

Supplementary Materials: Individual differences in sociocognitive traits in semi-free-ranging rhesus monkeys (*Macaca mulatta*)

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1. Supplemental methods

As reported in the main text, in the socioemotional responses task we showed monkeys conspecific photographs with matched neutral versus threat expressions using an apparatus. Figure S1 depicts images of the apparatus and setup as well as examples of the conspecific photograph stimuli.

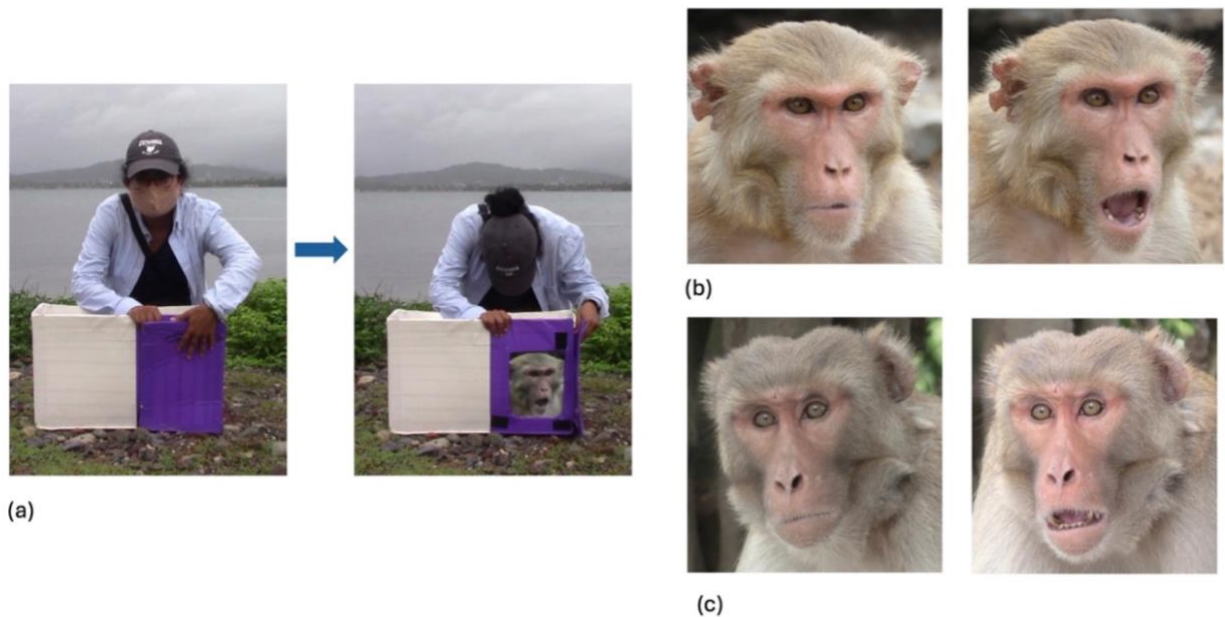


Figure S1: Setup and stimuli for socioemotional responses task. (a). We showed monkeys a photo of a conspecific by uncovering the window on an apparatus to reveal a conspecific monkey photograph. (b) In the first two trials, monkeys observed matched photos of a female conspecific producing first a neutral expression (left photo) and then the same individual producing a threat expression (right photo) (c) In the second two trials, monkeys observed matched photos of a male conspecific producing first a neutral expression (left photo) and then the same individual producing a threat expression (right photo).

2. Supplemental Results

2.1 Socioemotional responses task: analyses of individual variation

As reported in the main task, we first examined performance on all trials from monkeys who participated in this task in at least one of the testing years. Table S1 reports the parameter estimates for the full model from those analyses.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
Intercept	1.720	1.205, 2.234	0.262	6.555	< 0.0001
Photoset (reference = 1)	-0.147	-0.299, 0.004	0.077	-1.901	0.0571
Outgroup female photos (reference = no)	0.059	-0.342, 0.460	0.204	0.289	= 0.772
Outgroup male photos (reference = no)	-0.19	-0.490, 0.103	0.151	-1.276	= 0.201
Face stimuli (reference = female photos)	-0.328	-0.477, -0.179	0.075	-4.326	< 0.0001
Expression (reference = neutral)	-0.244	-0.376, -0.112	0.067	-3.621	= 0.0002
Age (in years)	-0.076	-0.099, -0.054	0.011	-6.778	< 0.0001
Sex (reference = female)	-0.007	-0.243, 0.228	0.120	-0.064	= 0.948
Face stimuli X Expression	0.358	0.150, 0.565	0.105	3.386	=0.0007

