# Animal Models of Schizophrenia

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The overarching goal of this database is to serve as an unbiased, centralized, publicly available and regularly updated collection of research models that might be useful for researchers studying schizophrenia and related disorders. While we have made every possible effort to include all potentially useful models that have been published, there may be some models that have been inadvertently omitted. We have also made every possible effort to ensure that this information is correct at the time of update. If your model is not included, or you would like to add new models or amend those listed here, please contact us.

Please note that not all phenotypes listed for a given model are necessarily expressed by all such models. Some of the DISC1 knockout mice do not have disrupted PPI, for example. For a full description of individual models, please refer to the appropriate citation. We have provided hyperlinks to all studies listed.

Schizophrenia Research Forum is much indebted to the Jim Koenig lab for all the work they have put into developing this table.

*Last updated 9 April 2009*

| ANIMAL PREPARATION | | PHENOTYPES ASSESSED | | | | | |
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| # | ***DEVELOPMENTAL PREPARATIONS*** | ***DA-related behavior*** | ***Gating*** | ***Cognitive Behavior*** | ***Social Behavior*** | ***Molecular/Morpho-logical Signature*** | ***Response to APD*** |
| 1 | Monkey Fetal Irradiation (Selemon, 2005) | | | | | Mid-gestational irradiation decreases both gray and white matter in frontal cortex. | |
| 2 | Mouse Prenatal Immune Challenge: **Human Influenza Virus** (Fatemi, 1999; Shi, 2003; Fatemi, 2005; Fatemi et al., 2008; Winter et al., 2008) | Decreased open field exploration | Impaired PPI | | Impaired social interaction | Reduced reelin expression in cortex layer 1; increased pyramidal cell density; cortical and callosal atrophy; reduced 5-HT levels in cerebellum | Clozapine and chlorpromazine increase PPI – hyper-reversal of PPI deficit. |
| 3 | Rat 24 hour Maternal Deprivation on Post-natal Day 9 (Ellenbroek, 1998; López-Gallardo et al., 2008; Llorente et al., 2008; Suárez et al., 2008) | | Disrupted PPI, Effect develops after puberty | | | **Males only:** neuronal degeneration and increased GFAP+ cells in cerebellum; increased astrocytes in hippocampus. **Both sexes:** altered cannabinoid receptor expression in hippocampus; increased plasma glucocorticoid levels | Haloperidol reverses PPI deficit |

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| # | ***DEVELOPMENTAL PREPARATIONS*** | ***DA-related behavior*** | ***Gating*** | ***Cognitive Behavior*** | ***Social Behavior*** | ***Molecular/Morpho-logical Signature*** | ***Response to APD*** |
| 4 | Rat Antimitotic Agent – MAM or AraC (Gourevitch, 2004; Flagstad, 2004; Elmer, 2004) Moore et al., 2006; Featherstone et al., 2007; Le Pen et al., 2006; Lodge and Grace 2007) | Enhanced response to amphetamine and MK-801 (post-puberty) | Disrupted PPI (post-puberty) | Learning deficits in Morris water maze, object recognition, and attentional set-shifting; no change in 5-choice serial reaction time task | Decreased social interaction (deficit present prior to puberty) | Decreased brain, hippocampus weight; increased neuron density in prefrontal cortex; enhanced NAc DA release to amphetamine; increased firing of dopaminergic neurons | |
| 5 | Rat Isolation Rearing (Geyer, 1993; Varty, 1998; Weiss, 2000; Heidbreder, 2000; Bianchi et al., 2006; Day-Wilson et al., 2006; Ferdman et al., 2007; Roncada et al., 2008; McLean et al., 2008; Bloomfield et al., 2008; Fone and Porkess, 2008; Alquicer et al., 2008; Schubert et al., 2008) | Enhanced amphetamine-induced locomotion and DA release (strain-dependent) | Disrupted PPI (strain- dependent) | Impaired novel object recognition and attentional set-shifting | Increased social interaction and aggression (males) | Reduced PFC volume (neuron # unchanged) and GAT-1 expression; altered accumbal protein expression (some correlated with PPI deficits); reduced accumbal dendritic length and spine density | Raclopride reversed PPI deficit |
| 6 | Rat Maternal Malnutrition (Palmer et al., 2004; 2008) | Enhanced amphetamine- but not MK-801-induced locomotion and apomorphine-induced stereotopy; (females only with post-pubertal onset) | Disrupted PPI (females only with post-pubertal onset) | | | Increases in NMDA receptor binding (sex- and region-specific); increased DA receptor binding and decreased DA transporter binding in striatum (females only) | |

