum substrate 1	1.16	1.51	-1.16	-1.15	1.32
G05	Mm.33903	NM_013660	Sod1	Superoxide dismutase 1, soluble	1.16	-1.32	-1.15	-1.15	1.33
C11	Mm.4679	NM_010275	Hes1	Hairy and enhancer of split 1 (Drosophila)	1.16	1.52	1.74	1.73	1.33
B01	Mm.103205	NM_007553	Bmp4	Bone morphogenetic protein 4	1.16	-1.36	1.73	-1.15	1.30
E04	Mm.5014	NM_010883	Notch2	Notch gene homolog 2 (Drosophila)	1.16	-1.32	-1.16	-1.15	-1.51
B04	Mm.474282	NM_009871	Cdk5rap2	CDK5 regulatory subunit associated protein 2	1.16	-1.32	-1.15	-1.15	1.33
F09	Mm.489878	NM_008900	Ptn	Pleiotrophin	1.15	1.52	-1.19	1.74	1.33
A09	Mm.136217	NM_008553	Ascl1	Achaete-scute complex homolog 1 (Drosophila)	1.15	1.52	-1.15	-1.15	-1.54
F03	Mm.397111	NM_013625	Pard3	Par-3 (partitioning defective 3) homolog (C. elegans)	1.15	1.51	-1.16	-1.17	-1.52
D04	Mm.384027	NM_019572	Mdk	Midkine	1.15	1.51	-2.34	-1.15	-1.55
B05	Mm.289427	NM_025876	Chrm2	Cholinergic receptor, muscarinic 2, cardiac	1.15	1.51	1.76	-1.14	2.68
C02	Mm.272443	NM_007889	Egf	Epidermal growth factor	1.15	1.50	-1.16	1.75	2.60
B08	Mm.448632	NM_203491	Dcx	Doublecortin	1.15	1.51	-1.16	-2.33	1.33
E07	Mm.485843	NM_010928	Nrg1	Neuregulin 1	1.15	1.49	-2.40	-1.15	1.33
E08	Mm.5142	NM_008730	Nrp1	Neuropilin 1	1.15	1.51	-1.16	-1.17	1.30
D01	Mm.589	NM_008155	Hey2	Hairy/enhancer-of-split related with YRPW motif 2	1.15	1.51	-1.15	-1.15	1.32
E06	Mm.135266	NM_008711	Nrcam	Neuron-glia-CAM-related cell adhesion molecule	1.15	1.51	-1.17	-1.17	1.31
F12	Mm.469963	NM_009007	Rtn4	Reticulon 4	1.15	-1.34	-1.15	-1.16	-1.51
D08	Mm.103615	NM_013905	Ndn	Necdin	1.15	1.50	-2.34	-1.17	-1.52
F06	Mm.1371	NM_008781	Pax6	Paired box gene 6	1.15	-1.34	-1.16	-1.15	-1.52
F07	Mm.439659	NM_008782	Pou3f3	POU domain, class 3, transcription factor 3	1.15	-1.33	-1.15	-1.15	-1.51
C08	Mm.7995	NM_010200	Gpi1	Glucose phosphate isomerase 1	1.15	1.54	1.79	1.79	2.72
D07	Mm.103573	NM_013904	Mtap2	Microtubule-associated protein 2	1.15	-1.33	-1.15	-1.16	-3.05
E05	Mm.4636	NM_010894	Nr2e3	Nuclear receptor subfamily 2, group E, member 3	1.15	1.52	1.75	1.74	2.67
C03	Mm.3374	NM_010110	Ep300	E1A binding protein p300	1.15	-1.34	-2.35	-1.15	-1.52
A03	Mm.333734	NM_009630	Adora2a	Adenosine A2a receptor	1.15	1.50	-1.16	1.73	1.33
F01	Mm.39095	NM_008744	Olig2	Oligodendrocyte transcription factor 2	1.15	-1.33	-1.16	1.74	-1.53
C06	Mm.290822	NM_001003817	Flna	Filamin, alpha	1.15	-1.33	-1.17	-1.16	1.32
F05	Mm.292834	NM_021409	Pax5	Paired box gene 5	1.15	1.51	1.75	1.75	2.66
E11	Mm.271745	NM_008737	Ntn1	Netrin 1	1.14	-1.32	-1.15	-1.15	-3.02
D12	Mm.451574	NM_025282	Neurog2	Neurogenin 2	1.14	-1.32	1.74	-2.29	-1.51
F11	Mm.279690	NM_008973	Robo1	Roundabout homolog 1 (Drosophila)	1.14	1.51	1.74	1.74	1.32
B09	Mm.21013	NM_008176	Dlg4	Discs, large homolog 4 (Drosophila)	1.14	1.53	-1.15	1.76	1.33
E02	Mm.27592	NM_019825	Nog	Noggin	1.13	1.51	-1.16	-1.16	1.32
G08	Mm.35784	NM_009237	Stat3	Signal transducer and activator of transcription 3	1.13	3.15	1.80	1.76	2.73
C04	Mm.252481	NM_010113	Erbb2	V-erb-b2 erythroblastic leukemia viral oncogene homolog 2, neuro/glioblastoma derived oncogene homolog (avian)	1.13	-1.40	-1.14	-1.16	-1.56
A01	Mm.489229	NM_009599	Ache	Acetylcholinesterase	1.12	1.49	1.75	1.75	2.67
G02	Mm.440639	NM_194053	S100b	S100 protein, beta polypeptide, neural	1.12	1.47	-1.21	1.75	2.68
A05	Mm.490092	NM_009685	Apbb1	Amyloid beta (A4) precursor protein-binding, family B, member 1	1.11	1.50	1.69	-1.18	2.66
A06	Mm.305152	NM_009696	Apoe	Apolipoprotein E	-1.72	-1.31	-1.15	-1.14	1.34
G07	Mm.289739	NM_178804	Sox3	SRY-box containing gene 3	-1.72	-1.32	-2.29	-2.30	-1.51
D09	Mm.983	NM_010556	Ndp	Norrie disease (pseudoglioma) (human)	-1.73	-1.31	-1.15	-1.14	-1.50
D05	Mm.390859	NM_008235	Mef2c	Myocyte enhancer factor 2C	-1.74	-1.32	-1.15	-1.14	-1.50
B10	Mm.27256	NM_007864	Dll1	Delta-like 1 (Drosophila)	-1.74	-1.33	-2.30	-2.30	-3.04
D10	Mm.8042	NM_008380	Neurod1	Neurogenic differentiation 1	-1.74	-1.32	-1.15	-2.30	-1.51
E03	Mm.400253	NM_010882	Notch1	Notch gene homolog 1 (Drosophila)	-1.75	-1.34	-1.16	-1.15	-3.08
G06	Mm.57202	NM_009170	Sox2	SRY-box containing gene 2	-1.77	-1.33	-1.15	-1.15	-1.51
F02	Mm.327698	NM_011855	Pafah1b1	Platelet-activating factor acetylhydrolase, isoform 1b, subunit 1	-1.79	1.50	-1.18	-1.15	1.32
E01	Mm.2389	NM_001081049	Nf1	Neurofibromatosis 1	-1.82	-1.39	-1.16	-1.16	-1.53
H01	Mm.3317	NM_010368	Actb	Actin, beta	-1.77	-1.33	-1.16	-1.16	-1.53
H02	Mm.299381	NM_013556	B2m	Beta-2 microglobulin	1.16	1.50	-1.15	-1.16	1.32
H03	Mm.2180	NM_008302	Gapdh	Glyceraldehyde-3-phosphate dehydrogenase	1.16	1.58	1.81	1.82	1.34
H04	Mm.304088	NM_008084	Gusb	Glucuronidase, beta	1.14	-1.35	-1.18	-1.18	1.32
H05	Mm.391967	NM_007393	Hsp90ab1	Heat shock protein 90 alpha (cytosolic), class B member 1	1.15	-1.32	-1.15	-1.15	-1.53

