

Dlgap4 (GKAP4)

1 Mouse generation

1.1 Mutation

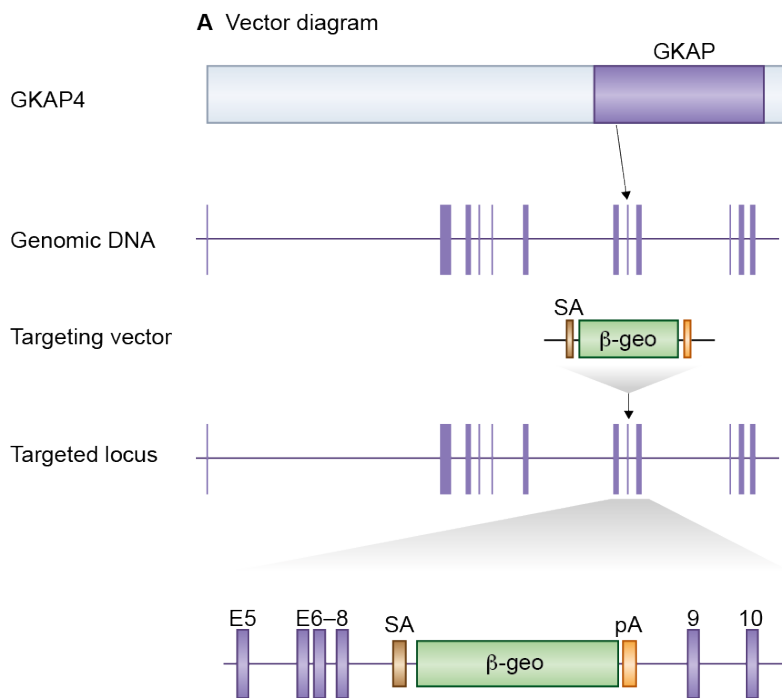


Figure 1: *Details of the mutation*

A mouse embryonic stem (ES) cell line (CA0132, strain 129/Ola) with an insertional mutation in *Dlgap4* was obtained from Sanger Institute Gene Trap Resource (SIGTR - sanger.ac.uk/PostGenomics/genetrapp/). The insertional mutation in CA0132, by the gene-trapping vector, pGT0lxr, that was designed to create an in-frame fusion between the 5' exons of the trapped gene and a reporter, β -geo (a fusion of β -galactosidase and neomycin phosphotransferase II), occurred in intron 8-9. Thus, the gene-trapped locus is predicted to yield a fusion transcript containing exons 1-8 of *Dlgap4* and β -geo. The ES cells were injected into C57BL/6 blastocysts to create chimeric mice, which were bred with 129S5 mice to generate heterozygous *Dlgap4*-mutant mice. Location of *Dlgap4* gene trap. *Dlgap4* is a 13 exon gene encoding a protein that contains a GKAP domain (top). The *Dlgap4* gene trap is located in intron 8-9.

1.2 Genotyping

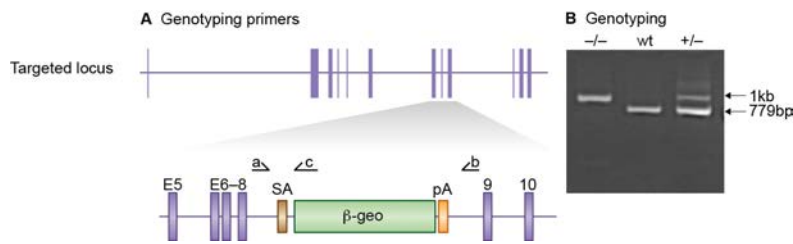


Figure 2: *Genotyping details*

Genomic DNA was isolated from ES cells or mouse tissues by Wizard SV 96 Genomic DNA purification system (Promega Cat A2371). Genotyping PCR consisted of a 779bp product amplified from the wild-type (wt) allele using a forward primer A (5'- GGTTCTTTTACTCAGAGCATG -3') in the wt sequence deleted by targeted mutation and a reverse primer B (5'- CAAACAGACATGTGGACAGAC -3') upstream of the cassette. A 1kb product was amplified from the targeted allele using primer A with reverse primer C (5'- GGTTACGTTGGTGTAGATGG -3'), within the beta-geo cassette. After enzymatic amplification for 35 cycles (45 seconds at 94 degC, 45 seconds at 55 degC, and 1 minute at 72 degC), the PCR products were size-fractionated on a 2% agarose gel in 1x Tris borate-EDTA buffer. Primers used for genotyping (a,b, c). PCR genotyping of gene trap GKAP4 mice using a common forward primer, a, and reverse primers b and c to amplify the wt and mutant alleles respectively.

