Supplementary materials for "Behavioural variation and learning across the lifespan in wild white-faced capuchin monkeys." (Susan Perry)

Materials are arranged according to the section of the article where they are mentioned in the main text.

Section 2: How do personality traits/attitudes relevant to learning change with age?

SI Table 1: Model predictions (estimate of fixed effects, with standard errors) for linear mixed effects models in which age predicts values of personality ratings. *** PrChi <0.001. df=1 in all models.

	creative	active	alert	attentive	curious	opportunistic	neophobic	playful
fixed effects (estimate, SE)								
intercept	3.326 ± 0.032	3.533 ± 0.037	2.646 ± 0.029	3.028 ± 0.030	3.681 ± 0.035	3.178 ± 0.030	2.502 ± 0.031	3.836 ± 0.036
age	-0.037 ± 0.003	-0.052 ± 0.004	0.059 ± 0.004	0.0004 ± 0.0041	-0.080 ± 0.003	-0.015 ± 0.003	0.059 ± 0.003	-0.097 ± 0.004
LRT and significance level, fixed effect age	95 ***	107 ***	167 ***	0.0067 P= 0.9	306 ***	24 ***	249 ***	312 ***
Random Effects: SD [correlation]								
Monkey (intercept)	0.439	0.507	0.274	0.368	0.517	0.312	0.423	0.533
monkey-age slope	0.036 [corr. -0.74]	0.040 [corr. -0.64]	0.052 [corr. -0.83]	0.044 [corr.-0.61]	0.042 [corr.-0.82]	0.021 [corr. -0.41]	0.033 [corr. -0.81]	0.041 [corr.-0.69]
rater intercept	6.48E-05	0.128	0.104	3.90E-05	0.072	0.00013	0.0007375	0.104
# ratings	7928	7996	7996	7918	7995	7920	7843	7996
# monkeys	439	439	439	439	439	439	439	439
# raters	83	84	84	83	84	83	82	84

SI Table 2: Model predictions (estimate of fixed effects, with standard errors) for 8 quadratic mixed effects models in which age predicts values of personality ratings. ** PrChi<0.01, *** PrChi <0.001. df=1 in all models.

