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Supplementary material

Appendix.1

Table A1 . Full results of phylogenetic generalized least squares analyses for **brightness of exposed patches** repeated on 100 phylogenies. For every estimate (regression coefficient, SE, F- and p-value), we provide its mean and 95% confidence interval (LCI-UCI). Reference categories are “Monogamy” for Mating, “Closed” for Nest type and “Sedentary” for Migration. The λ value (LCI-UCI) is 0.66 (0.34-1.13). N = 412 species in the PGLS analyses.

Response: **brightness (PC1)**	Estimate			SE			F			p		
Predictors	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI
Intercept	-0.24	-0.85	0.23	0.38	0.26	0.57						
Diff. in Attentiveness[^2]	-0.10	-0.13	-0.05	0.10	0.10	0.11	1.22	0.23	1.94	0.33	0.16	0.63
Mating (Polygamy)	0.19	-0.07	0.41	0.18	0.18	0.19	1.48	0.32	2.97	0.26	0.05	0.73
Mating (Lek)	0.33	-0.09	0.55	0.32	0.22	0.35						
Body Mass [Log$_{10}$]	-0.21	-0.29	-0.13	0.08	0.07	0.09	7.77	2.03	13.19	0.02	0.00	0.16
Nest type (Open)	0.14	-0.01	0.41	0.13	0.12	0.16	2.14	0.00	7.06	0.57	0.01	1.00
Migration (Partial)	0.21	0.10	0.24	0.13	0.12	0.14	3.67	0.56	4.85	0.08	0.01	0.57
Migration (Migratory)	0.35	0.14	0.41	0.14	0.13	0.15						
Diff. in Attentiveness[^2]*Nest Type	0.06	0.03	0.09	0.12	0.11	0.13	0.26	0.07	0.56	0.63	0.46	0.79

Table A2. Full results of phylogenetic generalized least squares analyses for **hue of exposed patches** repeated on 100 phylogenies. For every estimate (regression coefficient, SE, F- and p-value), we provide its mean and 95% confidence interval (LCI-UCI). Reference categories are "Monogamy" for Mating, "Closed" for Nest type and "Sedentary" for Migration. The λ value (LCI-UCI) is 0.74 (0.50-1.02). N = 412 species in the PGLS analyses.

Response: **hue (PC2)**	Estimate			SE			F			p		
Predictors	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI
Intercept	-0.61	-1.50	-0.34	0.44	0.31	0.73						
Diff. in Attentiveness[^2]	-0.16	-0.35	-0.12	0.10	0.10	0.12	2.73	1.44	10.34	0.17	0.00	0.23
Mating (Polygamy)	0.18	0.09	0.29	0.18	0.16	0.21	4.71	2.52	9.06	0.02	0.00	0.08
Mating (Lek)	1.02	0.92	1.23	0.35	0.28	0.49						
Body Mass [Log$_{10}$]	-0.21	-0.28	-0.02	0.08	0.07	0.10	8.07	0.03	11.03	0.10	0.00	0.85
Nest type (Open)	0.03	-0.04	0.19	0.13	0.11	0.15	0.43	0.01	1.57	0.67	0.21	0.94
Migration (Partial)	0.07	-0.11	0.15	0.12	0.09	0.13	6.45	2.26	9.15	0.01	0.00	0.11
Migration (Migratory)	0.42	0.18	0.51	0.13	0.10	0.14						
Diff. in Attentiveness[^2]*Nest Type	0.12	0.07	0.32	0.12	0.11	0.13	1.32	0.36	6.89	0.40	0.01	0.55

Table A3. Full results of phylogenetic generalized least squares analyses for **brightness of concealed patches** repeated on 100 phylogenies. For every estimate (regression coefficient, SE, F- and p-value), we provide its mean and 95% confidence interval (LCI-UCI). Reference categories are “Monogamy” for Mating, “Closed” for Nest type and “Sedentary” for Migration. The λ value (LCI-UCI) is 0.53 (0.16-1.11). N = 412 species in the PGLS analyses.

Response: **brightness (PC1)**	Estimate			SE			F			p		
Predictors	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI
Intercept	-0.54	-1.76	0.00	0.35	0.18	0.70						
Diff. in Attentiveness[^2]	-0.18	-0.30	-0.15	0.10	0.09	0.13	3.17	2.09	7.20	0.08	0.01	0.15
Mating (Polygamy)	0.26	0.11	0.51	0.19	0.18	0.22	2.97	1.16	9.15	0.10	0.00	0.35
Mating (Lek)	0.61	0.30	1.18	0.33	0.29	0.45						
Body Mass [Log$_{10}$]	-0.25	-0.43	-0.21	0.08	0.06	0.11	12.24	3.95	24.43	0.01	0.00	0.05
Nest type (Open)	0.10	-0.06	0.79	0.13	0.08	0.17	7.10	0.14	95.28	0.44	0.00	0.70
Migration (Partial)	0.09	-0.08	0.14	0.13	0.12	0.15	9.57	1.49	13.27	0.02	0.00	0.23
Migration (Migratory)	0.54	0.22	0.65	0.14	0.13	0.16						
Diff. in Attentiveness[^2]*Nest Type	0.13	0.09	0.34	0.12	0.11	0.14	1.32	0.62	6.86	0.32	0.01	0.43