1.3 Breeding

Birth of $6^{\Delta Y} S^{b/c}$ mice did not follow Mendelian ratios with 30% of offspring being homozygous knockouts. Genotypes of 3-week-old pups from $6^{\Delta Y} S^{b/c}$ intercrosses identified 21 wt, 85 $6^{\Delta Y} S^{b/c}$ and 46 $6^{\Delta Y} S^{b/c}$ progeny (Chi-squared $p=0.006$). Male and female $6^{\Delta Y} S^{b/c}$ mice developed normally to adulthood, exhibited normal body size and no gross abnormalities. $6^{\Delta Y} S^{b/c}$ mice were maintained by backcrossing onto the 129S5/SvEvBrd background; heterozygous males and females were fertile and used to set up intercrosses to generate homozygous and wildtype mice to study.

2 Behaviour

2.1 Definitions

Table 1: *Definitions of Behaviour Variables*

Experiment	Variable	Units	Description
Elevated Plus Maze	EPM total distance	cm	Total distance (cm) travelled in any arm or central zone of the EPM
Elevated Plus Maze	EPM max speed	cm/s	Maximum speed (cm/s) travelled in any arm or central zone of the EPM
Elevated Plus Maze	EPM % time in open	percent	Percentage of time in the open or closed arms of the EPM spent in open arms
Elevated Plus Maze	EPM time in centre	s	Total time (s) spent in the central zone of the EPM
Elevated Plus Maze	EPM max speed, open vs closed	cm/s	Difference between the maximum speed (cm/s) observed in the open arms and the closed arms of the EPM
Open Field/Novel Object	OF, NOE total distance	log10 cm	Total distance travelled (log10 cm) during initial exposure to the open field and in presence of the novel object
Open Field/Novel Object	NOE vs OF distance travelled	cm	Difference in distance travelled (cm) in presence of the novel object and during initial exposure to open field
Rotarod	RR naive fall time	log10 s	Fall time on accelerating rotarod (log10 s), naive performance in session 1
Rotarod	RR learning	s/trial	Learning on rotarod, measured as increase in fall time per trial (s/trial) in session 1
Rotarod	RR memory	s	Memory on rotarod, measured as excess fall time at middle of session 2 relative to middle of session 1
Fear Training	Fear learning, trial effect	percent freezing	Fear learning, measured as extra % time freezing before third trial compared to % time freezing before first trial
Fear Training	Fear learning, tone effect	percent freezing	Fear learning, measured as increase in % time freezing due to third tone compared to increase in % time freezing due to first tone
Contextual Memory	Contextual memory, mean	percent freezing	Contextual memory, measured as difference in % time freezing during first 120 s re-exposure to the box compared to first 120 s in the box on previous day
Contextual Memory	Contextual memory, change	percent freezing	Contextual memory, measured as increase in % time spent freezing from first time bin of 30 s to fourth bin of 30 s during 120 s re-exposure to the box
Cued Memory	Cued memory, mean	percent freezing	Cued memory, measured as increase in % time spent freezing during 120 s of tone re-exposure compared to increase in % time spent freezing during initial tone on previous day
Cued Memory	Cued memory, change	percent freezing	Cued memory, measured as increase in % time spent freezing from first time bin of 30 s to fourth bin of 30 s during 120 s re-exposure to the tone

2.2 Behaviour Overview

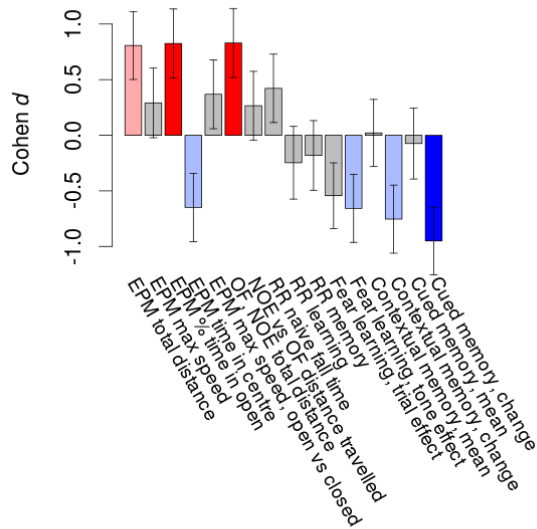


Figure 3: Behaviour Overview. Alteration in a repertoire of eight innate and eight learned behavioural variables is shown. Cohen d effect sizes of the mutation are presented \pm SE.

Mutant mice showed medium overall behavioural difference from wildtypes, with seven of 16 behavioural variables significantly impacted in these mutants. In the elevated plus maze task, three behavioural variables of five were significantly impacted in mutants. In the open field/novel object exploration task, one behavioural variable, OF NOE total distance, was significantly increased in mutants. In the fear learning task, one behavioural variable, fear learning tone effect, was significantly decreased in mutants. In the contextual memory task, one behavioural variable, contextual memory change, was significantly decreased in mutants. In the cued memory task, one behavioural variable, cued memory change, was significantly decreased in mutants. Only the rotarod task was unaffected. Definitions of variables may be found below.