Table S1 **Predicted HuD binding sites in NeuroD1 3'UTR**

>ENSMUSG00000034701|ENSMUST00000041099

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   1 AGGCACGTCAGTTTCACTATTCCCGGGAAACGAATCCACTGTGCGTACAGTGACTGTCCT
  61 GTTTACAGAAGGCAGCCCTTTTGCTAAGATTGCTGCAAAGTGCAAATACTCAAAGCTTCA
 121 AGTGATATATGTATTTATTGTCGTTACTGCCTTTGGAAGAAACAGGGGATCAAAGTTCCT
 181 GTTCACCTTATGTATTGTTTTCTATAGCTCTTCTATTTTAAAAATAATAATACAGTAAAG
 241 TAAAAAAGAAAATGTGTACCACGAATTTCGTGTAGCTGTATTCAGATCGTATTAATTATC
 301 TGATCGGGATAAAAAAAATCACAAGCAATAATTAGGATCTATGCAATTTTTAAACTAGTA
 361 ATGGGCCAATTAAAATATATATAAATATATATTTTTCAACCAGCATTTTACTACCTGTGA
 421 CCTTTCCCATGCTGAATTATTTTGTTGTGATTTTGTACAGAATTTTTAATGACTTTTTAT
 481 AACGTGGATTTCCTATTTTAAAACCATGCAGCTTCATCAATTTTTATACATATCAGAAAA
 541 GTAGAATTATATCTAATTTATACAAAATAATTTAACTAATTTAAACCAGCAGAAAAGTGC
 601 TTAGAAAGTTATTGCGTTGCCTTAGCACTTCTTTCTTCTCTAATTGTAAAAAAGAAAAGA
 661 AAAGAAAAAAAACCAACAAATTGCACAATTTGAGCAATTCATCTCACTTTAAAGTTTTTC
 721 CTGCTCGCTCCCTAAAATAGAAACCAGACCCATAACACTCAAGAGGATGAAAACCGAAAT
 781 GCATTCCTTATCAAAACACATCAATTCATTACTTGCACAAGCTTGTAAATACATATTATA
 841 AATAAATGCCAACACACACTCCTTTAAATCAAAAGCTGCTTGACTATCACATACAATTTG
 901 CACTCTTTCTTTTTAGTCTTTTACTTCTTTGAATTCCATGATTTTACGGAGTGTTTGAAG
 961 ATATTGATGTTTCCAGAAAATATAAATGCATGATTTTATACATAGTCAAACAAATGGTGG
1021 TTTGTCATCTATTCATGTAATAAATCTGAGCCTAAATTTATTCAGGTTGTTAATGTTGGG
1081 TTTTTATACCTGTGTAGTCAGTTAGTACAGTAGTTTAAATAAAATTCAAACCATCGAATT
1141 CATAATTAGAACAATAGCTGTTGCATGTAAAATGCAGTCCAGAATAAGTGCTGTTTGAGA
1201 TGTGATGCTGGTACTACTGGAATTGACATGTACTGTAATCTTGTTTGTAATCCTGTGTAT
1261 TATGGTGTAATGCACAATTTAGAAAACTCCCATGCAGTTGCAATAAAAATAGTATGGAAA
1321 ATCAAAACAATTGTTTCATTTCTTTCGAAAGTGGATTTTAAAGAGTAAAATTGTAGCGAG
1381 GAGGATCAACGTCTGTATTTGCTGAGTTAAATGTTAAACATTAGGAATAAAATATAGAGT
1441 TGA
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AUUUA ARED	132	555	569	578	1055	1276	
U-RICH GRE	436	902	903	905	906	909	910
MOTIF 1							
MOTIF 2							
MOTIF 3							

