Supplementary Online Materials

Information about monkey housing conditions:

The following information contains housing conditions of subject from each site (further details in Morton et al. 2013):

Table S1

Age, sex, and number of study subjects at each research site

Location	N	Groups	Age (mean years ± SD)	Sex Ratio (M:F)
Bucknell University	13	1	8.77 ± 6.18	4:9
Primatology Centre, Strasbourg	18	1	13.67 ± 7.84	6:12
GSU	12	2	9.67 ± 5.65	7:5
Living Links, UK	19	2	10.32 ± 10.99	12:7
Living Links, USA	29	2	14.90 ± 11.06	11:18
National Institutes of Health	26	6	8.39 ± 7.33	16:10
Yale University	10	1	7.9 ± 5.28	4:6

Living Links, UK. Nineteen capuchins were from the 'Living Links to Human Evolution' Research Centre at the Royal Zoological Society of Scotland, Edinburgh Zoo, UK (MacDonald and Whiten, 2011). These individuals were from two breeding groups, and each cohabited with a group of common squirrel monkeys. One of these individuals died prior to collecting behavioural data used to validate item ratings. Groups were housed in identically designed, mutually exclusive, 189 m^3 indoor enclosures with natural light and near-permanent access to a 900 m^2 outdoor enclosure containing trees and other vegetation, providing ample opportunity to engage in natural behaviours. At the time the ratings were made, the first group contained 4 adult males, 3 adult females, no sub-adults, 1 juvenile, and

3 infants (following age-sex class definitions in Fragaszy et al. 2004). The second group contained 4 adult males, 3 adult females, no sub-adults, 4 juveniles, and 1 infant. All group members were captive born except an adult male from the first group, who was hand-reared, and the original wild-caught alpha male of the second group; both of these individuals came to LL as established members of their groups. All monkeys received commercial TrioMunch pellets supplemented with fresh fruits/vegetables three times daily, and were given cooked chicken and hard boiled eggs weekly. Water was available *ad libitum* at all times.

Primatology Centre, University of Strasbourg. Eighteen capuchins belonged to a single group at the Primatology Centre of the University of Strasbourg, France, and consisted of 6 adult males, 12 adult females, 4 juveniles, and 0 infants. All monkeys were captive born except for the eldest female, which was hand-reared and most likely wild-born. The hand-reared female has been a member of the group since 1987. Monkeys were provided commercial monkey diet pellets and water *ad libitum*, and received fruit once a week. Monkeys were never food-deprived. All subjects were housed in an indoor ($99m^3$) and outdoor ($45m^2$) enclosure, consisting of multiple compartments.

Language Research Center, Georgia State University. Twelve capuchins belonged to two groups at Georgia State University (GSU) in Atlanta, Georgia, USA. The first group consisted of 2 adult males, 2 adult females, 2 juveniles, and 0 infants. The second group consisted of 1 adult male, 2 sub-adult males, 2 adult females, 1 juvenile, and 0 infants. All monkeys were captive born. For both groups, enclosures consisted of an indoor room (Group 1: $75.84m^3$; Group 2: $54.42m^3$) connected to a large outdoor enclosure (Group 1: $13.51m^2$; Group 2: $21.15m^2$). Group members spent most of their time in the outdoor area throughout the year, except when engaged in research, during bad weather, or overnight. Monkeys were provided commercial monkey chow three times a day (morning, noon, evening), and fruits and vegetables were given every evening. Water was available *ad libitum* at all times,

including during cognitive and behavioural testing. The enclosures were made of chain link fencing and were equipped with swings, ropes, and other materials to create three-dimensional living conditions to enrich the monkeys. The older study subjects had previously been housed together in various combinations at Yerkes National Primate Research Center, before being relocated to GSU 5 years ago, prior to the survey. S. F. B. worked with the animals at both facilities.

