

SUPPLEMENTARY MATERIAL

Individual variation in cognitive style reflects foraging and anti-
predator strategies in a small mammal

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Appendix A

Assessment of cognitive style and personality

We initially assessed 86 voles (45 males and 41 females) for olfactory associative learning. The test consisted of two tasks: an initial learning task and a reversal learning task. The reward was the chance to return to the safety of the home cage. The test arena was a plastic Y-maze (40 cm long, 5 cm wide, walls 15 cm high) with bent arms, so that the end of the arm was not visible from where the animals were released. One of the openings at the end of the maze was closed with wire mesh; the other had a mesh flap of the same material allowing the vole to exit the maze and enter the home cage. Different odour cues were placed inside each arm of the maze about 5 cm from the intersection. The side of the open door and associated positive cue were alternated each time a vole entered the maze, to avoid arm bias effects. For reversal learning, we switched the positive and the negative cues, so that the previously rewarded odour now led to the blocked door. Both tasks were considered successfully solved when the vole chose the arm leading to the home cage in seven out of 10 consecutive trials. Learning and reversal learning were expressed as learning and reversal learning scores, the number of trials necessary to reach the criterion in the two tasks.

We also assessed among-individual differences in activity, exploration and boldness using two standardized laboratory tests¹³: the open field test and the novel object test. The open field test⁶³ measures the activity and exploration of a novel, empty, circular arena. The novel object test measures the animal's boldness and neophobia when an unknown object is placed in a familiar environment. Both tests were repeated 15 days later and repeatability of the measured traits was assessed (boldness: $R = 0.67$, $CI = 0.68-0.89$, $p < 0.001$; activity: $R = 0.74$, $CI = 0.65-0.84$, $p < 0.001$). Boldness and activity correlated at the phenotypic level (mean trait value per individual: $r_s = 0.43$, $P < 0.001$).

Learning speed, flexibility and personality were closely related³⁶, with faster, inflexible learners being bolder and more active than slower, flexible learners. After completing these assessments, we used the learning and reversal learning scores and the personality to rank the animals. We selected those

27 with more pronounced traits for the study presented here ($N = 30$ males, $N = 30$ females). The
28 groups differed in activity and boldness, as well as learning and reversal learning (Mann-Whitney-U
29 test, all $p < 0.05$, figure S1 in the Supplementary Material).

Fig. S1 – Learning, reversal learning, activity and boldness scores of the two groups of bank voles. The mean ($\pm$ SD) learning score for fast learners was 13.6 ± 1.8 and 20.1 ± 2.3 for slow learners. The mean reversal learning score was 19.5 ± 2.2 for fast learners and 13.9 ± 2.0 for slow learners. The mean boldness score was 0.83 ± 0.66 for fast learners and -0.63 ± 0.62 for slow learners. The mean activity score was 0.85 ± 0.75 for fast learners and -0.70 ± 0.72 for slow learners.