Supplementary Methods

Mice

All animal procedures were performed according to protocols approved by the University of Wisconsin-Madison Care and Use Committee. The *HuD* KO mice used in this study were created by Akamatsu et al [1], a 2.5-kb fragment containing intronic sequences upstream and a 6.1-kb fragment containing intronic sequences downstream of the second exon that contains the second RNA recognition motifs (25–265 bp of cDNA) were inserted into the target plasmid vector to delete a 1.0-kb genomic DNA fragment and induce a frame shift. The mice were backcrossing to C57BL6 background for 9 generations. Mice were group housed up to 4 per cage with the same gender and maintained on a 12-h light/dark cycle with food and water available ad libitum. For in vivo cell proliferation and terminal differentiation analyses using BrdU labeling, mice were given 4 injections of BrdU (50mg/kg) within 12 hours to label all dividing cells in adult germinal zones within this time period and sacrificed at 4 hours post-last injection based on published paradigm [2]. Mice were then euthanized either at 12 hours or 4 week after the last BrdU injection, by intraperitoneal injection of sodium pentobarbital followed by transcardially perfusion with saline followed by 4% paraformaldehyde (PFA). Brains were dissected out, post-fixed overnight in 4% PFA, and then equilibrated in 30% sucrose. Forty-μm brain sections were generated using a sliding microtone and stored in a -20℃ freezer as floating sections in 96-well plates filled with cryoprotectant solution (glycerol, ethylene glycol, and 0.1M phosphate buffer, pH 7.4, 1:1:2 by volume).

DNA Plasmids

The pcHuD plasmid contained DNA fragments corresponding to coding sequence (CDS) of human **HuD** was clones in pcDNA3 as described in Anderson et al, [3]. The plasmid expressing a small hairpin inhibitory RNA (shHuD) under U6 promoter for HuD knockdown was a gift of Dr. Antonia Ratti and previously used in Allen, Bird et al [4]. To create retroviral vector expressing *shHuD,* we amplified the U6-*shRNA* cassettes using the following primers: forward: 5'-CTCTCGAGGTCGACGGTATC-3', reverse: 5'-GCGGTTAACAGACTGCCTTGGGAAAAGC-3'. We then cloned the PCR product between the HapI and ClaI restriction sites of a retrovirus vector that is also expressing EGFP driven by CAG promoter [2, 5]

The plasmid containing DNA fragments corresponding to coding sequence (CDS) of mouse *SATB1* was purchased from Genecopoeia (Rockville, MD, USA), and P2A-FLAG-SATB1was subcloned into a lentiviral vector expressing red florescent protein mCherry using the following primers: forward (containing P2A-FLAG): 5'-TGGACGAGCTGTACAAGGGAAGCGGAGCTACTAACTTCAGCCTGCTG AAGCAGGCTGG AGACGTGGAGGAGAACCCTGGACCTGATTACAAGGATGACGACGATAAGGATT ACAAGGATGACGACGATAAGGATTACAAGGATGACGACGATAAGATGGATCATTTGAACGAGGC-3', reverse: 5'-CAGGTTTAAACTCGAG TCAGTCTTTCAAGTCGG-3'.

The mouse Lenti-*shSATB1* (SureSilencing) plasmids were purchased from Genecopoeia. The efficiency and specificity of shRNA knockdown were determined by transfecting into Neuro2A using Lipofectamine 2000 (Invitrogen, #11668-027) or HEK293T cells using calcium phosphate method, and analyzed at 60-hr post-transfection. The targeted sequence were: GGAAAGGAACCATGTTACC (*shSATB1*-1) and ACAGCACGTACTATGCAAA (*shSATB1*-3). We then cloned the *shSATB1*-1 targeting sequence into the retrovirus vector that is also expressing EGFP driven by CAG promoter

3'-UTR sequence of *Satb1* was PCR amplified directly from purified mouse cortical genomic DNA

using AccuPrime™ Pfx DNA Polymerase according to the manufacturer's protocol (Invitrogen, # 12344024, Carlsbad, CA, USA). The primers contain XhoI and NotI restriction sites for aiding infusion into digested psiCHECK-2 dual luciferase vector (Promega, # C8021, Madison, WI, USA) using In-Fusion HD Cloning Kit (Takara, #011614, Otsu, Shiga, Japan). The primers used are:

Satb1 3'UTR 1 forward:	TAGGCGATCGCTCGAGGAGAACAGTATTCTTTTCAGC
Satb1 3'UTR 1000 reverse:	TTGCGGCCAGCGGCCGCTTTCACATTAATTGCATA
Satb1 3'UTR 1001 forward:	TAGGCGATCGCTCGAGATAATTGATGTTTGCAAT
Satb1 3'UTR 1897 reverse:	TTGCGGCCAGCGGCCGCCACGGGAACCCTAACAAAG
Satb1 3'UTR 2001 forward:	TAGGCGATCGCTCGAGTTTCCTGGTGGTCTAAAT
Satb1 3'UTR 3000 reverse:	TTGCGGCCAGCGGCCGCCTAGTCACCTTTGTTTTC
Satb1 3'UTR 3001 forward:	TAGGCGATCGCTCGAGTATGTGTGCCCTACCTGTGT
Satb1 3'UTR 3555 reverse:	TTGCGGCCAGCGGCCGCTTGTCCAAAGACATGCAAG
Satb1 3'UTR 3709 reverse:	TTGCGGCCAGCGGCCGCTCATGTTTTAAACATTAATTCC

