

Supplementary Materials: Individual repeatability, species differences, and the influence of socio-ecological factors on neophobia in 10 corvid species

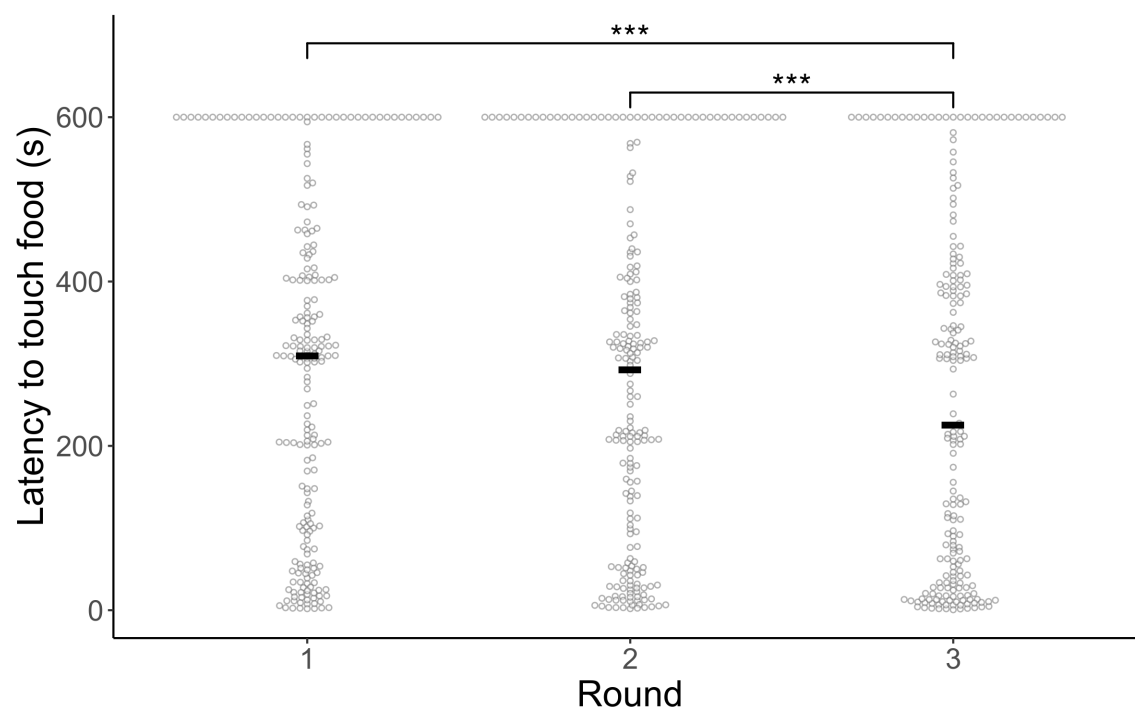


Figure S1. Latency to touch familiar food in each round, across all conditions and species. Round 3 differs from round 1 and 2, while round 1 and 2 do not differ from each other. Points represent individuals, lines represent median.