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| # | ***DEVELOPMENTAL PREPARATIONS*** | ***DA-related behavior*** | ***Gating*** | ***Cognitive Behavior*** | ***Social Behavior*** | ***Molecular/Morpho-logical Signature*** | ***Response to APD*** |
| 7 | Rat Neonatal Immune Challenge: **Borna Disease Virus** (Solbrig, 2000; Pletnikov et al, 2002; Hans, 2004; Pletnikov et al., 2000; Eisenman et al., 1999; Lancaster et al., 2007) | Enhanced novelty induced locomotor activity in Fisher rats; enhanced amphetamine-induced locomotion | Disrupted PPI in Fisher rats | | Reduced social interaction | Impairs BDNF synaptogenesis; prefrontal cortex thinning; loss of cerebellar Purkinje neurons; increased norepinephrine and 5-HT levels in cortex and cerebellum (post-pubertal) | |
| 8 | Rat Placental Insufficiency/Birth Insults (Boksa, 2004; Hoeger et al., 2000; Wakuda et al., 2008; Juarez et al., 2008) | Enhanced amphetamine-induced locomotion and accumbal dopamine release | | Performance on Morris water maze and T-maze appears normal | | Reduced DA release in PFC, increased DAT in NAc (basal), decreased DA receptor expression; reduced dentate granule cells; region- and age-specific alterations in dendritic spine development | |
| 9 | Rat Prenatal Immune Challenge: **LPS** (Borrell et al., 2002; Baharnoori et al., 2008; Fortier et al., 2004, 2007; Hava et al., 2006; Romero et al., 2007, 2008) | Increased amphetamine-induced locomotion | Enhanced acoustic startle; disrupted PPI (worse in males) | | Reduced social interaction, possibly due to increased anxiety | Reduced dendritic complexity in PFC and hippocampus; increased accumbal DA and striatal DOPAC; elevated serum cytokine levels; altered frontal synaptophysin expression (direction of some changes are age-dependent) | PPI deficit and elevated serum cytokines both reversed by haloperidol |

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| 10 | Rat Prenatal Variable Stress (Kinnunen, 2003; Koenig, 2005; Lee et al., 2007) | Increased response to amphetamine and PCP with post-pubertal onset | Disrupted PPI and N40 | Impaired object and social recognition | Impaired social interaction present in adolescent and adult rats; reversal by oxytocin; no effect of cross-fostering | NMDA, GABAergic and presynaptic protein dysregulation | Social interaction deficit not improved by haloperidol. |
| 11 | Rat Prenatal Vitamin D Insufficiency (Kesby et al., 2006; Eyles et al., 2006, 2007; Féron et al., 2005; Almeras et al., 2007; McGrath et al., 2008; Harms et al., 2008) | Enhanced MK-801 induced hyperlocomotion | No disruption in PPI | | No deficit in social behavior | Enlarged lateral ventricles; thinned cortex; altered brain expression of proteins involved in mitochondrial function, calcium homeostasis, and synaptic plasticity | Stress reactivity unchanged |
| 12 | Rodent Prenatal Immune Challenge: **PolyI:C** *(delivery timing varies)* (Shi et al., 2003; Meyer et al., 2005; 2006, 2008a, 2008b; Ozawa et al., 2006; Zuckerman and Weiner, 2003, 2005; Zuckerman et al., 2003; Smith et al., 2007; Makinodan et al., 2008; Shi et al., 2009) | No change in total distance traveled in open field but reduced center exploration; increased response to amphetamine and MK-801 (emerges after puberty)--not rescued by cross-fostering | Disrupted PPI and changes in latent inhibition (post-puberty); PPI deficit not rescued by cross-fostering | Reduced escape latency in Morris water maze; impairment n novel object recognition memory and latent inhibition (post-puberty); classical fear conditioning, active avoidance and discrimination learning appear normal | Reduced social interaction | Amphetamine-induced DA release increased; increased hippocampal pyknotic cells; increased DA turnover and reduced binding to D2 receptors in striatum; reduced reelin- and parvalbumin-expressing neurons in PFC; reduced D1 receptors in PFC; increased TH expression in striatum; reduced density of cerebellar Purkinje cells; delayed myelination of hippocampus | Deficits in latent inhibition and novel object recognition memory are improved by clozapine but not haloperidol |