1.3 kb HuD Promoter-reporter plasmids cloned into the MCS of the PGL4.14 vector were kindly provided by Dr Bernard J. Jasmin (University of Ottawa, Ottawa, Canada) [6]. *NeuroD1*-luciferase, a gift from Dr. F.H. Gage, the 2.5 kb of glial fibrillary acidic protein (*Gfap*) promoter-firefly luciferase reporter gene and an internal control plasmid containing *Renilla luciferase* (R-Luc) driven by human elongation factor (*EF-1α*) promoter, gifts from Dr. Kinichi Nakashima (Kyushu University, Japan) were described previously [7, 8].

Isolation and Analyses of aNSCs

Adult -derived NSCs were isolated from 6- to 8-week-old *HuD* KO mice and wild-type (WT) littermates as described before [9] with modifications. Briefly, SVZ were dissected using forceps and 27 gauge needle (BD, #305109) and place in Hank's balanced salt solution (HBSS; Invitrogen, # 14025-126) on ice. Tissue was spin down and digested using MACS Neural Tissue Dissociation kit (Miltenyi Biotech, # 130-090-753, San Diego, CA, USA). After dissociation with a fire-polished glass pipette,

cells were filtered through a 70-μm cell strainer (BD Falcon, #252350, CA) and washed with HBSS, the single-cell suspension from each sample was collected and cultured in proliferating medium (Neurobasal containing B27 serum-free supplement (Invitrogen, # 17504-044) 20 ng/ml basic fibroblast growth factor (FGF-2; PeproTech, #K1606, Rocky Hill, NJ, USA), 20 ng/ml epidermal growth factor (EGF, PeproTech, #A2306), 1% Antibiotic-Antimycotic, and 2 mM L-glutamine, in a 5% CO2 incubator at 37°C. Half of the medium was replaced every two days. Proliferation and differentiation analyses were performed as described in our publications [2, 10]To study cell proliferation, we dissociated neural stem cells with trypsin and plated them on 24 well plates with poly-L-ornithin (Sigma-Aldrich, #P-3655, St. Louis, MO, USA) and laminin (BD Biosciences, #354232, San Jose, CA, USA)-coated coverslips at a density of 10,000 cells per well in proliferation medium (see above). At 20 h post-plating, 5 μM 5-bromo-2'-deoxyuridine (BrdU, SigmaAldrich, #B5002) was added into the culture medium for 8 h. NSCs were then washed with PBS and fixed with 4% paraformaldehyde for 30 min at room temperature, followed by immunohistochemical analysis. To detect BrdU incorporation, fixed cells were pretreated with 1M HCl for 30 min at 37°C, washed with borate buffer, pH 8.5, for 30 min, and followed by standard immunocytochemical protocol For the differentiation assay, at 24 h post-plating, cells were changed into differentiation medium, which is Neurobasal medium containing 5 μM forskolin (Sigma-Aldrich, #F-6886) and 1 μM retinoic acid (Sigma-Aldrich, #R-2625) for 4 d. Upon fixation with 4% paraformaldehyde, the coverslips were subjected to our standard immunohistochemistry protocol.

Immunocytochemistry

Immunocytochemistry staining was carried out as described [7, 11, 12]. Briefly, cells were fixed with 4% paraformaldehyde for 20 min, and then washed with Tris-buffered saline (TBS, 50 mM Tris-Cl, pH 7.5, 150 mM NaCl) for 30 min. Cells were preblocked using TBS containing 2% normal goat serum

(VECTOR, #S-1000, Burlingame, CA, USA) and 0.1% Triton X-100 for 30 min, followed by overnight incubation with primary antibodies. After washing with TBS, cells were incubated with fluorescent secondary antibodies, followed by counterstaining with the fluorescent nuclear dye 4',6-dimidino-2'-phenylindole dihydrochloride (DAPI, Roche Applied Science, Indianapolis, IN). The coverslips were mounted with polyvinyl alcohol (PVA) mounting medium with DABCO (Sigma-Aldrich, # 10981) and stored in cold and dark before and during analysis. The numbers of marker-positive cells ($BrdU^+$, $TuJ1^+$, or $GFAP^+$, etc), as well as total cells ($DAPI^+$) and total Lenti- -infected cells (shRNA-GFP^+, $mCherry^+$, or $SATB1^+$) were quantified using an Olympus BX51 microscope equipped with a MicroFire digital camera (Optronics) and a motorized stage using a 20X objective lens. The quantification was carried out using an unbiased stereology method with assistance from StereoInvestigator software (MBF Biosciences, Williston, VT, USA). The percentage of differentiated cells was calculated as the number of marker-positive cells divided by the total number of DAPI, GFP^+, GFP^+/$mcherry^+$ or GFP^+/$SATB1^+$ positive cells. At least 3 independently viral infected cells were analyzed for statistical analysis.

Immunohistology

Immunohistology of brain tissue sections was performed as published in our papers [5, 12, 13]. For staining, floating brain sections were first washed in TBS to remove cryoprotectant and then blocked in the TBS buffer containing 2% normal serum and 0.2% triton-X 100, followed by incubation with primary antibodies diluted in TBS overnight in 4 ℃. After washing 3 times, secondary antibodies were incubated 1 h at room temperature. All sections were counterstained with DAPI.