Bucknell Primate Lab, Bucknell University. Fourteen of the capuchins belonged to a single group at Bucknell University in Lewisburg, Pennsylvania, USA. They were housed in one social group consisting of 2 adult males, 2 adult females, 5 sub-adult females, 5 juveniles, and 0 infants. All monkeys were captive born. The enclosure consisted of a series of seven compartments (totalling 630m^3) made of caging wire, which were interconnected by doorways or tunnels also made of caging wire. The compartments included various perches, swings, and poles to ensure a most naturalistic environment for climbing and movement. Monkeys were provided commercial monkey chow twice per day (morning, evening), fruits and vegetables were given once per day (morning), and an afternoon snack consisting largely of peanuts, raisins, and low-sugar cereal was given in the afternoon. Water was available *ad libitum* at all times. The older subjects (N = 4) had previously been housed at Yerkes National Primate Research Center before being relocated to Bucknell University 12 years ago.

Living Links, Yerkes National Primate Research Center, USA. Twenty-six brown capuchin monkeys housed in two separate social groups at Living Links, part of the Yerkes National Primate Research Center. One group consisted of 15 monkeys housed in 25 m^2, and the other of 11 monkeys in 31 m^2. Both groups had access to indoor and outdoor areas and were visually, but not acoustically isolated from each other. The monkeys received Purina monkey chow and water *ad libitum*, and trays containing fresh produce every evening.

Monkeys were never food or water deprived and all procedures were approved by the Institutional Animal Care and Use Committee (IACUC) prior to the commencement of the study.

Laboratory of Comparative Ethology, National Institutes of Health. Twenty-six capuchins came from two captive breeding group and several small bachelor groups at the Laboratory of Comparative Ethology, NICHD. At the time of the study, one group comprised 5 adults (4 female and 1 male, aged 7-30 years) and 4 juveniles (2 female and 2 male, aged 1-3 years). Three infants (1 female and 2 male, aged <6 months) were part of the group but were not rated for the current study. The second breeding group comprised 4 adults (3 female and 1 male, aged 5-12 years) and 4 juveniles (1 female and 3 male, aged 2-4 years). A further nine animals were pair-housed in cages; two pairs and a group of 3 animals were subadult to adult males (aged 4-9 years), and one pair was an adult female with a juvenile male (aged 25 and 1 year respectively). All monkeys were captive born, mother-reared, and housed in the LCE primate facilities at the NIH Animal Center near Poolesville, MD. Breeding groups were housed in one or two parts of three indoor runs (6.9 x 4.1 x 2.1m each), which were connected via sliding doors. Runs were furnished with swings, ladders and various platforms. Cage-housed monkeys were housed in quad cages (1.63 x 1.63 x .71 m per pair). All monkeys were provided with a variety of plastic and metal manipulanda. Monkeys were not food deprived for this study, and received daily nutritional supplements of seeds and fresh fruit or nuts. Commercial monkey biscuits (Labdiet 5045) and water were available *ad libitum*.

Comparative Cognition Laboratory, Yale University. Ten monkeys were at the Comparative Cognition Laboratory at Yale University, New Haven, Connecticut, USA. This group consisted of 4 adult males, 4 adult females, and 2 juvenile females. All monkeys were captive born. The monkeys were housed in an indoor enclosure (32 m^3) consisting of multiple

compartments. Commercial monkey pellets were provided twice daily (morning, afternoon) and supplemented with fruits, vegetables, nuts, and cereal daily. Water was available *ad libitum*.

Methods for the learning task at Living Links

The Living Links monkeys can volunteer to participate in non-invasive cognitive and learning experiments during morning and afternoon sessions four times a week (Monday, Tuesday, Thursday, Friday). On each research day, each group undergoes a morning session from 8:30 to 10:30, and an afternoon session from 11:00 to 13:00. Typically, due to scheduling demands from other researchers, each group undergoes testing on a particular experiment per day (either the morning or afternoon session). Since the establishment of LL in 2008, subjects have been involved in a number of cognitive studies, with a wide array of methodological designs; however, the tasks and methods of administration in the present study had not been used before.

All monkeys (N=18, excluding infants) were given the opportunity to engage in a learning task, but only 15 monkeys volunteered to participate in the task. Testing took place in research cubicles, which were divided into two compartments (both 54.6cm x 66cm x 71.1 cm) and separated by a transparent plastic door that was halfway open. Subjects could freely volunteer to participate in testing by walking into the research cubicles, which were connected to monkeys' indoor/outdoor enclosures. Participating monkeys could freely walk between the two compartments.