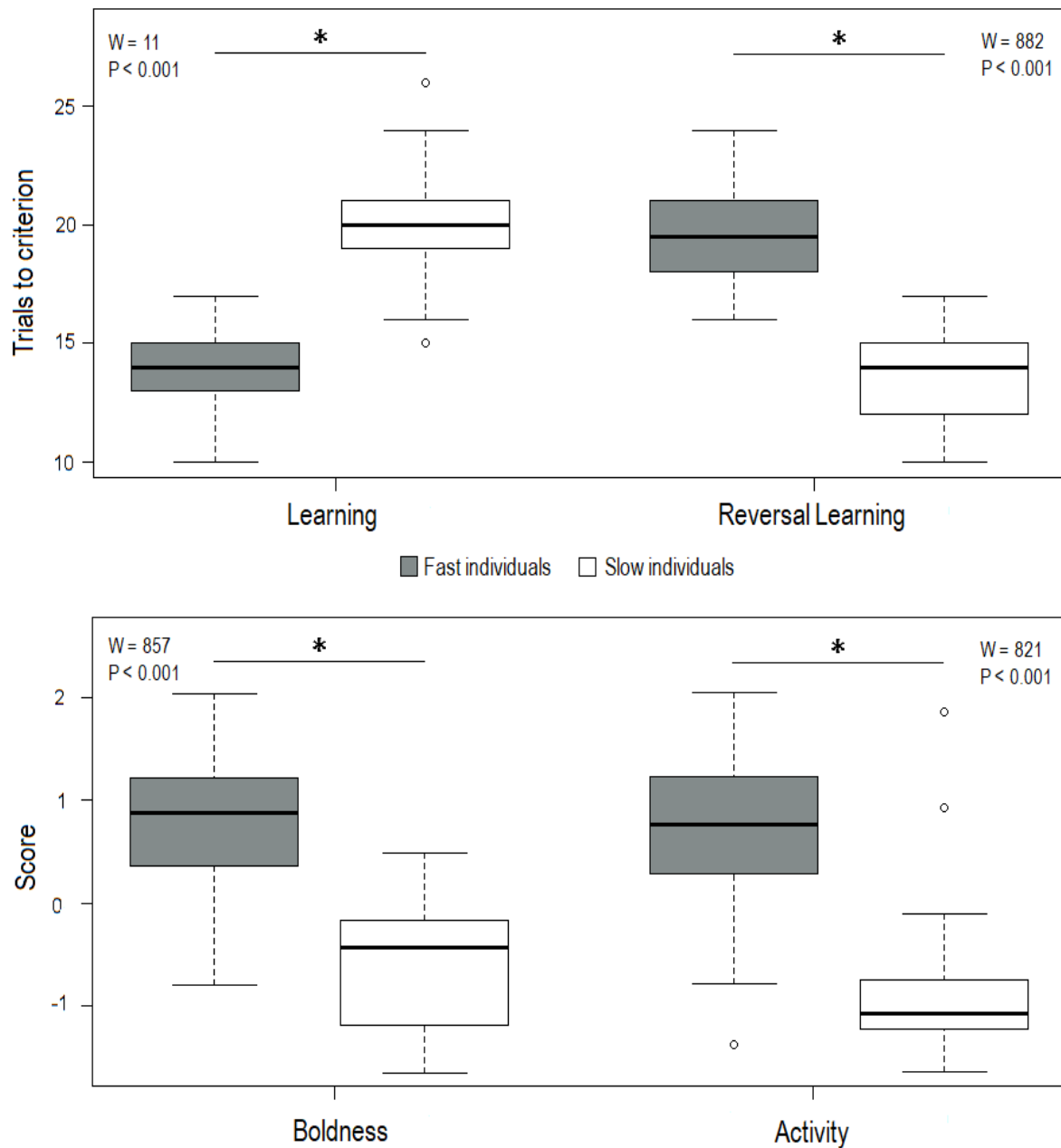


Table S1 – Results of the full models for giving-up densities (GUDs), number of visits, duration of visits, proportion of time spent foraging and in vigilance in relation to cognitive style/personality (fast vs slow), risk area (high-risk vs low-risk), experimental day, sex and time of day (day vs night) for 5 days of observations of 39 individual bank voles (*Myodes glareolus*) in outdoor enclosures. Statistically significant effects are highlighted in bold.