Table A4 . Full results of phylogenetic generalized least squares analyses for **hue of concealed patches** repeated on 100 phylogenies. For every estimate (regression coefficient, SE, F- and p-value), we provide its mean and 95% confidence interval (LCI-UCI). Reference categories are "Monogamy" for Mating, "Closed" for Nest type and "Sedentary" for Migration. The λ value (LCI-UCI) is 0.75 (0.54-1.18). N = 412 species in the PGLS analyses.

Response: **hue (PC2)**	Estimate			SE			F			p		
Predictors	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI	Mean	LCI	UCI
Intercept	-0.13	-1.04	0.50	0.39	0.31	0.54						
Diff. in Attentiveness[^2]	-0.05	-0.08	0.01	0.10	0.09	0.10	0.42	0.01	0.76	0.56	0.38	0.94
Mating (Polygamy)	0.04	-0.08	0.10	0.17	0.16	0.18	1.23	0.14	3.27	0.36	0.04	0.87
Mating (Lek)	0.45	0.02	0.72	0.32	0.28	0.33						
Body Mass [Log$_{10}$]	-0.37	-0.55	-0.33	0.07	0.07	0.08	24.99	16.35	54.97	0.00	0.00	0.00
Nest type (Open)	0.03	-0.07	0.23	0.13	0.12	0.15	0.76	0.16	2.45	0.46	0.12	0.69
Migration (Partial)	-0.19	-0.33	-0.13	0.12	0.12	0.13	3.87	2.40	4.66	0.03	0.01	0.09
Migration (Migratory)	0.13	-0.16	0.25	0.13	0.12	0.14						
Diff. in Attentiveness[^2]*Nest Type	0.04	0.01	0.06	0.11	0.11	0.12	0.14	0.00	0.27	0.74	0.60	0.96

Table A5 . Sample sizes of species used in our comparative analyses given for individual taxonomic families and further split by levels of our categorical predictors (nest type, mating system, and migration strategy).

Family	**Total sample size**	**Nest type**		**Mating system**			**Migration strategy**		
	(No species)	Closed	Open	Lek	Monogamy	Polygamy	Migratory	Partial	Sedentary
Aegithalidae	2	2	0	0	1	1	0	1	1
Aegithinidae	1	0	1	0	1	0	0	0	1
Alaudidae	5	1	4	0	5	0	0	3	2
Bombycillidae	1	0	1	0	1	0	1	0	0
Cardinalidae	3	0	3	0	3	0	0	1	2
Certhiidae	3	3	0	0	3	0	0	1	2
Cinclidae	1	1	0	0	1	0	0	0	1
Cisticolidae	2	2	0	0	2	0	0	0	2
Climacteridae	3	3	0	0	3	0	0	0	3
Conopophagidae	1	0	1	0	1	0	0	0	1
Corvidae	21	4	17	0	21	0	0	2	19
Cotingidae	4	0	4	2	2	0	0	0	4
Cracticidae	1	0	1	0	1	0	0	0	1
Dendrocolaptidae	3	3	0	1	2	0	0	0	3
Drepanididae	6	0	6	0	6	0	0	0	6
Emberizidae	40	6	34	0	38	2	17	11	12
Epthianuridae	1	0	1	0	1	0	0	1	0
Estrildidae	1	1	0	0	1	0	0	0	1
Eupetidae	1	0	1	0	1	0	0	0	1
Fringillidae	22	2	20	0	21	1	2	13	7
Furnariidae	2	2	0	0	2	0	0	0	2

Grallinidae	1	0	1	0	1	0	0	0	1
Hirundinidae	7	5	2	0	7	0	4	2	1
Icteridae	10	2	8	0	7	3	4	2	4
Laniidae	4	0	4	0	4	0	0	3	1
Malaconotidae	1	0	1	0	1	0	0	1	0
Maluridae	3	3	0	0	3	0	0	0	3
Meliphagidae	9	0	9	0	9	0	0	2	7
Mimidae	3	0	3	0	3	0	1	0	2
Monarchidae	4	0	4	0	4	0	0	3	1
Motacillidae	11	3	8	0	11	0	5	4	2
Muscicapidae	6	5	1	0	6	0	6	0	0
Nectariniidae	3	3	0	0	3	0	0	0	3
Neosittidae	1	0	1	0	1	0	0	0	1
Notiomystidae	1	1	0	0	0	1	0	0	1
Oriolidae	1	0	1	0	1	0	0	0	1
Orthonychidae	2	2	0	0	2	0	0	0	2
Pachycephalidae	3	0	3	0	3	0	0	1	2
Paradisaeidae	4	0	4	2	0	2	0	0	4
Paradoxornithidae	2	1	1	0	2	0	0	0	2
Paridae	14	14	0	0	14	0	0	0	14
Parulidae	29	9	20	0	27	2	17	4	8
Passeridae	7	6	1	0	7	0	0	4	3
Petroicidae	5	0	5	0	5	0	1	0	4
Philepittidae	1	1	0	1	0	0	0	0	1
Pipridae	2	0	2	1	0	1	0	0	2
Ploceidae	7	7	0	0	3	4	0	1	6
Pomatostomidae	1	1	0	0	1	0	0	0	1