During each trial, two white-opaque cups were placed in front of the monkey, one cup was on the left side of the sliding door and one cup was on the right side. The position of each cup (left or right compartment) was randomly selected for each new trial. The two cups differed in size, with one cup twice as tall as the other cup. For this task, the goal was for the

monkey to learn that by moving and sitting in the compartment facing the larger cup, they would receive a food reward that was located inside the cup. If the monkey failed a trial, no food was rewarded, and the trial was ended. Monkeys received a maximum of 12 trials per session, with each trial separated by 5-7 seconds. Each monkey received 12 trials per session per day until they met learning criteria (i.e. >80% correct across three consecutive sessions), or for a maximum of 264 trials. For each correct trial, subjects received a food reward (e.g. raisin or piece of papaya). During testing, movements made by the experimenter (F.B.M.) were limited only to setting up each new trial. Temperature and lighting are controlled within the indoor testing enclosures. Eye gaze of the experimenter during testing was directed at the floor; eye gaze and position of the experimenter behind the apparatus remained the same for each trial to prevent subjects from making "associative cues". All sessions were video recorded using a SONY 60X HD camcorder mounted 1.5m away from the test subject (and directly behind the experimenter) on a tripod; videos were later coded by the experimenter. A binomial test established that subjects would need to score at least 80% of trials (i.e. $\geq$10 of 12 trials) correctly on a given session for it to be statistically above chance (Morton et al. 2013). Individuals scoring $\geq$80% of trials correctly on three consecutive sessions were considered to have learned the task, and their testing subsequently ended.

Table S2

Data used to perform analyses on 127 capuchins

Monkey	Location	Social Group	Group size	Age (Years)	Log_Age	Sex	Dominance	Curiosity	Sociability	Innovation
1	6	1	22	15	1.18	M	6.67	5.33	4.67	3.67
2	6	1	22	12	1.08	F	3	4	4.6	3.8
3	3	7	11	14	1.15	F	5.86	4.38	5.29	3.29
4	5	12	9	7	0.85	F	5	4	4.5	3.5
5	6	1	22	13	1.11	M	6.2	5.6	3.2	3.8
6	6	1	22	22	1.34	F	2.33	3	4.33	2.67
7	7	15	10	14	1.15	M	1	2.5	2.5	1.5
8	4	10	15	12	1.08	F	3.33	5.33	4.67	4.33
9	4	10	15	6	0.78	F	4	4.67	4.67	3.33
10	4	10	15	8	0.9	M	3.67	5.67	4.67	3.33
11	4	10	15	25	1.4	F	3.67	4.67	4.33	2.67
12	6	1	22	38	1.58	F	1.2	3	2.4	3
13	3	7	11	5	0.7	M	2.43	5.57	6	5.71
14	3	7	11	2	0.3	M	3	5.17	6.33	4.83
15	1	2	14	16	1.2	M	3.5	5	3.5	5.5
16	1	2	14	10	1	F	1	3.5	3.5	3
17	3	14	12	40	1.6	M	6.67	3.67	5	2.48
18	3	14	12	10	1	M	2.4	2.8	3.2	1.78
19	2	9	6	21	1.32	M	5	4.75	5.25	4
20	7	15	10	12	1.08	M	7	4	4.5	3
21	3	14	12	5	0.7	M	3.5	5.5	5.5	4.98
22	2	8	6	13	1.11	M	7	5.25	4.25	3.25
23	2	8	6	14	1.15	F	1.2	3	2.2	3.2
24	5	12	9	19	1.28	M	6.67	4	5.33	4.33
25	4	10	15	6	0.78	F	4.33	3.67	4	4.33
26	4	10	15	8	0.9	F	3.33	4	3.33	4
27	2	9	6	14	1.15	M	7	5	4.25	3.5
28	7	15	10	2	0.3	M	4	6	4.5	4.5
29	7	15	10	1	0	F	2.5	6	6.5	6
30	7	15	10	9	0.95	F	1.5	3	5	2.5
31	7	15	10	4	0.6	F	2	3	4.5	2.5
32	5	5	3	9	0.95	M	6.67	4.33	3.67	3.67
33	5	4	2	6	0.78	M	6.33	5.33	3.33	4.33
34	5	12	9	3	0.48	M	2	5.5	5	4.5
35	5	12	9	2	0.3	M	1.5	5.5	4	4.5
36	4	11	11	36	1.56	M	3.5	3	4.5	2.5
37	3	14	12	2	0.3	M	2.75	5.75	6.75	2.5
38	5	12	9	10	1	F	1.67	2.67	4.67	3