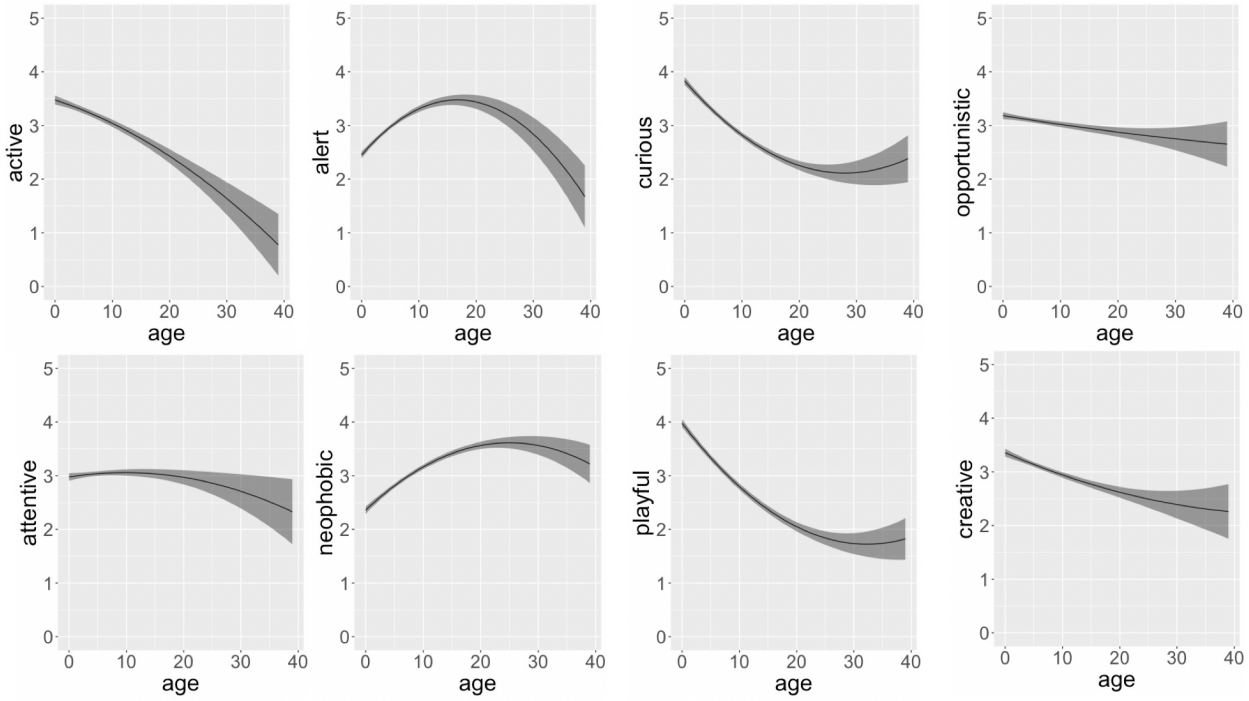
	creative	active	alert	attentive	curious	opportunistic	neophobic	playful
fixed effects (estimate, SE)								
intercept	3.357 ± 0.038	3.474 ± 0.043	2.450 ± 0.032	2.976 ± 0.036	3.829 ± 0.039	3.184 ± 0.034	2.358 ± 0.035	3.977 ± 0.039
age	0.046 ± 0.007	-0.035 ± 0.007	0.122 ± 0.007	0.017 ± 0.008	-0.123 ± 0.006	-0.017 ± 0.007	0.100 ± 0.006	-0.140 ± 0.006
I(age^2)	0.0005 ± 0.0003	-0.0009 ± 0.0003	-0.0036 ± 0.0003	-0.0009 ± 0.0003	0.0022 ± 0.0003	0.0001 ± 0.0003	-0.0020 ± 0.0002	0.0022 ± 0.0002
LRT and significance level, fixed effect age	38 ***	20 ***	286 ***	5, P=0.026	266 ***	7 **	218 ***	307 ***
LRT and significance level, fixed effect I(age^2)	2 P= 0.14	7 **	128 ***	7 P=0.01	54 ***	0.12 P= 0.7	59 ***	51 ***
Random Effects: SD [correlation]								
Monkey (intercept)	0.435	0.513	0.196	0.368	0.474	0.312	0.384	0.494
monkey-age slope	0.035 [-0.74]	0.043 [-0.65]	0.040 [-0.69]	0.044 [-0.61]	0.032 [-0.82]	0.021 [-0.41]	0.022 [-0.82]	0.026 [-0.72]
rater intercept	0.00000	0.126	0.093	0.00000	0.079	0.00013	0.000046	0.111
# ratings	7928	7996	7996	7918	7995	7920	7843	7996
# monkeys	439	439	439	439	439	439	439	439
# raters	83	84	84	83	84	83	82	84

The raw data sets for these analyses are found in separate tabs of the file called "2_PersonalityRawData.xlsx".
The R code used to run these models and create these graphics are found in the file called "2_Personality_Rcode.R"

Additional methodological notes about the models in section 2:
Several convergence warnings were generated when running these models in R version 3.6.1, using the lme4 package. Following the advice on https://rdrr.io/cran/lme4/man/convergence.html, the models were rerun using "allFit" with all available optimizers. Because all 5 optimizers (except, sometimes, nlminbwrap) converged to approximately equivalent values, the warnings were assumed to be false positives.

The three models with warnings about being singular had very low variance for the random effect "respondent" in the model version we used (attentive: 4e-5, creative: 6.5e-5, and neophobic: 7.3e-4). Comparison of the full model with a model eliminating respondent as a random effect revealed virtually identical results.

SI Figure 1: Age-related changes in personality traits for quadratic mixed effect models including monkey identity, respondent identity, and monkey-age slope as random effects. X-axis is age in years, from 0 to 39 years of age. Y-axis is rating of that personality trait, from 0 to 5. Values are predicted estimates based on the quadratic model, and shaded areas represent 95% confidence intervals.