	GUDs						Visit N				Visit Duration					
	Estimate	SE	DF	F	P		Estimate	SE	z	P	Estimate	SE	DF	F	P	
Intercept	0.64	0.03	1 345	1008.1	< 0.001		1.40	0.05	29.0	< 0.001	4.59	0.09	1 624	7137.24	< 0.001	
Cognitive style/personality (Slow)	-0.01	0.03	1 36	20.4	< 0.001		-0.28	0.06	-5.0	< 0.001	0.52	0.11	1 36	1.40	0.244	
Area (High-risk)	0.19	0.02	1 345	806.1	< 0.001		-0.90	0.08	-10.8	< 0.001	-0.77	0.06	1 624	670.65	< 0.001	
Experimental day	-0.04	0.01	1 345	39.3	< 0.001		0.22	0.02	9.1	< 0.001	0.21	0.02	1 624	368.97	< 0.001	
Sex (M)	0.01	0.03	1 36	0.1	0.75		-0.10	0.04	-2.4	0.02	-0.06	0.11	1 36	0.17	0.686	
Time of day (Night)			/				0.07	0.05	1.3	0.21	0.08	0.04	1 624	100.03	< 0.001	
Cognitive style/personality:Area	0.29	0.02	1 345	162.2	< 0.001		-0.82	0.10	-8.2	< 0.001	-1.37	0.07	1 624	286.04	< 0.001	
Cognitive style/personality:Experimental day	-0.03	0.01	1 345	43.0	< 0.001		-0.01	0.04	-0.3	0.78	0.15	0.03	1 624	1.02	0.314	
Area:Experimental day	-0.02	0.01	1 345	53.4	< 0.001		0.01	0.04	0.3	0.74	-0.02	0.03	1 624	54.76	< 0.001	
Area:Time of day			/				1.10	0.09	11.9	< 0.001	0.67	0.07	1 624	95.88	< 0.001	
Cognitive style/personality:Area:Experimental day	0.16	0.02	1 345	99.6	< 0.001		-0.49	0.07	-7.1	< 0.001	-0.45	0.05	1 624	74.78	< 0.001	

	Foraging						Vigilance					
	Estimate	SE	DF	F	P		Estimate	SE	DF	F	P	
Intercept	73.38	1.48	1 625	4860.1	< 0.001		26.62	1.48	1 625	3249.2	< 0.001	
Cognitive style/personality (Slow)	-26.90	1.76	1 36	138.9	< 0.001		26.90	1.76	1 36	138.9	< 0.001	
Area (High-risk)	-25.68	1.19	1 625	433.8	< 0.001		25.68	1.19	1 625	433.8	< 0.001	
Experimental day	4.79	0.57	1 625	52.7	< 0.001		-4.79	0.57	1 625	52.7	< 0.001	
Sex (Male)	0.75	1.58	1 36	0.2	0.67		-0.75	1.58	1 36	0.2	0.67	
Time of day (Night)	2.61	0.91	1 625	10.1	0.002		-2.61	0.91	1 625	10.1	0.002	
Cognitive style/personality:Area	13.15	1.95	1 625	76.6	< 0.001		-13.15	1.95	1 625	76.6	< 0.001	
Cognitive style/personality:Experimental day	-3.72	0.84	1 625	66.0	< 0.001		3.72	0.84	1 625	66.0	< 0.001	
Area:Experimental day	0.06	0.84	1 625	8.3	0.004		-0.06	0.84	1 625	8.3	0.004	
Cognitive style/personality:Area:Experimental day	-5.58	1.41	1 625	15.7	< 0.001		5.58	1.41	1 625	15.7	< 0.001	

Table S2 – Giving-up densities (GUDs), number of visits, duration of visits, proportion of time spent foraging and in vigilance in relation to cognitive style/personality (fast vs slow), experimental day, sex and time of day (day vs night) in the high-risk and low-risk area for 5 days of observations of 39 individual bank voles (*Myodes glareolus*) in outdoor enclosures. Statistically significant effects are highlighted in bold.