39	5	12	9	31	1.49	F	3.5	3	5	3.5
40	5	12	9	3	0.48	M	4.5	6	4.5	4.5
41	5	12	9	13	1.11	F	5.5	4.5	5.5	3.5
42	5	4	2	5	0.7	M	1.33	5.33	3.67	4
43	7	15	10	13	1.11	F	6	4	6.5	4.5
44	5	5	3	7	0.85	M	3.67	4.33	4	3.67
45	3	7	11	11	1.04	F	3.86	5.23	5.29	5.14
46	3	7	11	6	0.78	M	2.14	5.95	2.57	5.29
47	6	1	22	19	1.28	F	3.4	3.4	5	3.8
48	6	1	22	24	1.38	F	4.6	3.8	3	2.2
49	6	1	22	12	1.08	F	4.2	5	5.4	3.6
50	3	14	12	11	1.04	F	3	4	4	4
51	4	11	11	10	1	F	6	4.83	4.83	3
52	4	11	11	9	0.95	F	3.5	5.5	5.5	5.5
53	5	3	2	5	0.7	M	3	4	5.5	4
54	2	9	6	3	0.48	F	4	5.67	4	5
55	2	8	6	7	0.85	M	1	7	5	4
56	5	13	8	5	0.7	F	4.25	5.5	5.25	4.75
57	2	9	6	14	1.15	F	6	4.5	4	4
58	5	13	8	12	1.08	F	5	4.2	5.2	4
59	5	13	8	3	0.48	M	6.5	4	4.5	4
60	5	6	2	1	0	M	1.5	4.5	4.5	4
61	2	8	6	6	0.78	M	3.5	6.25	5.25	6.25
62	5	13	8	5	0.7	F	2.67	5.33	5.33	5
63	4	11	11	12	1.08	M	5.5	5.5	6	3
64	5	6	2	26	1.41	F	2	3	4	2
65	5	13	8	2	0.3	M	1.5	5.5	5	4
66	4	11	11	28	1.45	F	4	5.5	6	3
67	4	11	11	7	0.85	M	3.5	5.5	5.5	6.5
68	5	13	8	12	1.08	F	2	3.67	3.67	3.67
69	4	10	15	40	1.6	F	3.33	4.67	3.67	2
70	3	7	11	4	0.6	M	2.33	3.60	3.67	3.1
71	5	13	8	11	1.04	M	6.67	4.33	4.33	4.67
72	4	10	15	14	1.15	M	6	4.33	5	3
73	3	7	11	40	1.6	M	3.57	3.52	5.14	2.83
74	7	15	10	8	0.9	F	6.5	5.5	6.5	4.5
75	3	14	12	3	0.48	M	2.6	5.4	6.2	5
76	1	2	14	16	1.2	M	7	6.5	7	2
77	7	15	10	2	0.3	F	5.5	6.5	6.5	6.5
78	5	5	3	7	0.85	M	1.33	4	4.33	4
79	4	11	11	10	1	F	4	5	2.5	2.5
80	2	8	6	9	0.95	F	6	5.5	5.18	4.23
81	4	11	11	27	1.43	F	4	4	4	2
82	1	2	14	16	1.2	F	1	1.5	2	3.5