Table S1: Predictors of looking to all photographs in the socioemotional responses task. Parameters are from the full model (model 4), but the best fit model did not include sex; reference level for the predictors are noted in the table as relevant.

As reported in the main text, we then examined predictors of looking to the female photographs using the whole dataset. Table S2 reports the parameter estimates for the full model (which was the best fit) from those analyses.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
Intercept	1.702	1.153, 2.250	0.279	6.079	< 0.0001
Photoset (reference = 1)	-0.168	-0.341, 0.003	0.087	-1.920	= 0.0547
Outgroup (reference = no)	0.088	-0.334, 0.512	0.216	0.410	= 0.681
Sex (reference = female)	0.101	-0.133, 0.335	0.119	0.846	= 0.397
Age (in years)	-0.098	-0.124, -0.071	0.013	-7.265	< 0.0001
Expression (reference = neutral)	-0.547	-0.867, -0.227	0.163	-3.349	= 0.0008
Age X Expression	0.026	0.001, 0.050	0.012	2.116	= 0.034

Table S2: Predictors of looking to female photographs in the socioemotional responses task. Parameters are from the full model (model 5: which was also the best-fit model); reference level for the predictors are noted in the table as relevant.

As reported in the main text, our second set of analyses for the socioemotional responses task examined predictors of looking to the male photographs using the whole dataset. Table S3 reports the parameter estimates for the full model from those analyses.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
Intercept	1.444	0.817, 2.071	0.319	4.514	< 0.0001
Photoset (reference = 1)	-0.246	-0.493, -0.000	0.125	-1.960	= 0.0498
Outgroup (reference = no)	-0.195	-0.602, 0.211	0.207	-0.941	= 0.346
Sex (reference = female)	-0.069	-0.509, 0.369	0.224	-0.311	= 0.755
Age (in years)	-0.070	-0.104, -0.036	0.017	-4.025	< 0.0001
Expression (reference = neutral)	-0.120	-0.439, 0.1978	0.162	-0.742	= 0.458
Age X Expression	0.015	-0.019, 0.050	0.017	0.884	= 0.376

Table S3: Predictors of looking to male photographs in the socioemotional responses task. Parameters are from the full model (model 5; the best fit model 3 included age but not sex or age X expression); reference level for the predictors are noted in the table as relevant.

As reported in the main text, our third set of analyses for the socioemotional responses task examined predictors of the looking time difference score (Looking to Threat - Looking to Neutral Photograph) using the whole dataset. Table S4 reports the parameter estimates for the full model from those analyses.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
Intercept	-0.027	-1.025, 0.970	0.509	-0.053	= 0.957
Photoset (reference = 1)	-0.497	-0.900, -0.094	0.205	-2.420	= 0.016
Outgroup (reference = no)	-0.661	-1.357, 0.034	0.355	-1.862	= 0.063
Sex (reference = female)	-0.427	-0.847, -0.008	0.214	-1.998	= 0.047
Age (in years)	0.053	0.001, 0.105	0.026	2.020	= 0.044
Face (reference = female photos)	1.127	0.129, 2.124	0.509	2.214	= 0.027
Age X Face	-0.037	-0.116, 0.040	0.040	-0.945	= 0.345

Table S4: Predictors of difference scores in the socioemotional responses task. Parameters are from the full model (model 5; the best fit model 4 included age and face, but not the age X face interaction); reference level for the predictors are noted in the table as relevant.