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| # | ***DRUG-INDUCED PREPARATIONS*** | ***DA-related behavior*** | ***Gating*** | ***Cognitive Behavior*** | ***Social Behavior*** | ***Molecular/Morpho-logical Signature*** | ***Response to APD*** |
| 13 | Basolateral Amygdala Picrotoxin Infusion-Rat (Berretta, 2001; Gisabella, 2005; Berretta and Benes, 2006) | | | | | | GABA antagonism in BLA decreases GAD67 in HPC, GABA antagonism in BLA increases HPC LTP |
| 14 | Ceftriaxone-Induced Glutamate Transporter Upregulation (Bellesi et al., 2008) | | Impairs PPI | | | | |
| 15 | CHX Induced Glutathione Depletion (Dean et al., 2009) | | | Disrupted short-term spatial memory | | Reduced striatal and cortex glutathione levels | |
| 16 | Disinhibition of Ventral Hippocampus (Bast et al., 2001a; Bast et al., 2001b; Zhang et al., 2001; Peleg-Raibstein et al., 2005) | Increased locomotor activity | Disrupted PPI | Disrupted fear conditioning | | Increased accumbens and cortex dopamine | Haloperidol and clozapine block hyperactivity but no effect on PPI deficit |
| 17 | Methamphetamine Treatment-Chronic (Arai et al., 2009; Abekawa et al., 2008) | | Disrupted PPI | Impaired recognition memory | | Increased TUNEL-positive cells in mPFC | Memory impairment blocked by GABA(B) agonist, PPI disruption and TUNEL-positive cell counts blocked by olanzapine and risperidone |
| 18 | Neonatal EGF Treatment (Futamura et al., 2003; Tohmi et al., 2005; Sotoyama et al., 2007) | Increased locomotor activity | Impaired PPI | | Reduced social behavior | Enhanced cAMP response to D2R activation | Haloperidol reduced motoric activity, clozapine improved social deficit |
| 19 | NMDA Receptor Antagonist Rx (MK801, PCP, Ketamine)-Acute (Jentsch and Roth, 1999; | Increases locomotor activity and stereotopy, ataxia | Disrupted PPI 1 day after PCP, and 15 minutes after PCP, but not 7 or 28 days | Decreased working memory, disrupted fear conditioning, long-term spatial | Impaired social interaction | Impaired LTP, decreased AMPA receptor density | Enhanced locomotor responses blocked by APD, glycine transporter-1 |