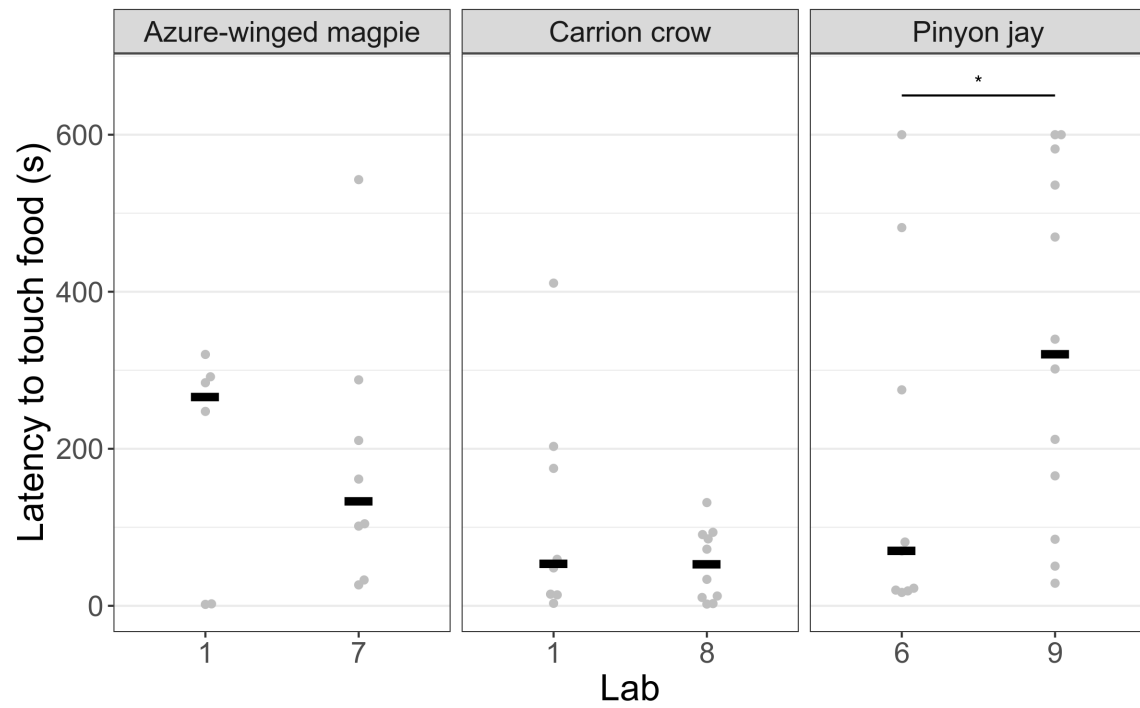


Figure S2. Lab effect on latency to touch familiar food in azure-winged magpies, carrion crows, and pinyon jays.

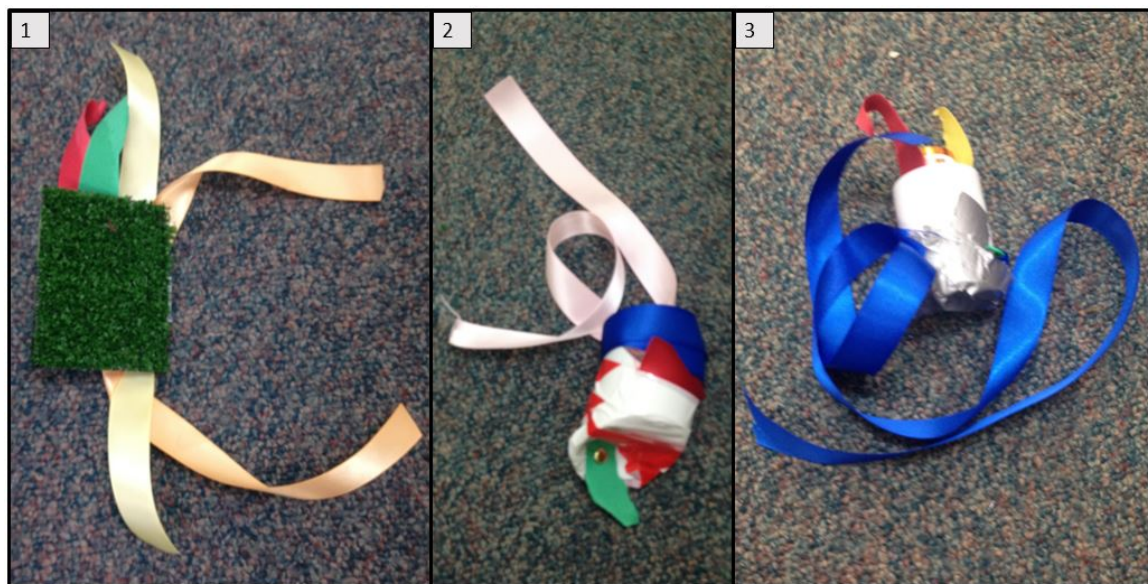


Figure S3. Example of novel objects for Eurasian jays.