83	4	11	11	7	0.85	M	3.5	3.5	6	7
84	4	11	11	2	0.3	M	2	2	7	5
85	1	2	14	8	0.9	F	1	4	5.5	4
86	7	15	10	14	1.15	M	2	2.5	3	2
87	4	11	11	12	1.08	F	4.5	5.5	3.5	2.5
88	2	8	6	3	0.48	M	2.67	5.67	5.67	5
89	1	2	14	9	0.95	F	5	7	6.5	6.5
90	1	2	14	3	0.48	F	4	7	4.5	7
91	1	2	14	1	0	M	2	6.5	6.5	5.5
92	6	1	22	11	1.04	F	1.33	3.67	4.33	3.33
93	4	11	11	24	1.38	M	4	3.5	6.5	5.5
94	5	12	9	2	0.3	F	1.5	6	5	3.5
95	6	1	22	10	1	F	3.8	4.6	5.2	4
96	3	14	12	3	0.48	F	1.6	4.6	5.4	4.16
97	3	7	11	6	0.78	F	3.67	3.77	5.33	2.82
98	6	1	22	10	1	F	2.4	4.2	4.6	3.6
99	6	1	22	10	1	M	4.8	6.6	4.4	5.8
100	3	7	11	10	1	M	6.29	4.04	4.43	2.4
101	6	1	22	10	1	M	3.2	4.2	3.8	3.6
102	6	1	22	8	0.9	M	5.2	6	5.2	5.2
103	6	1	22	11	1.04	F	5.8	5.6	4.2	4.2
104	1	2	14	3	0.48	F	2	3	3	2
105	6	1	22	8	0.9	M	4.2	6	5.8	5
106	4	10	15	15	1.18	F	2	2	5	4
107	3	14	12	9	0.95	F	3.33	4.83	5	3.65
108	4	10	15	7	0.85	F	5	3.67	4.33	2.67
109	1	2	14	5	0.7	F	4	3	5	2.5
110	6	1	22	8	0.9	F	2.67	5	4.67	4.33
111	5	3	2	9	0.95	M	6.67	5	4	4.67
112	1	2	14	19	1.28	F	6	4.5	6.5	1
113	1	2	14	2	0.3	M	3	7	7	4.5
114	4	10	15	9	0.95	M	4	3.5	5.35	3.5
115	1	2	14	6	0.78	F	6.5	6.5	5.5	5
116	5	13	8	3	0.48	M	2.5	5	4	3.5
117	4	10	15	40	1.6	F	5	3.67	5	3
118	3	14	12	8	0.9	F	2.5	4.67	5.33	5
119	3	14	12	7	0.85	M	1.83	3.67	3.17	3
120	6	1	22	5	0.7	F	1.5	4.5	4	5
121	2	9	6	3	0.48	M	2	6	6	5
122	4	11	11	2	0.3	M	2	2	7	5
123	4	11	11	14	1.15	F	4.5	3	3.5	4.5
124	4	11	11	28	1.45	F	4.5	4	4.5	2.5
125	4	11	11	7	0.85	F	3.5	3.5	4.5	4
126	4	11	11	7	0.85	M	3	3.5	6	6

127	2	9	6	9	0.95	F	1.75	6.5	3.5	6.25

Table S3

Behavioural data for Living Links monkeys

	Behavioural Codings				Item Ratings			
Monkey	Social Rank	% Participation	Learning Performance	% Time Close Proximity	Dominance	Curiosity	Innovation	Sociability
1	14.58	88.89	59.10	55.87	5.86	4.38	3.29	5.29
2	-12.67	100.00	77.40	21.11	2.43	5.57	5.71	6.00
3	-8.00	100.00	79.30	51.11	3.00	5.17	4.83	6.33
4	9.33	.00	--	44.68	6.67	3.67	2.48	5.00
5	4.00	55.56	54.17	32.97	2.40	2.80	1.78	3.20
6	-.33	72.22	59.00	35.56	3.50	5.50	4.98	5.50
7	-1.67	100.00	51.70	53.51	2.75	5.75	2.50	6.75
8	.67	100.00	67.20	30.56	3.86	5.23	5.14	5.29
9	-6.17	100.00	86.70	15.56	2.14	5.95	5.29	2.57
10	6.67	5.56	41.70	71.19	6.00	4.83	3.00	4.83
11	-5.17	27.78	71.10	26.52	2.33	3.60	3.10	3.67
12	-6.67	72.22	59.20	40.00	2.60	5.40	5.00	6.20
13	-2.00	100.00	81.70	23.33	1.60	4.60	4.16	5.40
14	3.80	22.22	67.63	50.00	3.67	3.77	2.82	5.33
15	18.46	.00	--	45.81	6.29	4.04	2.40	4.43
16	4.67	11.11	50.00	58.10	3.33	4.83	3.65	5.00
17	-4.67	100.00	77.10	51.67	2.50	4.67	5.00	5.33
18	-9.33	.00	--	3.89	1.83	3.67	3.00	3.17