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| | Manahan-Vaughan, 2008; Manahan-Vaughan, 2008; Zavitsanou, 2008; Palsson, 2008; Kanahara, 2008; Pietersen, 2007; Gaisler-Salomon, 2008; Karasawa, 2008; Ishiyama, 2007) | | later, abnormal latent inhibition | memory deficits, impaired passive-avoidance, recognition memory deficit | | | inhibition rescues LTP, PPI disruption attenuated by agmatine, glycine, D-serine, not D-cycloserine, fear conditioning disruption prevented by clozapine but not haloperidol, LI abnormalities reversed by risperidone and M100907, passive avoidance impairment reversed by lurasidone, recognition memory deficit reversed by clozapine and D-serine but not haloperidol |

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| # | GENETIC PREPARATIONS | DA-related behavior | Gating | Cognitive Behavior | Social Behavior | Molecular/Morphological Signature | Response to APD |
| 20 | Adenosine Kinase Transgenic Mice (Yee, 2007) | Reduced locomotor response to amphetamine; enhanced locomotor response to MK-801 | | Learning deficits in Morris water maze and Pavlovian conditioning | | Overexpression of adenosine kinase; reduced levels of adenosine in brain | |
| 21 | Alpha-CaMKII KO, Heterozygous (Yamasaki, 2008; Chen, 1994) | Increased locomotor | | Deficits in working memory | Increased aggressive behavior | Impaired neuronal development in the dentate gyrus | |
| 22 | AMPAR GluR1 Subunit KO (Bannerman, 2004; Wiedholz, 2008) | Hyperactive, no effect of MK-801 on locomotor behavior | PPI deficit | Disrupted spatial working memory | Disorganized social behaviors | Slowed extracellular DA clearance in striatum | Anxiety prone; Hyperactivity reversed by haloperidol |
| 23 | Aph1B/C KO (Dejaegere, 2008) | Enhanced hyperactivity in response to amphetamine | PPI deficits, hypersensitive to MK-801 (increased PPI deficits) | Impaired working memory on Morris water maze | | Enhanced DA turnover in ventral striatum; gamma-secretase dependent cleavage of Nrg1 is impaired | Haloperidol and clozapine reverse PPI deficits |
| 24 | Apomorphine Susceptible Rat (Ellenbroek, 2002; Hara, 2008; Weber, 2008) | Enhanced locomotor response to novel open field | Disrupted PPI and diminished latent inhibition; Visual and acoustic PPI deficits; Sprague-Dawley rats more sensitive than Long Evans | | | Preferential mobilization of NMDAR NR1 subunits in D1R containing neurons of the nucleus accumbens | |
| 25 | BACE1 KO (Savonenko, 2008) | Increased novelty-induced hyperactivity; hypersensitivity to locomotor effects of MK-801 | PPI deficits | Working memory deficits; impaired in inhibitory avoidance task | Alterations in social recognition | Impaired processing of NRG1; decreased spine density and mature spines in CA1 | Clozapine attenuates novelty-induced hyperactivity and normalizes PPI deficits |
| 26 | Beta-arrestin 2 KO (Beaulieu, 2005) | Decreased locomotor response to amphetamine | | | | Normal DARRPP-32 phosphorylation after amphetamine | |

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| 27 | Calcineurin Agamma KO (Miyakawa, 2003) | Enhanced response to amphetamine | Disrupted PPI and latent inhibition | Decreased working memory | Impaired social interaction | Inducible KO | |
| 28 | Cannabinoid Receptor 1 (CB1) KO (Haller, 2005) | Decreased PCP-induced locomotion | | | No effect on social interaction | | |
| 29 | Catecholamine O-methyl transferase (COMT) KO (Gogos, 1998; Huotari, 2004; Babovic, 2008) | No potentiation of amphetamine-induced locomotion | | Impaired recognition memory in heterozygous only | No deficit in sociability or social novelty in KO or hets | Increased DOPAC, D1 and D2 unchanged. | Increased anxiety and aggression. |
| 30 | Chakragati Mouse (ckr) (Verma, 2008) | Circling, hyperactive | PPI and latent inhibition deficits | | Reduced social interactions | Enlarged ventricles | |
| 31 | Chromosome 22 Deletion (Paylor, 2001) | | Disrupted PPI | Impaired cognitive function | | | |
| 32 | Complexin I KO (Glynn, 2005; Drew, 2007) | Decreased amphetamine-induced locomotion | | No cognitive deficits in two-choice swim tank | Social deficits; no preference for social novelty; no aggressive behavior in resident-intruder paradigm | | |
| 33 | Complexin II KO (Yamauchi, 2005) | | | Decreased LTP; reduced Morris water maze performance only after stress | | | |
| 34 | Corticotropin Releasing Factor (CRF) Overexpression (Dirks, 2003) | | Disrupted PPI | | | | |