Table S1

Linear mixed models with main effect of lab on latency to touch familiar food for the three species that were tested in two labs

	Azure-winged magpie			Carrion crow			Pinyon jay		
Fixed effect	χ^2	df	p-value	χ^2	df	p-value	χ^2	df	p-value
lab	1.024	1	0.312	0.078	1	0.78	4.35	1	0.037

Table S2

Pairwise comparisons of novel object difference scores between species

	Estimate	Standard error	z	p-value
Azure-winged magpie - 'Alalā	-0.248	0.140	-1.777	0.076
Blue jay - 'Alalā	-0.431	0.162	-2.660	0.008
Carrion crow - 'Alalā	-0.056	0.127	-0.438	0.661
Clark's nutcracker - 'Alalā	-0.555	0.155	-3.590	0.000
Common raven - 'Alalā	0.148	0.131	1.127	0.260
Eurasian jay - 'Alalā	-0.058	0.111	-0.522	0.602
Large-billed crow - 'Alalā	-0.687	0.138	-4.985	0.000
New Caledonian crow - 'Alalā	-0.382	0.163	-2.338	0.019
Pinyon jay - 'Alalā	-0.307	0.113	-2.727	0.006
Blue jay - Azure-winged magpie	-0.183	0.202	-0.905	0.366
Carrion crow - Azure-winged magpie	0.193	0.175	1.101	0.271
Clark's nutcracker - Azure-winged magpie	-0.307	0.196	-1.566	0.117
Common raven - Azure-winged magpie	0.396	0.178	2.227	0.026
Eurasian jay - Azure-winged magpie	0.191	0.164	1.165	0.244
Large-billed crow - Azure-winged magpie	-0.438	0.183	-2.397	0.017
New Caledonian crow - Azure-winged magpie	-0.134	0.203	-0.658	0.510
Pinyon jay - Azure-winged magpie	-0.059	0.165	-0.358	0.720
Carrion crow - Blue jay	0.375	0.193	1.942	0.052
Clark's nutcracker - Blue jay	-0.124	0.212	-0.584	0.559
Common raven - Blue jay	0.579	0.196	2.955	0.003
Eurasian jay - Blue jay	0.373	0.183	2.040	0.041
Large-billed crow - Blue jay	-0.255	0.200	-1.275	0.202
New Caledonian crow - Blue jay	0.049	0.219	0.224	0.823
Pinyon jay - Blue jay	0.124	0.184	0.671	0.502
Clark's nutcracker - Carrion crow	-0.499	0.187	-2.670	0.008
Common raven - Carrion crow	0.204	0.168	1.210	0.226
Eurasian jay - Carrion crow	-0.002	0.153	-0.014	0.989
Large-billed crow - Carrion crow	-0.631	0.173	-3.639	0.000
New Caledonian crow - Carrion crow	-0.326	0.194	-1.678	0.093
Pinyon jay - Carrion crow	-0.252	0.154	-1.632	0.103
Common raven - Clark's nutcracker	0.703	0.190	3.704	0.000
Eurasian jay - Clark's nutcracker	0.497	0.176	2.819	0.005
Large-billed crow - Clark's nutcracker	-0.132	0.194	-0.677	0.498
New Caledonian crow - Clark's nutcracker	0.173	0.213	0.811	0.417
Pinyon jay - Clark's nutcracker	0.248	0.178	1.394	0.163
Eurasian jay - Common raven	-0.206	0.156	-1.317	0.188
Large-billed crow - Common raven	-0.834	0.176	-4.733	0.000
New Caledonian crow - Common raven	-0.530	0.197	-2.689	0.007
Pinyon jay - Common raven	-0.455	0.158	-2.890	0.004
Large-billed crow - Eurasian jay	-0.629	0.162	-3.886	0.000
New Caledonian crow - Eurasian jay	-0.324	0.184	-1.760	0.078
Pinyon jay - Eurasian jay	-0.250	0.141	-1.768	0.077
New Caledonian crow - Large-billed crow	0.304	0.201	1.512	0.131
Pinyon jay - Large-billed crow	0.379	0.163	2.325	0.020
Pinyon jay - New Caledonian crow	0.075	0.185	0.402	0.687