2.3 Elevated Plus Maze - Innate/Instinctive Behaviour

Table 2: Analysis of Innate or Instinctive Variables: mean(SEM) of behaviour scores for wildtype and mutant males and females, with p -values of differences

Variable	Units	Wildtype M (n=10)	Wildtype F (n=11)	Mutant M (n=14)	Mutant F (n=10)	P(sex x mutation)	P(mutation)
EPM total distance	cm	744 (66)	981 (59)	1305 (122)	1041 (190)	0.046 *	0.011 *
EPM max speed	cm/s	17.3 (1.2)	18.6 (0.6)	20.3 (0.9)	17.8 (2.4)	0.17	0.38
EPM percent time in open	%	17 (5)	22.1 (5.2)	26.6 (4.8)	59.4 (11.6)	0.051	0.0021 **
EPM time in centre	s	102 (13)	109 (12)	81 (13)	74 (15)	0.57	0.045 *
EPM max speed, open vs closed	cm/s	-8.1 (2.3)	-6.2 (1.8)	-6.3 (1.2)	-2.8 (2.4)	0.68	0.18

EPM total distance: Total distance (cm) travelled in any arm or central zone of the EPM

EPM max speed: Maximum speed (cm/s) travelled in any arm or central zone of the EPM

EPM percent time in open: Percentage of time in the open or closed arms of the EPM spent in open arms

EPM time in centre: Total time (s) spent in the central zone of the EPM

EPM max speed, open vs closed: Difference between the maximum speed (cm/s) observed in the open arms and the closed arms of the EPM

2.4 Open Field & Novel Object Exploration - Innate/Instinctive Behaviour

Table 3: Analysis of Innate or Instinctive Variables: mean(SEM) of behaviour scores for wildtype and mutant males and females, with p-values of differences

Variable	Units	Wildtype M (n=10)	Wildtype F (n=11)	Mutant M (n=14)	Mutant F (n=10)	P(sex x mutation)	P(mutation)
OF, NOE total distance	log ₁₀ cm	3.15 (0.08)	3.3 (0.08)	3.53 (0.07)	3.36 (0.12)	0.071	0.0095 **
NOE vs OF distance travelled	cm	150 (240)	-380 (210)	140 (350)	80 (200)	0.41	0.46

OF, NOE total distance: Total distance travelled (log₁₀ cm) during initial exposure to the open field and in presence of the novel object

NOE vs OF distance travelled: Difference in distance travelled (cm) in presence of the novel object and during initial exposure to open field

2.5 Motor Behaviour - Innate/Instinctive Ability, Learning & Memory

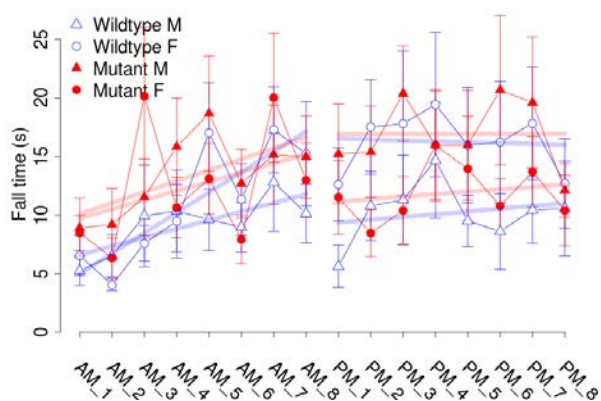


Figure 4: RR histories. Mutant and wildtype (WT) males and females as indicated. Data represent mean \pm SEM.

Table 4: RR analysis: mean(SEM) of behaviour scores for wildtype and mutant males and females, with p-values of differences

Variable	Units	Wildtype M (n=10)	Wildtype F (n=11)	Mutant M (n=14)	Mutant F (n=10)	P(sex x mutation)	P(mutation)
RR naive fall time	log ₁₀ s	0.76 (0.11)	0.78 (0.07)	0.87 (0.12)	0.96 (0.08)	0.77	0.17
RR learning	s/trial	0.7 (0.5)	1.7 (0.5)	0.9 (0.5)	0.8 (0.4)	0.24	0.48
RR memory	s	1 (1.2)	5.2 (2.6)	3.5 (2.3)	-0.6 (2.4)	0.074	0.55

RR naive fall time: Fall time on accelerating rotarod (log₁₀ s), naive performance in session 1

RR learning: Learning on rotarod, measured as increase in fall time per trial (s/trial) in session 1