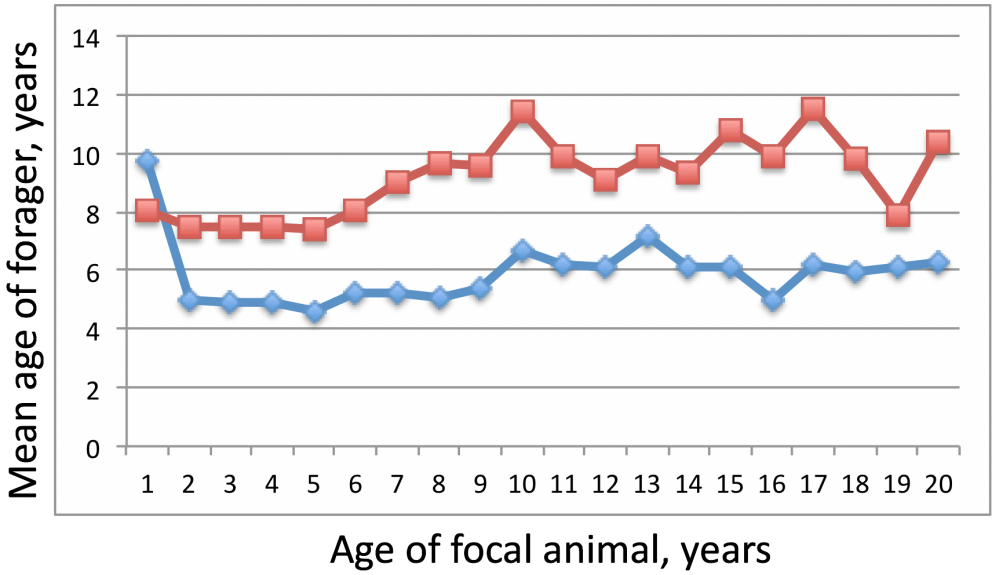
Section 3: How do capuchins change with age regarding their motivation to seek information about foraging from conspecifics?

SI Figure 2: Three juvenile capuchins peer at an adult male who is foraging on rare insects, while a fourth juvenile watches from a greater distance. They are emitting "scary food peep" vocalizations - a call normally produced when handling (or watching someone else handle) potential prey that can be hazardous in some way (e.g. wasps having particularly dangerous stings, maggots gleaned from others' wounds or found in faeces, or dead prey).

The raw data, along with the code used to create the model described in the main text, are found in separate tabs of the file called "3_PeeringData_code.xlsx"

Section 4: What is the role of age in individuals' choices about whose foraging to observe?

SI Figure 3: Y axis shows age of the forager, X-axis shows age of the focal. Blue line (diamonds) shows mean age of foragers whom the focal ignored; red line (squares) shows mean age of foragers the focal watched. This is a plot of raw data, not model predictions.