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| 35 | DBA/2 Mouse (Stevens, 1998; Shubenina, 2008; Simosky, 2008; Wildeboer, 2008; Stevens, 2008; Bortolato, 2007) | | Disrupted N40 gating and PPI | | | Decreased levels Glu, tau and GABA in hippocampus | Phenotype reversed by a7-nicotinic and $\alpha 4\beta 2$ receptor agonist; by olanzapine via alpha7-nicotinic receptor; by gestational choline supplementation; by baclofen and clozapine |
| 36 | DISC 129S6/SvEv Mouse (Koike, 2006; Kvajo, 2008) | | | Working memory deficit | | DISC1 mutation; deficit in hippocampal short term plasticity; altered organization of neurons in dentate gyrus | |
| 37 | DISC1 KO (Hikida et al., 2007; Duan et al., 2007; Pletnikov, 2007; Clapcote et al., 2007) | Enhanced locomotor activity | Disrupted PPI; Decreased latent inhibition | | Impaired social interaction | Decreased cortical parvalbumin-containing cells, accelerated neurogenesis with aberrant connectivity | |
| 38 | $Disc1_{tr}$ (Truncated) Mouse (Shen, 2008) | Increased immobility | Impaired conditioning of latent inhibition | | | Enlarged ventricles; reduced parvalbumin neurons in hippocampus and mPFC | |
| 39 | Disheveled 1 KO (Lijam, 1997) | | Disrupted PPI | | Impaired social interaction | | |

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| 40 | Dopamine Transporter KO (Spielewoy et al., 2000; Ralph et al., 2001; Trinh, 2003; Rodriguiz, 2004; Morice, 2007; Weiss et al., 2007) | Increased DA and decreased D1R, D2R, hyperactive | Disrupted PPI | Impaired adaption to environmental changes in Morris water maze | Impaired social behavior | Decreased LTD in hippocampus | More aggressive; impairments in Morris water maze reversed by haloperidol and acute nicotine treatment; LTD reversed by haloperidol |
| 41 | Dysbindin-1, Sandy (sdy) Mouse (Murotani, 2007; Bhardwaj, 2008; Takao, 2008; Feng, 2008; Hattori, 2008; Chen, 2008) | Delayed hyperactivity in novel environment; less active in open field | | Object recognition deficit; impaired long-term memory retention and working memory | Decreased social interaction | DTNBP1 mutation with lack of dysbindin protein; increase in DA metabolism in different brain regions; reduced snapin in hippocampus; decreased DA levels in cortex, hippocampus and hypothalamus; altered kinetics of transmitter release | |
| 42 | ErbB4 KO (Golub, 2004; Roy et al., 2007) | Reduced spontaneous activity; hyperactivity in open field | | Reduced Morris water maze learning | | Reduced myelination, enhanced DA receptor expression | |
| 43 | FEZ1 KO (Sakae, 2008) | Hyperactive; enhanced response to MK-801 and methamphetamine | | | | Increased methamphetamine-induced DA release in nucleus accumbens | |
| 44 | $GABA_A$alpha3 Receptor KO (Yee, 2005) | Spontaneous locomotor activity slightly increased but not after amphetamine | Disrupted PPI | | | | PPI defect improved by haloperidol Rx |