The primary antibodies used were: chicken anti-GFP (1:1000, Invitrogen, #A10263), mouse anti-Tuj1 (1:1000, Covance, #MMS-435P, Princeton, NJ, USA), rat anti-BrdU (1:3000, Abcam, #ab-6326, Cambridge, UK), rabbit anti-GFAP (1:2000, DAKO, #Z0334, Carpinteria, CA, USA), chicken anti-Nestin (1:500, Aves Labs, #NES0407, Tigard, OR, USA), mouse anti-NeuN (1:1000, MAB377), mouse

anti-calretinin (1:500, MAB1568), mouse anti-Mash1 (1: 200, BD Biosciences, #556604), rabbit anti-tyrosine hydroxylase (TH) (1:250, AB152), and rabbit anti-calbindin (1:500, AB1778) were from Millipore, rabbit anti-doublecortin (1:500, Cell Signaling Technology, #4604S, Beverly, MA, USA), goat anti-SATB1 (1:100, Santa Cruz Biotechnology, #sc-5989, Dallas, CA, USA), mouse anti-HuD (1:200, Santa Cruz Biotechnology, #sc-28299), goat anti-HuD (1:100, Santa Cruz Biotechnology, #sc-5977), rabbit anti-flag (1:1000, Cell Signaling Technology, #2368S) antibodies. Fluorescent secondary antibodies were from Invitrogen (Carlsbad, CA, USA) and used by 1:500 dilution: goat anti-chicken-488 (#A11039), goat anti-mouse-488(#A11029), goat anti-mouse Alexa Fluor 568 (#A11031), goat anti-rabbit 568 (# A11011), goat anti-rat Alexa Fluor 568 (#A11077), goat anti-rabbit Alexa Fluor 647 (#A21245), donkey anti-goat 568 (# A11057), donkey anti-rabbit 647 (#A31573).

To analyze the fate of the cells generated from SVZ, 1 in 6 serial sagittal sections, containing SVZ, RMS and olfactory bulb (relative to bregma, lateral: 1.0 mm to 1.4 mm) were analyzed by Image J. For Brdu injected mice, at least 100 $Brdu^+$ cells in each slice were randomly selected and their phenotypes (double labeling with TH, CR, CB or NeuN) were determined. For recombinant virus-infected cells in mice injected with both retrovirus (GFP) and lentivirus (SATB1 stained with Flag-antigen labeled with Alexa Fluor 568), GFP^+ single positive (green) and $GFP^+/SATB1^+$ double positive (yellow) cells were counted, and at least 50 GFP^+, GFP^+SATB1^- or GFP^+SATB1^+ cells in each slice were randomly selected and their phenotypes (double labeling with DCX or NeuN) were determined. The data were presented as the percentage of DCX^+ or $NeuN^+$ cells in the GFP^+, GFP^+SATB1^- , or GFP^+SATB1^+ populations by Image J. The volumes of periglomerular layer (PGL) and granule cell layer (GCL) (3-dimentional size) in olfactory bulb and the total number of cells were measured using StereoInvestigator (MBF Bioscience, Inc) with a 5-μm guard zones at both top and bottom of the sections, as described elsewhere [14].

High content image analysis

To quantify NSC differentiation, NSCs was cultured in 24 well-plates to go through the proliferation or differentiation, after the fixation and staining, cells was incubated in TBS. The images were acquired on an Operetta System (Perkin Elmer) using a 20 X LWD objective in wide-field mode in combination with filters for DAPI (excitation filter: 360–400 nm; emission filter: 410–480 nm), Alexa Fluor 488 (excitation filter: 460–490 nm; emission filter: 500–550 nm), Alexa Fluor 546 (excitation filter: 520–550 nm; emission filter: 560–630 nm), and Alexa Fluor 647 (excitation filter: 620–640 nm; emission filter: 650–760 nm). The laser autofocus was applied and 20 image fields were acquired per well. For quantitative analyses, individual cells were segmented based on the DAPI nuclear stain using the Find Nuclei building block in the Harmony High Content Imaging and Analysis Software (PERKIN ELMER) and GFP intensity was quantified within the DAPI defined boundaries for each cell. The Select population module of Harmony allowed setting a fluorescence intensity threshold in order to identify the sub-population of virus infected GFP^+ cells. $Tuj1^+$ and $GFAP^+$ cells were selected in those GFP^+ populations by the Neurite Detection or building blocks.

RNA Immunoprecipitation (IP)

RNA-IP was performed as describe [9, 12] . Briefly, WT and HuD KO SVZ NSCs were harvested and homogenized in 1ml of ice-cold lysis buffer (10 mM Hepes [pH 7.4], 200 mM NaCl, 30 mM EDTA, and 0.5% Triton X-100) with 2X complete protease inhibitors (Roche, #11873580001). Nuclei and debris were pelleted at 3,000 X g for 10 min; the supernatant was collected and raised to 300 mM NaCl, and clarified at 14,000 X g for 30 min. The resulting supernatant was pre-cleared for 1 h with 100 µl recombinant protein G agarose (Invitrogen) (washed with lysis buffer first). An aliquot of precleared input was saved for RNA extraction (200 µl) and protein analysis (100 µl). A monoclonal antibody

against HuD (Santa Cruz Biotechnology, #sc-28299) was incubated with recombinant protein A dynabeads at 4ºC for 2 h and washed 3 times with lysis buffer. RNase Inhibitors (Roche) will be added to the remaining lysates. The precleared lysates were immunoprecipitated with antibody-coated recombinant protein G agarose at 4ºC for 2 hours. After third wash with the lyses buffer, 10% of immunoprecipitate was saved for protein analysis. The remaining was washed one more time and was re-suspended into Trizol (Invitrogen, #15596018) for RNA isolation.