Figure S1

Histograms of the distribution of each ratings item

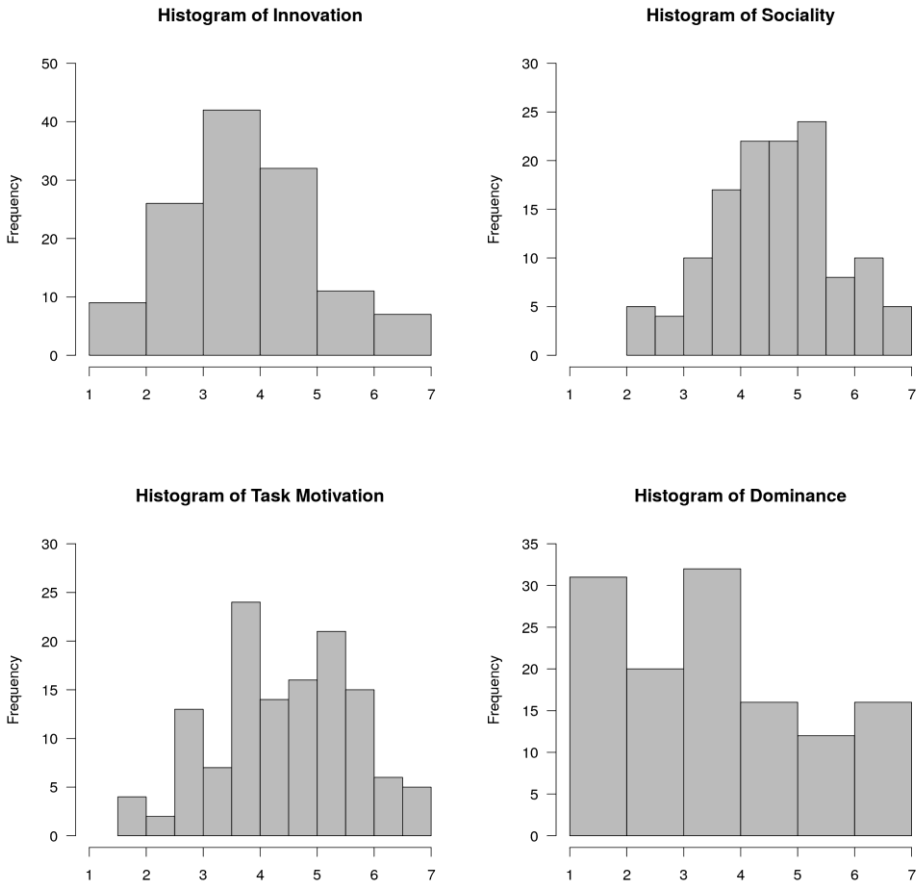

Figure S2

QQ-Plots for normality of innovation, sociality, task motivation and uniformity of dominance