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| 45 | Galphas Overexpression in Forebrain (Kelly, 2008) | Hyperlocomotion | PPI deficit | Impaired hippocampus-dependent learning and memory retrieval | | Enlarged ventricles | PPI deficits reversed by haloperidol and rolipram |
| 46 | GAP-43 KO (Metz, 2004) | Hyperactive in open field, reduced anxiety | Disrupted PPI | | | | |
| 47 | GDI1 Knockout (D'Adamo, 2002) | | | Impaired short-term memory | Diminished social behavior | | Less aggression |
| 48 | GLAST (EAAT1) KO (Karlsson, 2008) | Locomotor hyperactivity in novel environment; exaggerated hyperactivity in response to MK-801 | | | | | Phenotype normalized by haloperidol and mGlu2/3 agonist |
| 49 | Glycine Transporter KO (Tsai, 2004) | Locomotor response to psycho-stimulants same as wild-type | Reduced sensitivity to amphetamine to disrupt PPI but more MK-801 induced disruption | Improves memory retention | | Increased NMDA receptor expression and function | |
| 50 | $Grin1^{D481N}$ (Labrie, 2008) | | Persistent latent inhibition | Spatial recognition impairments | Social approach deficits | Reduced NMDAR glycine affinity | Phenotype reversed by D-serine treatment |
| 51 | GSK-3beta Knockout (Amar, 2004; Bersudsky, 2008) | | Disrupted PPI correlates with enzyme activity; no PPI disruption (Bersudsky) | | | | |
| 52 | Heterozygous Tbx1 and Gnb1 KO (Paylor, 2006; Ishiguro, 2008) | | Reduced PPI | | | | |

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| 53 | Heterozygous Nurr1 KO (Rojas et al., 2007) | Hyperactive in novel environment and also after amphetamine | | Decreased emotional memory | | Reduced DA turnover in striatum; Increased DA turnover in PFC | Haloperidol reverses spontaneous hyperactivity |
| 54 | Heterozygous Reeler Mouse (Ballmaier, 2002; Costa, 2002; Podhorna, 2004; Krueger, 2006; Barr, 2008; Pillai, 2008) | Enhanced mesolimbic dopamine | Cross-modal PPI deficits, no unimodal PPI deficit | Decreased working memory; no decrease in prefrontal cortex dependent task | Impaired social interaction | Reduced GAD 67, increased DNA methylation; increased truncated TrkB receptor, decreased BDNF/TrkB signaling in frontal cortex | |
| 55 | Homer1a KO (Szumlinski, 2005) | Enhanced locomotor behavior to MK-801 and methamphet-amine | Disrupted PPI | Decreased radial arm maze performance | | Decreased glutamate release in PFC following cocaine Rx | |
| 56 | Inducible Mutant hDISC1 Mice (Pletnikov, 2008a; Pletnikov, 2008b) | Spontaneous hyperactivity | | Deficient spatial memory in females | Alterations in social interaction | Attenuation of neurite outgrowth in cortical neurons; enlarged ventricles | |
| 57 | Insulin Receptor KO (Zhao et al., 2006) | | Decreased startle amplitude | | | Decreased insulin receptor and Akt signaling; reduced phosphorylated GSK-3 | Clozapine alleviates insulin resistance |
| 58 | MCH KO Mice (Smith, 2008) | Increased basal locomotor activity; hypersensitive locomotor response to d-amphetamine | | | | | |
| 59 | mGluR1 Knockout (Brody, 2003) | | Disrupted PPI | | | | Not reversed by raclopride |