Table S3

Pairwise comparisons of novel food difference scores between species

	Estimate	Standard error	z	p-value
Blue jay - Azure-winged magpie	-0.005	0.179	-0.031	0.976
Carrion crow - Azure-winged magpie	0.145	0.156	0.932	0.352
Clark's nutcracker - Azure-winged magpie	-0.010	0.173	-0.059	0.953
Common raven - Azure-winged magpie	0.010	0.158	0.066	0.948
Eurasian jay - Azure-winged magpie	0.446	0.146	3.046	0.002
Large-billed crow - Azure-winged magpie	0.012	0.162	0.072	0.942
New Caledonian crow - Azure-winged magpie	-0.186	0.179	-1.040	0.298
Pinyon jay - Azure-winged magpie	0.024	0.146	0.164	0.869
Carrion crow - Blue jay	0.151	0.171	0.879	0.380
Clark's nutcracker - Blue jay	-0.005	0.187	-0.025	0.980
Common raven - Blue jay	0.016	0.173	0.091	0.927
Eurasian jay - Blue jay	0.452	0.163	2.771	0.006
Large-billed crow - Blue jay	0.017	0.177	0.097	0.923
New Caledonian crow - Blue jay	-0.180	0.192	-0.937	0.349
Pinyon jay - Blue jay	0.029	0.163	0.181	0.856
Clark's nutcracker - Carrion crow	-0.155	0.166	-0.936	0.349
Common raven - Carrion crow	-0.135	0.150	-0.900	0.368
Eurasian jay - Carrion crow	0.301	0.138	2.187	0.029
Large-billed crow - Carrion crow	-0.133	0.154	-0.867	0.386
New Caledonian crow - Carrion crow	-0.331	0.171	-1.930	0.054
Pinyon jay - Carrion crow	-0.121	0.137	-0.883	0.377
Common raven - Clark's nutcracker	0.021	0.168	0.122	0.903
Eurasian jay - Clark's nutcracker	0.456	0.157	2.902	0.004
Large-billed crow - Clark's nutcracker	0.022	0.172	0.127	0.899
New Caledonian crow - Clark's nutcracker	-0.175	0.187	-0.936	0.349
Pinyon jay - Clark's nutcracker	0.034	0.157	0.218	0.827
Eurasian jay - Common raven	0.436	0.140	3.113	0.002
Large-billed crow - Common raven	0.001	0.156	0.009	0.993
New Caledonian crow - Common raven	-0.196	0.173	-1.131	0.258
Pinyon jay - Common raven	0.014	0.139	0.098	0.922
Large-billed crow - Eurasian jay	-0.435	0.145	-3.007	0.003
New Caledonian crow - Eurasian jay	-0.632	0.163	-3.876	0.000
Pinyon jay - Eurasian jay	-0.422	0.127	-3.337	0.001
New Caledonian crow - Large-billed crow	-0.197	0.177	-1.116	0.265
Pinyon jay - Large-billed crow	0.012	0.144	0.085	0.932
Pinyon jay - New Caledonian crow	0.210	0.163	1.290	0.197

Table S4

Individual temporal and contextual repeatability

Control	Novel object	Novel food	Overall repeatability
N=216, R=0.542 (0.468, 0.621), $p < 0.001$	N=215, R=0.548 (0.475, 0.628), $p < 0.001$	N=132, R=0.477 (0.376, 0.589), $p < 0.001$	N=217, R=0.462 (0.399, 0.520), $p < 0.001$