	Low risk						High risk					
GUDs	Estimate	SE	DF	F	P		Estimate	SE	DF	F	P	
Intercept	0.65	0.03	1	154	1213.9	< 0.001	0.45	0.03	1	154	341.0	< 0.001
Cognitive style/personality (Slow)	-0.01	0.04	1	36	0.0	0.88	0.28	0.04	1	36	64.2	< 0.001
Experimental day	-0.04	0.01	1	154	118.9	< 0.001	-0.06	0.01	1	154	0.7	0.41
Sex (Male)	0.02	0.04	1	36	0.3	0.57	-0.001	0.04	1	36	0.0	0.97
Cognitive style/personality:Experimental day	-0.03	0.01	1	154	7.5	0.01	0.13	0.01	1	154	175.8	< 0.001
Visit N	Estimate	SE		z	P		Estimate	SE		z	P	
Intercept	1.40	0.05		27.9	< 0.001		0.50	0.08		6.1	< 0.001	
Cognitive style/personality (Slow)	-0.29	0.05		-5.4	< 0.001		-1.10	0.09		-12.0	< 0.001	
Experimental day	0.22	0.02		11.4	< 0.001		0.24	0.03		8.7	< 0.001	
Sex (Male)	-0.10	0.05		-1.8	0.07		-0.11	0.08		-1.5	0.14	
Time of day (Night)	0.07	0.05		1.3	0.21		1.17	0.08		15.3	< 0.001	
Cognitive style/personality:Experimental day				/			-0.50	0.06		-8.8	< 0.001	
Visit Duration	Estimate	SE	DF	F	P		Estimate	SE	DF	F	P	
Intercept	4.59	0.13	1	346	4243.2	< 0.001	3.81	0.09	1	241	5255.8	< 0.001
Cognitive style/personality (Slow)	0.52	0.15	1	36	12.4	0.001	-0.89	0.11	1	36	48.2	< 0.001
Experimental day	0.21	0.02	1	346	473.6	< 0.001	0.21	0.02	1	241	43.8	< 0.001
Sex (Male)	-0.07	0.15	1	36	0.2	0.65	-0.05	0.11	1	36	0.0	0.83
Time of day (Night)	0.08	0.04	1	346	5.2	0.02	0.77	0.04	1	241	322.7	< 0.001
Cognitive style/personality:Experimental day	0.15	0.03	1	346	34.3	< 0.001	-0.32	0.03	1	241	85.4	< 0.001
Foraging	Estimate	SE	DF	F	P		Estimate	SE	DF	F	P	
Intercept	73.96	1.64	1	346	4516.0	< 0.001	46.63	1.83	1	241	2020.6	< 0.001
Cognitive style/personality (Slow)	-26.91	1.87	1	36	206.6	< 0.001	-13.71	2.15	1	36	30.9	< 0.001
Experimental day	4.79	0.51	1	346	68.6	< 0.001	4.92	0.69	1	241	12.9	< 0.001
Sex (Male)	0.30	1.87	1	36	0.0	0.88	1.64	2.03	1	36	0.8	0.39
Time of day (Night)	1.87	1.05	1	346	3.2	0.08	3.78	1.59	1	241	4.7	0.03
Cognitive style/personality:Experimental day	-3.73	0.75	1	346	24.8	< 0.001	-9.21	1.26	1	241	53.2	< 0.001
Vigilance	Estimate	SE	DF	F	P		Estimate	SE	DF	F	P	
Intercept	26.04	1.64	1	346	1604.0	< 0.001	53.37	1.83	1	241	2939.0	< 0.001
Cognitive style/personality (Slow)	26.91	1.87	1	36	206.6	< 0.001	13.71	2.15	1	36	30.9	< 0.001
Experimental day	-4.79	0.51	1	346	68.7	< 0.001	-4.92	0.69	1	241	12.9	< 0.001
Sex (Male)	-0.30	1.87	1	36	0.0	0.88	-1.64	2.03	1	36	0.8	0.39
Time of day (Night)	-1.87	1.05	1	346	3.2	0.08	-3.78	1.59	1	241	4.7	0.03
Cognitive style/personality:Experimental day	3.73	0.75	1	346	24.8	< 0.001	9.21	1.26	1	241	53.2	< 0.001