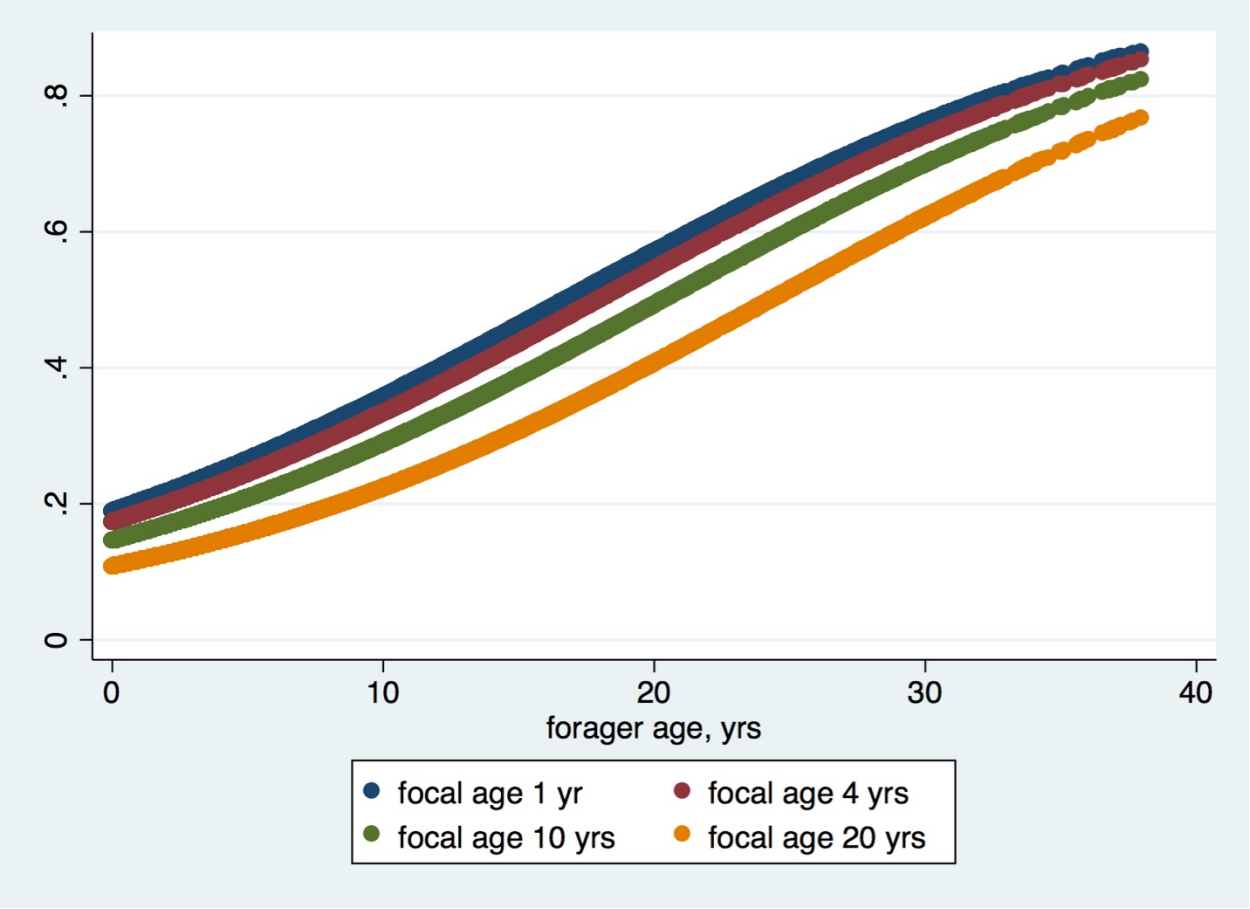


SI Table 3: Mixed-effects logistic regression model output demonstrating effects of focal monkey's age and foraging monkeys' age on probability that the focal animal will watch the forager's actions.*

	Odds ratio	SE	P	95% CI
Fixed effects:				
Focal age	0.966	0.004	<0.001	0.958 to .974
Forager age	1.091	0.005	<0.001	1.082 to 1.101
constant	0.238	0.016	<0.001	0.208 to 0.272
Random effects:				
Focal identity	0.158	0.027		0.112 to 0.222
Forager identity	0.371	0.041		0.298 to 0.461

*A model run exclusively on focal monkeys under age 21 (sample size of 71144 observations) yielded similar results (Odds ratio of 0.963 for focal age, and 1.094 for forager age, both P<0.001), so the results seem not to have been biased by low sampling in the older age ranges.

SI Figure 4: Model predictions regarding impact of forager age on the odds of the forager being watched by the focal animal, for 4 different focal animal ages corresponding to infancy (age 1), juvenile (age 3), young adult (age 10), and middle-aged adult (age 20).



The raw data, along with the code used to create the model described in the main text and presented in SI Table 2 and SI Figure 4, are found in separate tabs of the file called "4_Dataset_Code_focal-forager_ages_watching.xlsx".

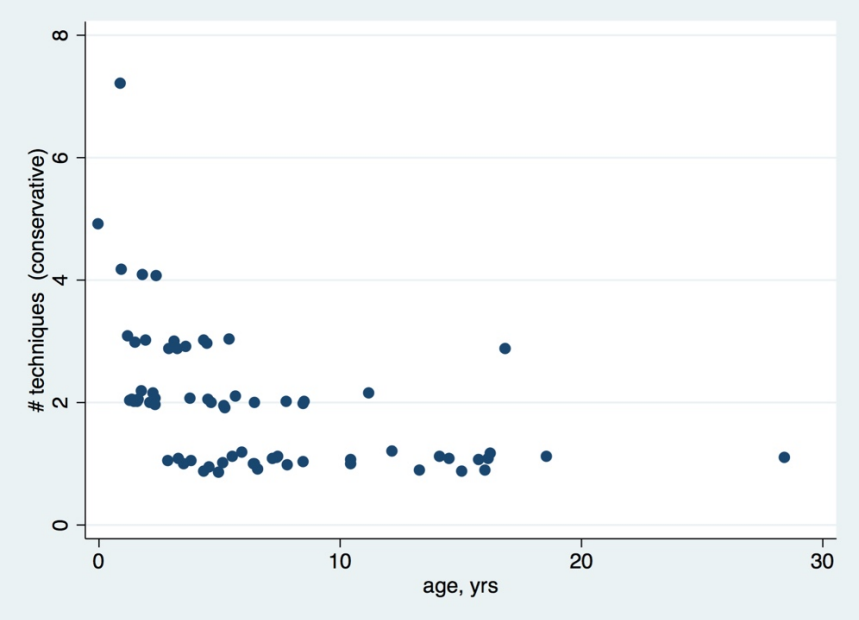
Section 6: Age-related changes in behavioural repertoires:

The raw data, along with the coding scheme and the code used to create the model described in the main text and described in SI Table 3, are found in separate tabs of the file called "6_Luehea_diversity_dataset_coding.xlsx"

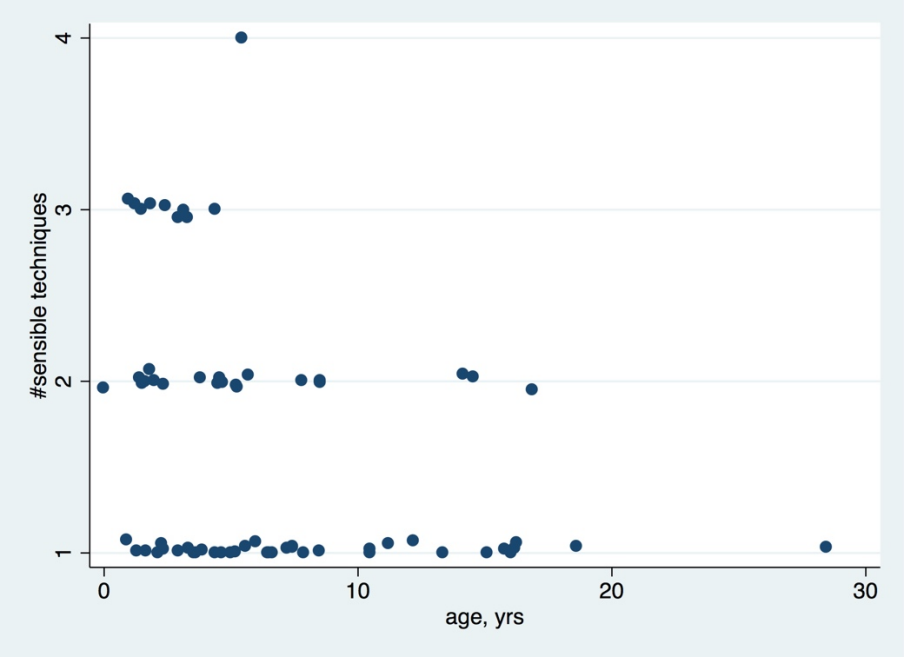
SI Table 4: Model predictions for 4 Poisson models with cluster-robust standard error, in which age predicts # of techniques used to process *Luehea* fruits, using a different coding scheme for behavioral diversity. N=68 observations, SE adjusted for 37 clusters (in monkey).

Model	Coef.	SE	P>|z|	95% CI
Model 1: liberal coding				
age	-0.090	0.020	<0.001	-0.130 to -0.051
constant	1.397	0.131	<0.001	1.140 to 1.654
Model 2: conservative coding				
age	-0.068	0.017	<0.001	-0.102 to -0.034
constant	1.038	0.115	<0.001	0.812 to 1.264
Model 3: sensible techniques				
age	-0.035	0 .009	<0.001	-0.053 to -0.016
constant	0.684	0 .091	<0.001	0.506 to 0.862
Model 4: silly techniques				
age	-0.408	0.161	0.01	-0.723 to -0.094
constant	1.018	0.504	0.04	0 .030 to 2.006

SI Figure 5: Age-related changes in diversity of techniques used to process *Luehea* fruits. This is a raw data plot using the more conservative coding scheme.



SI Figure 6: Age-related changes in diversity of techniques used to process *Luehea* fruits. This is a raw data plot of those behaviours coded as "sensible" (i.e. producing a high yield of seeds).



SI Figure 7: Age-related changes in diversity of techniques used to process *Luehea* fruits. This is a raw data plot of those behaviours coded as "silly" (i.e. producing a low yield of seeds and often involving extraneous movements).