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| 60 | mGluR5 Knockout (Kinney, 2003; Brody, 2004; Gray, 2008) | Abnormal locomotor patterns; increased sensitivity to hyperlocomotive effects of MK-801 | Disrupted PPI | Short term spatial memory deficits | | | APD not effective; clozapine reversed PPI deficit and ameliorated locomotor disruption (Gray) |
| 61 | NCAM-180 KO (Wood, 1998) | | Disrupted PPI, no changes induced by apomorphine Rx | | | | Increase lateral ventricle size |
| 62 | Neuregulin 1 Hypomorph (Transmembrane Domain) (Stefansson, 2002 O'Tuathaigh et al., 2007; Dean, 2008; O'Tuathaigh, 2008) | Hyperactive in open field test | Disrupted PPI | No impairment in spatial learning or working memory but diminished social recognition memory | Increase in dominance related and aggressive behavior depending on environment | Reduced NMDA receptor activity; increased serotonin 2A receptors and serotonin transporters in CNS | Open field behavior reversed by clozapine but not PPI |
| 63 | Neurexophillin 3 KO (Beglopoulos, 2005) | Reduced rotorod performance | Disrupted PPI but increased startle response | | | Expressed in Cajal-Retzius cells | |
| 64 | NgR1 KO (Budel, 2008; Kim, 2004) | Mildly hypoactive | Strain-background dependent absence of PPI | Reduced spatial working memory | | | |
| 65 | NMDA NR1 Receptor Hypomorph (Mohn, 1999; Fradley, 2005) | Enhanced response to amphetamine | Disrupted PPI | | Impaired social interaction | 95% reduction in NR1 expression | Behaviors improved by APD |
| 66 | nPAS 1/3 KO (Erbel-Sieler, 2004; Pieper, 2005) | Enhanced open field locomotion | Disrupted PPI | Decreased social recognition | | Reduced reelin interneurons | |
| 67 | Oxytocin and Oxytocin Receptor KO (Ferguson, 2001; Takayanagi, 2005; Caldwell, 2008) | | PCP treatment induces large deficits in PPI | | Impaired social discrimination | | More aggressive |

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| 68 | PDE4B KO (Siuciak, 2008) | Reduced baseline motor activity; exaggerated locomotor response to amphetamine | Decreased PPI | No deficit in Morris water maze | | Decreased striatal DA and 5-HT activity | |
| 69 | Phosphodiesterase 1B KO (Reed, 2002) | Enhanced behavioral response to methamphetamine | | Morris water maze performance impairment | | Increased DARPP-32 phosphorylation | |
| 70 | PLC-beta1 KO (McOmish, 2008a,2008b; Koh, 2008) | Hyperactive | Sensorimotor gating deficits | Memory impairment and lack of acquisition on hippocampal-dependent fear conditioning task | Abnormal social behavior | | Clozapine (McOmish) and haloperidol (Koh) rescues sensorimotor deficits |
| 71 | Proline Dehydrogenase (ProDH) KO (Gogos, 1999; Paterlini, 2005) | Reduced open-field behavior, enhanced response to amphetamine and MK801 | Diminished PPI | | | COMT, calcineurin upregulation, reduced D1 and DARPP-32 expression, | |
| 72 | Regulator of G-protein Signaling 4 (RGS4) KO (Grillet, 2005) | | Subtle PPI deficits | Impaired working memory | | | |
| 73 | Retinoic Acid Receptor KO (Krezel, 1998) | Reduced open field locomotion | | | | Reduced D1R and D2R | |
| 74 | Selectively Bred Low PPI Wistar Rats (Schwabe, 2007; Dieckmann, 2007; Freudenberg, 2007) | Reduced motivation | PPI deficits, reduced startle habituation | Enhanced perseverative behavior | Decreased social interaction | | |
| 75 | Serine Racemase Targeted Disruption (Basu, 2008) | Hyperactive | | Impaired spatial memory | | Lack ability to produce D-Serine; altered glutamatergic neurotransmission | |
| 76 | SNAP 25 Mutant Mouse (Jeans, 2007; Johnson, 2008) | Deficit in exploratory behavior | PPI deficit | | No social interaction deficit | | |