Chromatin Immunoprecipitation (ChIP)

ChIP was performed according to published method [7, 15]. Briefly, aNSCs grown to 80%-90% confluent in 10cm plates were fixed by adding 1% formaldehyde (Sigma-Aldrich, #S33102) to culture medium for 20 min at room temperature and stop with Glycine buffer (190 mg Glycine in 1ml H2O) to final concentration of 0.14 M. After washing with cold PBS, cells were collected with cold PBS, washed, and suspended in 1mL cold cell lysis buffer (5mM PIPES, pH=8.0, 85mM KCl, 0.5% NP40, and 1X Complete Proteinase inhibitor, and incubated on ice for 5 min. Cell lysates were pelleted by centrifugation at 3000rpm for 5 min, resuspended in 1mL cold cell lysis buffer 5min on ice, and then re-pelleted to collect nuclei. Nuclei were lysed at room temperature with 500μL nuclei lysis buffer (50mM Tris pH 8.1, 10mM EDTA, 1%SDS and 1X Complete Protease inhibitor). Nuclear lysates were sonicated using Bioruptor^{TM} UCD-200 sonicator (Life Technologies) with 5 cycles in a high poweroutput, each cycle includes 5 pulses of 30 seconds power on within 10 minutes. The size of the sonicated chromatin (average size ~400-700bp) was verified by treating 5 μL aliquots with 1μL 20 mg/mL Proteinase K for 20 min at 50°C and running on a 1.5% agarose gel stained with SYBR Safe dye (Invitrogen, #S33102). The immunoprecipitating and washing were using Chip Assay Kit (Millipore, #17-295, Billerica, MA, USA). Briefly, 500 μL of sonicated chromatin, pre-cleared with salmon

sperm/tRNA blocked Protein A agarose for 60 min at 4°C in 5 ml IP dilution buffer (0.01% SDS, 1.1% TritonX-100,1.2mM EDTA, 20mM Tris pH 8.1, 500 mM NaCl) was used in immunoprecipitation reactions. Pre-cleared chromatin was rotated at 4℃ overnight with 10 μg of the appropriate antibody. Antibodies used were normal anti-Rabbit IgG (Millipore, #12-370), anti-rabbit SATB1 (Santa Cruz Biotechnology, #SC-28676). Antibodies were pulled down with 150 μL blocked Protein A agarose beads overnight at 4°C with rotation. The beads were washed sequentially one wash with low salt immune complex wash buffer, high salt immune complex wash buffer and LiCL immune complex wash buffer for 5 min at 4℃. And two washes with TE Buffer for 5 min at room temperature. Protein-DNA complexes were eluted from the Protein A agarose beads with 500μL fresh prepared IP elution buffer (50mM NaHCO3, 1% SDS) for 15 min at 37°C with rotation. Formaldehyde induced protein-DNA crosslinking were heat reversed by incubating protein-DNA complex at 65℃ for 4 hours. DNA was purified using Phenol:Chloroform:Isoamyl alcohol (25:24:1) (Life Technologies, #15593-031) isolations and precipitated with 2 volumes 100% ethanol and 10μg linear acrylamide at -20℃ overnight. Immunoprecipitated and purified DNA fragments were resuspended in 100 ml nuclease free water, 2 μl DNA was used in 20 μL SYBR Green real-time PCR reactions. Primers sequences spaced at 1kb intervals spanning 6 kb upstream to 1 kb downstream of *HuD* and *NeuroD1* were designed using primer premier 5.0 Software and were (5'-3'):

NeuroD1 downstream 0.2 Kb forward:	GCTCCAGGGTTATGAGATCGT
NeuroD1 downstream 0.2 Kb reverse:	TGTGGGCAATTACGAGGAGG
NeuroD1 upstream 0.8 Kb forward:	GAGCAGGTGACCGTTAGGTT
NeuroD1 upstream 0.8 Kb reverse:	GCCTTGACTCAACCTTCCTGA
NeuroD1 upstream 2 Kb forward:	GTTCCGGGAATATCCAGGTGT
NeuroD1 upstream 2 Kb reverse:	GGAGAGTTATTGGGGAGCGG
NeuroD1 upstream 2.5 Kb forward:	GCAGATTTAGGGCATTGCTCG
NeuroD1 upstream 2.5 Kb reverse:	TCCCAGTTATCTCCGCTTGC
NeuroD1 upstream 3.2 Kb forward:	GAGATTTGGGGAGAACGGGT
NeuroD1 upstream 3.2 Kb reverse:	GCTGGAATTGCCCGACTAGA