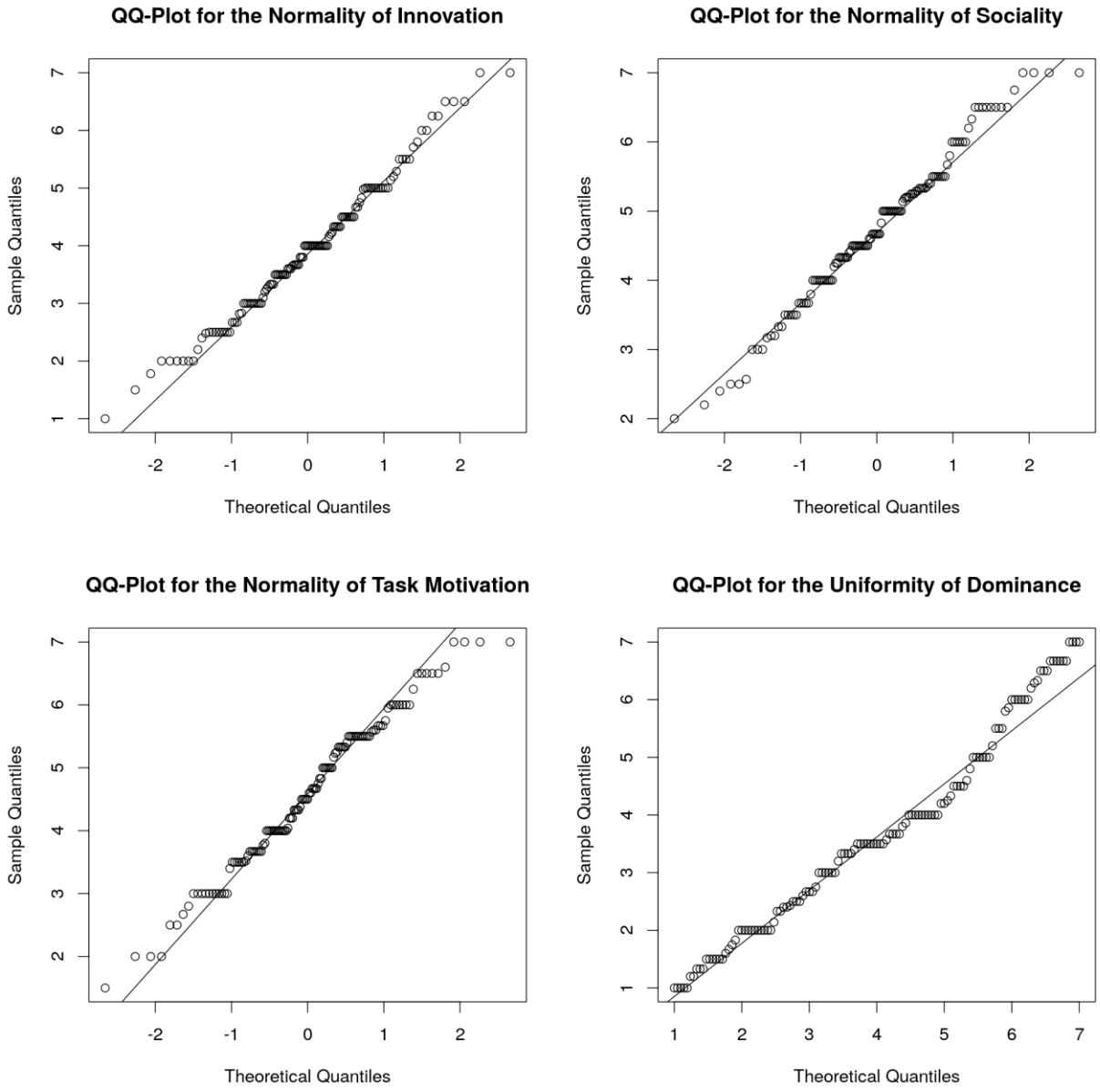

Table S4

Shapiro-Wilk test of normality

Variable	Statistic	P-value
Innovation	0.987	0.27
Sociability	0.986	0.213
Task Motivation	0.983	0.121
Dominance	0.949	0.001

Supplementary Analyses of Random Effects from Linear Mixed Models using Location as Grouping Factor:

Linear mixed model fit by REML ['lmerMod']

Formula: Innovation ~ Sociality + Group Size + log(Age, base = 10) + Sex + Dominance + Curiosity + (1| Location))

Data: capu

REML criterion at convergence: 376.3

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.83647	-0.65876	-0.07075	0.55400	3.01234

Random effects:

Groups	Name	Variance	Std.Dev.
Location	(Intercept)	0.003887	0.06235
Residual		1.007382	1.00368

Number of obs: 127, groups: Location, 7

Linear mixed model fit by REML [‘lmerMod’]

Formula: Innovation ~ Sociality + log(Age, base = 10) + Sex + Dominance + Curiosity + (Group.size | Location)

Data: capu

REML criterion at convergence: 369.8

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.84633	-0.62431	-0.09026	0.54429	3.09354

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
Location	(Intercept)	0.000e+00	0.000e+00	
	Group.size	1.346e-14	1.160e-07	NaN
Residual		9.987e-01	9.994e-01	

Number of obs: 127, groups: Location, 7