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| 77 | SREB2 Transgenic Mice (Matsumoto, 2008) | | PPI impairments | Contextual memory deficits in fear-conditioning task | Decreased social interaction | Overexpression of SREB2 (GPCR85) in forebrain; Reduced brain weight, increased ventricular volume | |
| 78 | STOP KO (Fradley, 2005; Bégou, 2008; Bouvrais-Veret, 2008; Powell, 2007; Brenner, 2007) | Hyperactive; alterations in dopaminergic neurotransmission in the mesolimbic pathway | Disrupted PPI | Deficits in short term memory and spatial learning; deficits in long-term memory and object recognition | Deficits in social learning and recognition | Enlarged ventricles; reduced volume of cortex and diencephalon; hypoglutamatergic activity | PPI deficit not blocked by clozapine |
| 79 | Synapsin II KO (Dyck, 2007) | | PPI deficit | | Social interaction deficit | | |
| 80 | SynGAP Heterozygote (Guo et al., 2009) | Hyperactive; increased stereotype in open field | Increased acoustic startle response; reduced PPI | Apparent working memory impairment in T-maze alternation task; Decreased fear conditioning. | Impaired social memory; deficit in social interaction | | Clozapine improves hyperactivity |
| 81 | Trace Amine 1 Receptor KO (Wolinsky et al., 2006) | Enhanced locomotor response to amphetamine | Disrupted PPI | | | Increased psychostimulant-induced DA release | |
| 82 | Transient D2 Receptor Overexpression (Kellendonk et al., 2006) | Hyperactive | | Impaired working memory | | Overexpression of D2 receptors in striatum | |
| 83 | Type III Nrg1 Targeted Disruption, Heterozygous (Chen, 2008) | | PPI deficits | Impaired short- term memory | | Enlarged ventricles; decreased dendritic spine density on subicular neurons | PPI deficits reversed by chronic nicotine treatment |

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| 84 | Neonatal Amygdalar Lesion (Daenen, 2002; Daenen, 2003; Hanlon, 2000; Weiner, 2003; Diergaarde et al., 2005; Bouwmeester et al., 2007) | Enhanced amphetamine or apomorphine induced locomotion | Increase acoustic startle response but impair PPI on animals lesioned on PND 7 but not PND 21; abnormally persistent latent inhibition | Impaired place navigation and spatial ability (not found by all studies); impaired spatial alternation and food hoarding | Social behaviors diminished in animals lesioned on PND 7 but not 21 but ventral HPC lesions did not affect social behavior | Increased lateral ventricular volume; reduced density of D1- and D2-like but not D3-like receptors and increased DA turnover in mesolimbic but not striatal regions | |
| 85 | Neonatal NGF-Induced Frontal Cortex Lesion (Lazar et al., 2008) | Hyperactivity | | | Social interaction deficit | | |
| 86 | Neonatal Ventral Hippocampal Lesion (Lipska, 2000; Lipska, 2004; Tseng et al., 2006, 2007, 2008; Endo et al., 2007; Marquis et al., 2008; Brady et al., 2008; Berg and Chambers, 2008) | Enhanced locomotor responses to amphetamine with post-pubertal onset; enhanced meth-amphetamine self-administration | Disrupted PPI | Various impairments in learning and memory | Impaired social behavior | Reduced presynaptic protein and growth factor expression, reduced NMDA receptor expression, impaired DA receptor expression in frontal cortex; impaired maturation of PFC; brain region- and age-specific changes in $GABA_A$ receptor expression; reduced PFC spine density; enhanced sensitivity to nicotine | Locomotor responses blocked by APD, social impairments blocked by clozapine but not haloperidol |
| 87 | Prefrontal Cortical Lesion (Miner, 1997; Wilkinson, 1997; Lipska, 1998; Lacroix, 2000) | Lesion potentiation of amphetamine induced locomotion under high stress conditions only | Medial lesions only augment PPI and lesions have no effect on LI | | | | |

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