NeuroD1 upstream 4.8 Kb forward:	TCCGCGTTTCTTTGATCAATCC
NeuroD1 upstream 4.8 Kb reverse:	ACCACATTGGTACACGTGGC
NeuroD1 upstream 6 Kb forward:	ATGAGCTGCCTCTTGACACC
NeuroD1 upstream 6 Kb reverse:	GGGAGGGATGTGAATGCCAA
HuD downstream 0.5 Kb forward:	GGCGTGTTGAGTTGTTGCTT
HuD downstream 0.5 Kb reverse:	ACCTCCAAGCTGCCTTCTTT
HuD upstream 0.5 Kb forward:	CTGCGAGACCCAATATTTGCC
HuD upstream 0.5 Kb reverse:	GACTGGCCAAGGTGTAGACG
HuD upstream 1.9 Kb forward:	ATGCAGGCCCAAAACATCCT
HuD upstream 1.9 Kb reverse:	GCCTCTCCCTTCGCTTCTTT
HuD upstream 2.5 Kb forward:	TAGAGTGCAGTGCAGCAAGT
HuD upstream 2.5 Kb reverse:	GCGCCCTTCAGGTAGAACAA
HuD upstream 3.5 Kb forward:	CCACTGTGCGGAGTAGGTAG
HuD upstream 3.5 Kb reverse:	AGATATCTCAGCTCGGTCGC
HuD upstream 5 Kb forward:	TCCATCTCTGGGAGATTTCAACT
HuD upstream 5 Kb reverse:	GATGCTGTTTGGGAGGCGTA
HuD upstream 5.3 Kb forward:	GTGGACGTTCAGAGCTTCA
HuD upstream 5.3 Kb reverse:	CAAAGCAAGCCCATAGCGTT

cDNA from IP and input from 3 independent chromatin preparations was used and all Real-time PCR reactions were carried out in duplicate for each sample on each amplicon. IP readings of both specific SATB1-immunoprecipitations (H-70) or non-specific immunoprecipitations (rabbit IgG only) were normalized Input sample.

RT-PCR, Real-Time PCR, and Pathway Arrays

RT-PCR and real-time PCR were performed using standard methods as described [2, 5, 7]. The first-strand cDNA was generated by reverse transcription with random primers using Transcriptor First Strand cDNA Synthesis Kit (Roche, #04896866001). Standard RT-PCR was performed using GoTaq DNA polymerase (Promega, #M3005). To quantify the mRNA levels using real-time PCR, aliquots of first-strand cDNA were amplified with gene-specific primers and universal SYBR Green PCR supermix (Bio-Rad, #172-5124) using a Step-1 Real-Time PCR System (Applied Biosystems). The PCR reactions

contained 20-40 ng of cDNA (except the cDNA for the IP, for which 5% of the cDNA was used for each gene examined), and 300 nM of forward and reverse primers in a final reaction volume of 20 μl. The ratio of different samples was calculated by the data analysis software built in with the Step-1 Real-Time PCR System.

To determine differential gene expression between WT and *HuD* KO mice, cDNA were synthesized from the total RNA from WT and *HuD* KO SVZ NSCs as described above. 10 ng cDNA was added into each well of a 96-well Neurogenesis Pathway Arrays (Qiagen/SABioscience, #PAMM-404Z, Valencia, CA, USA). Each sample was applied to one array and independent duplicates were analyzed for WT and *HuD* KO. Real time PCR and data analyses were performed according to manufacturer's menu. Briefly, the expression level of each gene was obtained by comparing to internal controls on the same array. The relative expression levels of genes in *HuD* KO compared with WT samples were then calculated with WT samples set as "1".

The sequences of primer used are as the following:

Satb1 forward:	ACAGACCTCCCCACATCATC
*Satb1*reverse:	TTCCACGGAAATTTTGGTTC
HuD forward:	CAATACGGTCGCATCATCAC
HuD reverse:	CCTTTGATGGCTTCTTCTGC
NeuroD1 forward:	TTAAATTAAGGCGCATGAAGGCC
NeuroD1 reverse	GGACTGGTAGGAGTAGGGATG
Tuj1 forward:	TATGAAGATGATGACGAGGAATCG
Tuj1 reverse:	TACAGAGGTGGCTAAAATGGG G
Gfap forward:	CCAAGCCAAACACGAAGCTAA
Gfap reverse:	CATTTGCCGCTCTAGGGACTC
Aquaporin 4 forward:	CTTTCTGGAAGGCAGTCTCAG
Aquaporin 4 reverse:	CCACACCGAGCAAAACAAAGAT
Gapdh forward:	AATGGGAAGCTTGTCATCAACG
Gapdh reverse:	GAAGACACCAGTAGACTCCACGACATA
E1a forward:	GGACCCAGTGAGAAGCGACT
E1a forward:	AGAACAGGAGGCAAGGTCTG

E1a2 forward:	TGAAATCAGCAGGACGCTTA
E1a3 forward:	GGCTGCCTGATATGGGATTA
E1a4 forward:	GACCTGCAGTTGTGACAGGA
E1b forward:	CCACCCCCTCCCAATAATAG
E1c forward:	GAACGTTGAGATGGGCAGTT
E1c1 forward:	ACGCTCCTTTCTGCTTTTGA
E2 reverse:	CCATTCCACTCCATCTGTGA

Actinomycin D Treatment and mRNA Stability Assay

Culture hippocampus neurons were treated with 10 μg/ml of actinomycin D (Sigma-Aldrich, #A1410) to inhibit gene transcription as described[2] and SVZ NSCs were collected at various time intervals for RNA isolation and real time PCR analysis. *Satb1* and *NeuroD1* mRNA levels were normalized to Gapdh. RNA decay kinetics and half-life were analyzed using a published method [16-18]. Briefly, for single rate decays we used the exponential function $M_t=M_0e^{-\lambda t}$ (M_t: amount of mRNA at t time, M_0: amount of mRNA t t=0. $\lambda=(\ln 2)/T_{1/2}$ ($T_{1/2}$ is the half-life of the mRNA). Since regression analysis indicated that the best fit for *Satb1*mRNA turnover in wild type cultures was obtained using a two-rate decay we calculated the T ½ separately before and after the inflection point a t=3 h).