2.2 Socioemotional responses task: stability across years

As reported in the main text, we next used the socioemotional responses task to examine if there was stability in individual performance across year by examining if inclusion of Year 1 looking time as a predictor improved fit above and beyond the primary experimental predictors. These analyses used looking to both female and male photos (when such data was available). Table S5 reports the parameter estimates for the full model from those analyses.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
(Intercept)	0.516	-0.099, 1.132	0.314	1.6435	= 0.10
Photoset in Yr 2 (reference = 1)	-0.188	-0.495, 0.117	0.156	-1.208	= 0.227
Outgroup in Yr 2 (reference = no)	0.315	-0.032, 0.662	0.177	1.7753	= 0.076
Sex (reference = female)	0.092	-0.211, 0.3971	0.155	0.5960	= 0.551
Age in Yr 2 (in years)	-0.052	-0.083, -0.020	0.016	-3.268	= 0.001
Face (reference = female photos)	-0.283	-0.497, -0.069	0.109	-2.599	= 0.009
Expression (reference = neutral)	-0.366	-0.536, -0.196	0.086	-4.216	< 0.0001
Looking Time in Yr1	0.064	0.021, 0.106	0.021	2.9528	= 0.003
Face X Expression	0.613	0.329, 0.898	0.145	4.2229	< 0.0001

Table S5: Predicting year 2 performance from year 1 performance in the socioemotional responses task. Parameters are from the full model (model 2, the best fit model); reference level for the predictors are noted in the table as relevant.

2.3 Gaze following task: analyses of individual variation

As reported in the main text, our first set of analyses for the gaze following task examined predictors of gaze following (whether or not the monkey ever looked). Table S5 reports the parameter estimates for the full model from those analyses.

Predictor	Estimate	95% C.I.	S.E.	z value	p value
Intercept	0.136	-0.998, 1.270	0.578	0.235	= 0.814
Trial Number (1-4)	-0.470	-0.888, -0.052	0.213	-2.204	= 0.027
Age (in years)	-0.029	-0.116, 0.057	0.044	-0.669	= 0.503
Sex (reference = female)	-0.120	-0.626, 0.386	0.258	-0.464	= 0.642
Age X Trial number	0.007	-0.024, 0.039	0.016	0.483	= 0.629

Table S5: Predictors of looking up in the gaze following task. Parameters are from the model including age, sex, and age X trial number (model 5; the best fit model 2 included only trial number); reference level for the predictors are noted in the table as relevant.

As reported in the main text, our second set of analyses for the gaze following task examined predictors of duration of gaze following for those individuals who did produce looks. Table S6 reports the parameter estimates for the full model from those analyses.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
Intercept	0.479	0.036, 0.923	0.226	2.122	= 0.034
Trial number (1-4)	-0.028	-0.118, 0.062	0.046	-0.609	= 0.542
Age (in years)	-0.019	-0.049, 0.010	0.015	-1.272	= 0.203
Sex (reference = female)	-0.015	-0.301, 0.270	0.145	-0.105	= 0.916

Table S6: Predictors of looking duration in the gaze following task. Parameters are from the model including sex and age (model 4; none of these factors improved fit compared to the base model); reference level for the predictors are noted in the table as relevant.

2.4 Gaze following task: stability across years

As reported in the main text, we next used the gaze following task to examine if there was stability in individual performance across year by examining if inclusion of Year 1 looking response as a predictor improved fit above and beyond the primary experimental predictors, for the subset of individuals who completed the task in both years. Table S7 reports the parameter estimates from those analyses.

Predictor	Estimate	95% C.I.	S.E.	z value	p value
Intercept	-0.621	-1.881, 0.638	0.643	-0.966	= 0.334
Trial number (1-4)	-0.395	-0.708, -0.083	0.159	-2.481	= 0.013
Age in Yr 2 (in years)	-0.001	-0.076, 0.074	0.038	-0.038	= 0.970
Sex (reference = female)	0.309	-0.442, 1.061	0.383	0.807	= 0.419
Look Y/N in Year 1	0.537	-0.144, 1.220	0.348	1.544	= 0.122

Table S7: Predicting year 2 performance from year 1 performance in the gaze following task. Parameters are from the model including Year 1 performance (model 2; this did not improve fit compared to the base model); reference level for the predictors are noted in the table as relevant.