RR memory: Memory on rotarod, measured as excess fall time at middle of session 2 relative to middle of session 1

2.6 Fear Conditioning - Learning & Memory

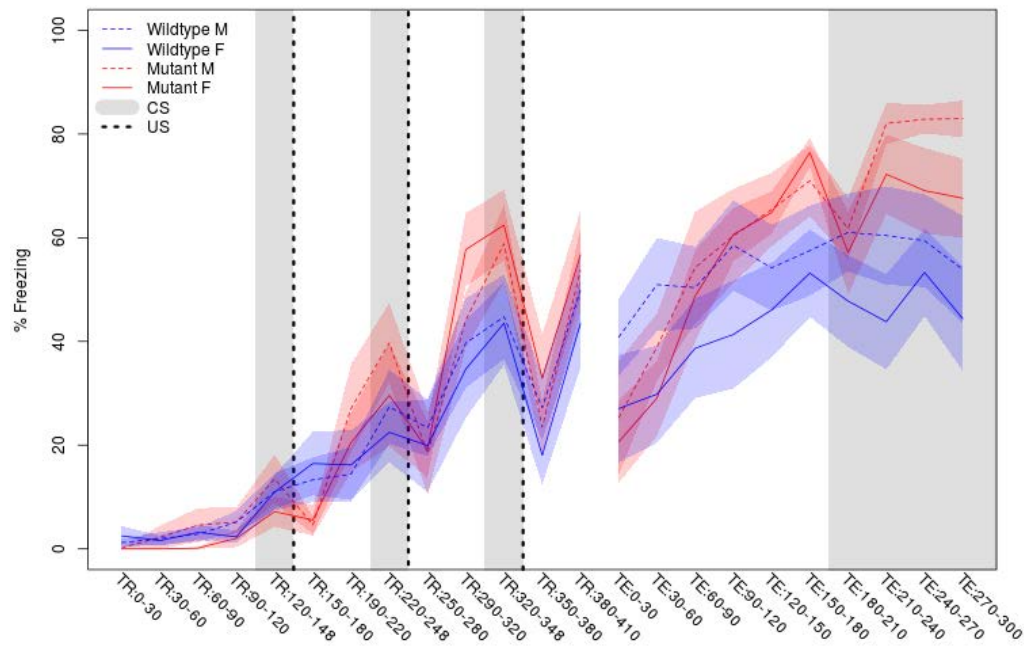


Figure 5: FC histories. Percent freezing presented as mean \pm SEM. TR:N-n, percent time spent freezing during time interval $N < t \leq n$ seconds on training day. TE:N-n, same on testing day.

Table 5: FC analysis: mean(SEM) of behaviour scores for wildtype and mutant males and females, with p-values of differences

Variable	Units	Wildtype M (n=10)	Wildtype F (n=11)	Mutant M (n=14)	Mutant F (n=10)	P(sex x mutation)	P(mutation)
Fear learning, trial effect	% freezing	38.9 (6)	55.7 (6.6)	34.5 (8.8)	32.3 (8.6)	0.24	0.1
Fear learning, tone effect	% freezing	2 (5.9)	4.5 (5.7)	-7.7 (4.4)	-7.9 (5.3)	0.8	0.045 *
Contextual memory, mean	% freezing	41.7 (7.8)	39.2 (5.6)	47.4 (7.8)	31.8 (8.9)	0.4	0.95
Contextual memory, change	% freezing	30.1 (11.1)	38 (10.6)	13.8 (5)	14.5 (6.6)	0.67	0.023 *
Cued memory, mean	% freezing	1.4 (4.5)	-10.4 (6.3)	-0.8 (6.4)	-14 (6.1)	0.91	0.64
Cued memory, change	% freezing	11.7 (7.2)	0.8 (7.9)	-16.7 (5.3)	-13 (7.4)	0.3	0.0033 **

Fear learning, trial effect: Fear learning, measured as extra percent time freezing before third trial compared to percent time freezing before first trial

Fear learning, tone effect: Fear learning, measured as increase in percent time freezing due to third tone compared to increase in percent time freezing due to first tone

Contextual memory, mean: Contextual memory, measured as difference in percent time freezing during first 120 s re-exposure to the box compared to first 120 s in the box on previous day

Contextual memory, change: Contextual memory, measured as increase in percent time spent freezing from first time bin of 30 s to fourth bin of 30 s during 120 s re-exposure to the box

Cued memory, mean: Cued memory, measured as increase in percent time spent freezing during 120 s of tone re-exposure compared to increase in percent time spent freezing during initial tone on previous day

Cued memory, change: Cued memory, measured as increase in percent time spent freezing from first time bin of 30 s to fourth bin of 30 s during 120 s re-exposure to the tone