Western Blotting Analyses

Protein samples were separated on SDS-PAGE gels (Bio-Rad) and then transferred to PVDF membranes (Millipore). After primary and secondary antibody incubations, signals on the membranes were detected and analyzed using a Li-CoR Western blotting system (Li-CoR). Primary antibodies used are: mouse anti-HuD (1:500, Santa Cruz Biotechnology, #sc-28299), goat anti-SATB1 (1:500, Santa Cruz Biotechnology, #sc-5989), rabbit anti-flag (1:2000, Cell Signaling Technology, #2368S), β-Actin (1:1000, Sigma, #A5441) were used as primary antibodies. Blots were washed and incubated with IRDye 800CW-conjugated or 700CW-conjugated antibody (Rockland Biosciences, Gilbertsville, PA,

USA). Infrared fluorescence images were obtained with the Odyssey infrared imaging system (Li-Cor Bioscience). Quantification was performed by using software Image J.

Luciferase Reporter Assays

Transfection of aNSCs was carried out using Fugene HD (Roche, #04709713001) based on the manufacturer's protocol with modification. Briefly, aNSCs were plated into 24-well P/L-coated plate for 24 hours. In a separate tube, 1 μg DNA was added into 50μl opti-DMEM medium (Invitrogen, #11058-021) followed by the addition of 3μl Fugene HD transfection reagent. The mixture was mixed by pipetting 3-5 times, incubated for 10 minute, and then added onto the cells. 24 hours later, the transfected cells were changed into differentiation medium for 24 hours before harvesting. Luciferase activity was detected using the Dual-Luciferase Reporter 1000 System (Promega, #E1980) based on the manufacturer's protocol. Briefly, collected cells were lysed in 100 μl of 1X passive lysis buffer at room temperature for 15 min. Then 20 μL of the lysate was added to 100 μl of Luciferase Assay Buffer II and mixed briefly. Firefly luciferase (F-luc) activity was immediately read using a SpectraMax M2E plate reader (Molecular Devices Corp). Next, 100 μl of Stop & Glo Buffer with Stop & Glo substrate was added and mixed briefly. Renilla luciferase (R-luc) activity was immediately read. For the *HuD*, *NeuroD1* and *Gfap* promotor activity, F-luc activity was normalized to R-luc activity to account for variation in transfection efficiencies. For *Satb1* 3'UTR, R-luc activity was normalized to F-luc activity to account for variation in transfection efficiencies. Each experiment was independently repeated 3-4 times.

Production of Lentivirus and Retrovirus

Lentivirus production was performed as described previous [11, 19, 20]. Retrovirus production was performed as described in our previous publications [5, 7, 19]. Briefly, lenti-viral DNA was co-

transfected with packaging plasmids pMDL, REV and pCMV-Vsvg into HEK293T cells using calcium phosphate method. Retroviral DNA was co-transfected with packaging plasmids pCMV-gag-pol and pCMV-Vsvg into HEK293T cells using calcium phosphate method. The viral transfer vector DNA and packaging plasmid DNA were transfected into 5X15 cm dishes of cultured HEK293T cells using the calcium phosphate method. The medium containing lentivirus was collected at 36 and 60 hours post-transfection, pooled, filtered through a 0.2-μm filter, and concentrated using an ultracentrifuge at 19 k rpm for 2 hours at 4°C using a SW27 rotor (Beckman). The virus was washed once and then resuspended in 100 μl PBS. We routinely obtained $1X10^9$ infectious viral particles /ml for lentivirus and $1X10^8$ infectious viral particles /ml for retrovirus. To study the effects of SATB1 on the proliferation and differentiation of NSCs, $1X10^7$ viral particles was added to the NSCs cultured in proliferating condition on a 10 cm tissue culture plate. After a 2-day incubation, infected NSCs were either collected for RNA analysis or trypsinized and plated into 24 well plates (Fisher, #87721), at a density of $1X10^5$ cells/well, for differentiation or proliferation analysis.

In vivo Virus Grafting

In vivo viral grating using stereotaxic surgery was performed as described [15] with modification. Briefly, 7- to 8-week-old C57B/L6 male mice were anesthetized with isofluorane and placed in a stereotactic instrument (Stoelting, Wood Dale, IL, USA). Microinjections were performed using custom-made injection 33-gauge needles (Hamilton, #776206, Reno, NV, USA) connected to a 10 μL syringe (Hamilton, #87930). Virus (1 μl with titer greater than $1X10^8$/ml for retrovirus, and 1 X 10^9/ml for lenti virus) was mixed and then stereotaxically injected into the SVZ using the following coordinates relative to bregma, caudal: +1.0 mm; lateral: +/−1.0 mm; ventral: −2.2 mm**,** and caudal: +0 mm; lateral: +/−1.4

mm; ventral: −1.9 mm. One week post viral grafting, mice were perfused for differential analysis. Mice were deeply anesthetized with pentobarbital and perfused with saline followed by 4% PFA.

Statistical Analysis

The results were assessed by Student's *t*-test to compare two groups or by one-way ANOVA with *Tukey post-hoc* test for multiple comparisons, or two-way ANOVA with *Bonferroni post-hoc* test by GraphPad Prism. Statistical comparison between 2 genotypes within the same treatment group and between different treatments groups within the same genotype were carried out for each experiment. In all tables and figures, data are expressed as mean with standard error of mean (mean ± SEM). * for $P < 0.05$, ** for $P < 0.01$, and *** for $P < 0.001$.

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