2.5 Task interrelationships

As reported in the main text, we next used data where a given monkey completed both tasks in the same year to test if responses in the gaze following task predicted responses in the emotions task, and vice versa. Table S8 reports the parameter estimates for predicting looking in the socioemotional responses task from gaze following.

Predictor	Estimate	95% C.I.	S.E.	t value	p value
Intercept	2.007	1.311, 2.702	0.354	5.658	< 0.0001
Photoset (reference = 1)	-0.276	-0.466, -0.086	0.097	-2.849	= 0.004
Outgroup female photos (reference = no)	-0.113	-0.656, 0.430	0.277	-0.408	= 0.683
Outgroup male photos (reference = no)	-0.345	-0.711, 0.020	0.186	-1.851	= 0.064
Face stimuli (reference = female photos)	-0.276	-0.450, -0.102	0.088	-3.118	= 0.002
Expression (reference = neutral)	-0.184	-0.340, -0.029	0.079	-2.325	= 0.020
Age (in years)	-0.075	-0.100, -0.050	0.012	-5.891	< 0.0001
Sex (reference = female)	-0.013	-0.281, 0.254	0.136	-0.100	= 0.920
Mean gaze following	0.143	-0.099, 0.385	0.123	1.156	= 0.247
Face X Expression	0.333	0.091, 0.575	0.123	2.698	= 0.007

Table S8: Predicting socioemotional task performance from gaze following performance in the same year. Parameters are from the model including average gaze following response (which did not improve model fit); reference level for the predictors are noted in the table as relevant.

We conducted the same basis analysis in the referees direction. Table S9 reports parameter estimates for predicting gaze following from looking time in the socioemotional responses task.

Predictor	Estimate	95% C.I.	S.E.	z value	p value
Intercept	-0.812	-1.792, 0.167	0.500	-1.624	= 0.104
Sex (reference = female)	-0.323	-0.836, 0.189	0.261	-1.236	= 0.216
Age (in years)	0.0291	-0.027, 0.085	0.028	1.011	= 0.312
Trial number (1-4)	-0.423	-0.593, -0.253	0.086	-4.885	< 0.0001
Mean socioemotional looking time	0.188	0.065, 0.310	0.062	3.0150	= 0.0025

Table S9: Predicting gaze following performance from socioemotional task performance in the same year. Parameters are from the model including average looking time (model 2; the best fit model); reference level for the predictors are noted in the table as relevant.

3. Supplemental Movie Captions

Video S1: Socioemotional responses task demonstration and example monkey looking responses. The first two videos show an example experimental demonstration of the procedure. In Video 1, the primary experimenter (the demonstrator) attracts the monkey's attention to the apparatus, and then uncovers the window to reveal a conspecific neutral photograph. During the timed trials, she holds a position where she looks down with her hat covering her eyes. Video 2 shows the same procedure, here uncovering a conspecific threat photograph from the same individual. In between trials, the experimenter would move the photographs in the apparatus to set up the next trial. Videos 3, 4, and 5 show example coding clips illustrating monkey looking responses in the task. As illustrated in these videos, coding clips start a few seconds before the primary experimenter said "now" and did not contain any information about the trial type, such that coders could assess them blind to experimental variables. On the videos, the secondary experimenter (cameraperson) then says "stop" after at least 10s have passed; clips were always coded for exactly 10s from the moment the trial started to equate total trial duration across monkeys.

Video S2: Gaze following task demonstration and example monkey responses. In Video 1, the primary experimenter (the actor) attracts the monkey's attention to her face, and then looks upwards. This demonstration includes a monkey's response to the experimenter's actions. In between trials, the experimenter would stand looking away from the monkey for at least 30s before starting the next trial using the same procedure. Videos 2, 3, and 4 show example coding clips illustrating monkey responses in the task. As illustrated in these videos, coding clips start a few seconds before the primary experimenter said "now" and do not contain any information about the monkey's trial number, so that coders could assess them blind to experimental variables. On the videos, the secondary experimenter (cameraperson) then says "stop" after at least 10s have passed; clips were always coded for exactly 10s from the moment the trial started to equate total trial duration across monkeys.