Table S5

Individual temporal repeatability within each species and condition

Species	Control	Novel object	Novel food
'Alalā	N=84, R=0.542 (0.428, 0.659), $p < 0.001$	N=84, R=0.540 (0.415, 0.642), $p < 0.001$	NA
Azure-winged magpie	N=13, R=0.309 (0.000, 0.659), $p = 0.044$	N=13, R=0.593 (0.240, 0.831), $p = 0.001$	N=14, R=0.233 (0.000, 0.602), $p = 0.121$
Blue jay	N=9, R=0.962 (0.876, 0.988), $p < 0.001$	N=9, R=0.814 (0.447, 0.939), $p < 0.001$	N=9, R=0.680 (0.234, 0.895), $p < 0.001$
Carrion crow	N=18, R=0.740 (0.458, 0.887), $p < 0.001$	N=17, R=0.755 (0.502, 0.893), $p < 0.001$	N=17, R=0.456 (0.101, 0.728), $p = 0.002$
Clark's nutcracker	N=10, R=0.535 (0.114, 0.835), $p = 0.002$	N=10, R=0.582 (0.168, 0.845), $p = 0.001$	N=10, R=0.492 (0.037, 0.799), $p = 0.005$
Common raven	N=15, R=0.638 (0.310, 0.841), $p < 0.001$	N=15, R=0.707 (0.394, 0.871), $p < 0.001$	N=15, R=0.630 (0.278, 0.837), $p < 0.001$
Eurasian jay	N=24, R=0.557 (0.323, 0.759), $p < 0.001$	N=24, R=0.290 (0.018, 0.561), $p = 0.012$	N=24, R=0.346 (0.043, 0.611), $p = 0.003$
Large-billed crow	N=13, R=0.496 (0.108, 0.773), $p = 0.001$	N=13, R=0.216 (0.000, 0.591), $p = 0.099$	N=13, R=0.426 (0.030, 0.722), $p = 0.006$
New Caledonian crow	N=9, R=0.177 (0.000, 0.600), $p = 0.189$	N=9, R=0.164 (0.000, 0.605), $p = 0.245$	N=9, R=0.000 (0.000, 0.460), $p = 1.000$
Pinyon jay	N=21, R=0.690 (0.464, 0.842), $p < 0.001$	N=21, R=0.863 (0.735, 0.930), $p < 0.001$	N=21, R=0.738 (0.533, 0.870), $p < 0.001$

Table S6

Individual contextual repeatability within each species

Species	Repeatability across conditions
'Alalā	N=84, R=0.545 (0.374, 0.683), $p < 0.001$
Azure-winged magpie	N=14, R=0.740 (0.449, 0.890), $p < 0.001$
Blue jay	N=9, R=0.889 (0.674, 0.967), $p < 0.001$
Carrion crow	N=18, R=0.721 (0.477, 0.867), $p < 0.001$
Clark's nutcracker	N=10, R=0.693 (0.333, 0.888), $p < 0.001$
Common raven	N=15, R=0.802 (0.580, 0.912), $p < 0.001$
Eurasian jay	N=24, R=0.583 (0.326, 0.765), $p < 0.001$
Large-billed crow	N=13, R=0.651 (0.328, 0.849), $p < 0.001$
New Caledonian crow	N=9, R=0.270 (0.000, 0.687), $p = 0.091$
Pinyon jay	N=21, R=0.800 (0.640, 0.905), $p < 0.001$

