Supplementary Material for

Akcay, C. Campbell, S. E., Beecher, M. D. (in press) The fitness consequences of honesty: under-signalers have a survival advantage in song sparrows. *Evolution*

Figure S1: Predicted survival as a function of soft song (z-scores), averaged across aggression scores.



**Lande-Arnold phenotypic selection analyses on rates of soft songs and aggressive behaviors.**

The tables below report coefficients from the summary output from R-code (attached as supplementary material). Note that the quadratic term coefficients and SEs need to be doubled for selection gradients. See main text for the details of the Lande-Arnold phenotypic selection analysis, as well as Lande and Arnold ([1983](#_ENREF_2)).

Table S1: rates of soft songs (zsoft) and time spent within 5m (ztime5).

 Estimate Std. Error t value Pr(>|t|)

zsoft 0.05828 0.15833 0.368 0.71410

ztime5 -0.07348 0.11598 -0.634 0.52872

I(zsoft^2) 0.27887 0.13478 2.069 0.04279 \*

I(ztime5^2) 0.01822 0.11983 0.152 0.87966

zsoft:ztime5 -0.61414 0.19957 -3.077 0.00313 \*\*

Residual standard error: 0.7611 on 61 degrees of freedom

Multiple R-squared: 0.1783, Adjusted R-squared: 0.111

F-statistic: 2.647 on 5 and 61 DF, p-value: 0.03131

Table S2: rates of soft songs (zsoft) and rate of flights (zflight).

 Estimate Std. Error t value Pr(>|t|)

zsoft -0.05585 0.16742 -0.334 0.7398

zflight 0.07824 0.15412 0.508 0.6135

I(zsoft^2) 0.19924 0.13068 1.525 0.1325

I(zflight^2) 0.01580 0.09493 0.166 0.8684

zsoft:zflight -0.44943 0.17007 -2.643 0.0104 \*

Residual standard error: 0.7816 on 61 degrees of freedom

Multiple R-squared: 0.1333, Adjusted R-squared: 0.06227

F-statistic: 1.877 on 5 and 61 DF, p-value: 0.1116

Table S3: rates of soft songs (zsoft) and closest approach (zclosest).

 Estimate Std. Error t value Pr(>|t|)

zsoft 0.27626 0.15272 1.809 0.07539 .

zclosest 0.33676 0.17127 1.966 0.05383 .

I(zsoft^2) 0.07529 0.09117 0.826 0.41211

I(zclosest^2) 0.05559 0.07402 0.751 0.45550

zsoft:zclosest 0.68638 0.22862 3.002 0.00388 \*\*

Residual standard error: 0.7598 on 61 degrees of freedom

Multiple R-squared: 0.1809, Adjusted R-squared: 0.1138

F-statistic: 2.695 on 5 and 61 DF, p-value: 0.02892

**Survival and age:** For 33 of the 67 subjects for whom we have survival information, we also have information on the exact age of the male because they were banded in the nest, in their juvenile plumage (before their first September) or singing plastic song during their first fall. In previous analyses, reported in [Akçay et al. (2014a](#_ENREF_1)), we did not find an effect of age on aggression scores or aggressive signaling scores. To ask whether the effects of the predictor variables on survival could be attributed to age we ran a separate set of analyses with the subset of subjects for whom we had age data by adding the age as a covariate in a Cox regression ([Cox 1972](#_ENREF_1)) along with the same predictor variables as in the phenotypic selection model. The Cox regression was carried out with the package ‘survival’ in R. ([Therneau and Lumley 2014](#_ENREF_3)). We then model-averaged the resulting model by taking every model within 2 ΔAIC of the best model. The model averaged results show a significant effect of age (birds that were older in 2009 were less likely to survive longer, which is somewhat trivial) and crucially, a significant interaction of soft songs and aggression scores, indicating negative correlational selection.

Table S4: Model selection table for Cox-Regression analysis. Full model contains the terms Age in 2009, Aggression Scores (linear and quadratic), Soft song rates (linear and quadratic) and Aggression scores\*Soft song rates (interaction term). See the R-code for more detail.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model Number | Intercept | Age in 2009 | Aggression Scores | Soft song rates | Soft song rates^2 | Aggression \*Soft Song | df | logLik | AICc | delta | weight |
| 2 | + | 0.2171 |  |  |  |  | 1 | -82.588 | 167.3 | 0 | 0.277 |
| 44 | + | 0.2894 | -0.01214 | -0.488 |  | 0.4363 | 4 | -79.281 | 168 | 0.68 | 0.197 |
| 26 | + | 0.2463 |  | -0.9587 | 0.2964 |  | 3 | -80.914 | 168.7 | 1.35 | 0.141 |
| 1 | + |  |  |  |  |  | 0 | -84.361 | 168.7 | 1.42 | 0.137 |
| 4 | + | 0.2396 | 0.1851 |  |  |  | 2 | -82.183 | 168.8 | 1.46 | 0.134 |
| 10 | + | 0.2234 |  | -0.1498 |  |  | 2 | -82.337 | 169.1 | 1.77 | 0.114 |
| Models ranked by AICc(x) |  |

Table S5: Averaged model for the Cox-regression.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Estimate | Std. Error |  z value | Pr(>|z|) |
| Age in 2009 | **0.2427** | **0.12** | **2.007** | **0.0448** |
| Aggression Scores | 0.0676 | 0.247 | 0.273 | 0.785 |
| Soft song rates | -0.5493 | 0.47 | 1.167 | 0.2432 |
| Aggression\*Soft Song | **0.4363** | **0.192** | **2.270** | **0.0232** |
| Soft song rates^2 | 0.2964 | 0.162 | 1.820 | 0.0688 |

**References**

Cox, D. 1972. Regression Models and Life-Tables. Journal of the Royal Statistical Society. Series B (Methodological) 34:187-220.

Lande, R., and S. J. Arnold. 1983. The measurement of selection on correlated characters. Evolution:1210-1226.

Therneau, T. M., and T. Lumley. 2014. Package ‘survival’.