Table S7
Subject information

Species	Lab	Sex (males/females or unknown)	Age (adults/juveniles)	Rearing information	Housing	Controlled feeding schedule
Common raven <i>Corvus corax</i>	Bugnyar	7/8	15/0	Hand-reared	Group/pair	No (fed prior to testing)
Carrion/hooded crow <i>C. corone</i> ; <i>C. cornix</i>	Bugnyar	4/4	8/0	Hand-reared	Group/pair	No (fed prior to testing)
Carrion crow <i>C. corone</i>	Nieder	10/0	10/0	Hand-reared	Group	Yes (tested before feeding)
Large-billed crow <i>C. macrorhynchos</i>	Izawa	8/5	13/0	Wild: parent reared	Group	Yes (fed 2 hours prior)
New Caledonian crow <i>C. moneduloides</i>	Taylor	3/6	4/5	Wild: parent reared	Group	No (fed prior to testing)
'Alalā <i>C. hawaiiensis</i>	Greggor	64/44	93/25	Hand-reared and parent-reared	Group/pair	No
Eurasian jay <i>Garrulus glandarius</i>	Clayton	14/10	24/0	Hand-reared	Group	Yes (fed 1 hour prior)
Pinyon jay <i>Gymnorhinus cyanocephalus</i>	Stevens	10/2	12/0	Wild: parent reared	Individual cages	No (tested at feeding time, fed after testing)
Pinyon jay <i>Gymnorhinus cyanocephalus</i>	Kelly	4/5	9/0	Wild: parent reared	Individual cages	No (tested at feeding time, fed after testing)
Blue jay <i>Cyanocitta cristata</i>	Gould	2/2 (5 unknown)	9/0	Hand-reared	Individual cages	No (tested at feeding time, fed after testing)
Clark's nutcracker <i>Nucifraga columbiana</i>	Kelly	7/3	10/0	Wild: parent reared	Individual cages	No (tested at feeding time, fed after testing)
Azure-winged magpie <i>Cyanopica cyanus</i>	Li	6/2	8/0	Parent-reared & Hand-reared	Individual cages	No (tested at feeding time, fed after testing)
Azure-winged magpie <i>Cyanopica cyanus</i>	Bugnyar & Massen	2/4	6/0	Parent-reared & Hand-reared	Group	No (fed prior to testing)

Species	Cage size (m)	Testing situation	Familiar with testing cage	Transportation to testing cage	Prior neophobia testing
Common raven <i>Corvus corax</i>	3×4×5	Alone	Yes (constant access)	Voluntary (trained/encouraged)	No (but frequent introduction of novel objects and food)
Carrion/hooded crow <i>C. corone</i> ; <i>C. cornix</i>	3×4×5	Alone	Yes (constant access)	Voluntary (trained/encouraged)	No (but frequent introduction of novel objects and food)
Carrion crow <i>C. corone</i>	1.4×1×1	Alone	Yes (habituated in prior experiment)	Moved	No (but frequent introduction of novel objects and food)
Large-billed crow <i>C. macrorhynchos</i>	2×2×2	Alone	Yes (constant access)	Moved	No
New Caledonian crow <i>C. moneduloides</i>	2×3×3	Alone	Yes (constant access)	Voluntary (flushed)	No
'Alalā <i>C. hawaiiensis</i>	6.1×6.1×5.5 – 12.2×6.1×5.5	Partner or juvenile social group present	Yes (home cage)	Tested in home cage	No
Eurasian jay <i>Garrulus glandarius</i>	2×2×1	Alone	Yes (constant access)	Voluntary (trained/encouraged or flushed)	No (but frequent introduction of novel objects and food)
Pinyon jay <i>Gymnorhinus cyanocephalus</i>	0.5×0.7×0.7	Alone	Yes (habituated in prior experiment)	Moved	Yes (experienced novel object task 3 years prior)
Pinyon jay <i>Gymnorhinus cyanocephalus</i>	0.9×0.6×0.8	Alone	Yes (identical to home cage)	Moved	No
Blue jay <i>Cyanocitta cristata</i>	1×0.5×0.5	Alone	No (habituated until ate food in under 10 minutes for 3 consecutive trials)	Moved	Yes (experienced novel object task 4 years prior)
Clark's nutcracker <i>Nucifraga columbiana</i>	0.9×0.6×0.8	Alone	Yes (identical to home cage)	Moved	No
Azure-winged magpie <i>Cyanopica cyanus</i>	0.8×0.5×0.9	Alone	No (habituated with two 30 minute sessions)	Moved	No
Azure-winged magpie <i>Cyanopica cyanus</i>	4.3×3×3	Alone	Yes (constant access)	Voluntary	No