Promeropidae	1	0	1	0	1	0	0	0	1
Prunellidae	3	0	3	0	0	3	0	1	2
Ptilogonatidae	1	0	1	0	1	0	0	0	1
Ptilonorhynchidae	5	0	5	3	2	0	0	0	5
Pycnonotidae	2	0	2	0	2	0	0	0	2
Regulidae	2	0	2	0	2	0	2	0	0
Remizidae	1	1	0	0	0	1	1	0	0
Rhipiduridae	2	0	2	0	2	0	0	1	1
Sittidae	5	5	0	0	5	0	0	2	3
Sturnidae	3	3	0	0	2	1	0	2	1
Sylviidae	19	7	12	0	15	4	12	6	1
Thamnophilidae	2	0	2	0	2	0	0	0	2
Thraupidae	10	3	7	0	10	0	0	0	10
Tichodromidae	1	1	0	0	1	0	1	0	0
Timaliidae	3	0	3	0	3	0	0	0	3
Troglodytidae	9	9	0	0	7	2	1	3	5
Turdidae	35	7	28	0	35	0	9	15	11
Tyrannidae	30	10	20	1	27	2	14	4	12
Vangidae	5	0	5	0	5	0	0	0	5
Vireonidae	6	0	6	0	6	0	3	3	0
Zosteropidae	1	0	1	0	1	0	0	0	1

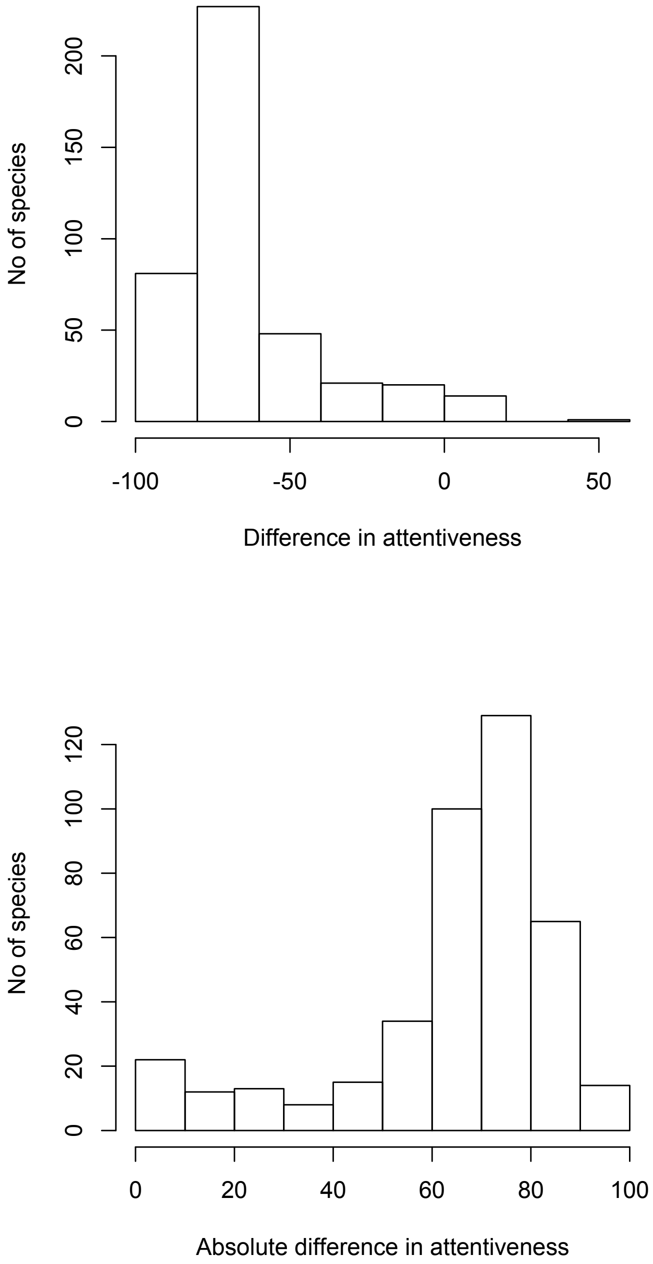


Fig. A1. Distribution of the difference between male and female parental care during incubation as i) difference in nest attentiveness (male attentiveness minus female attentiveness; above) and ii) absolute difference in nest attentiveness (i.e., absolute value of male attentiveness minus female attentiveness; below).

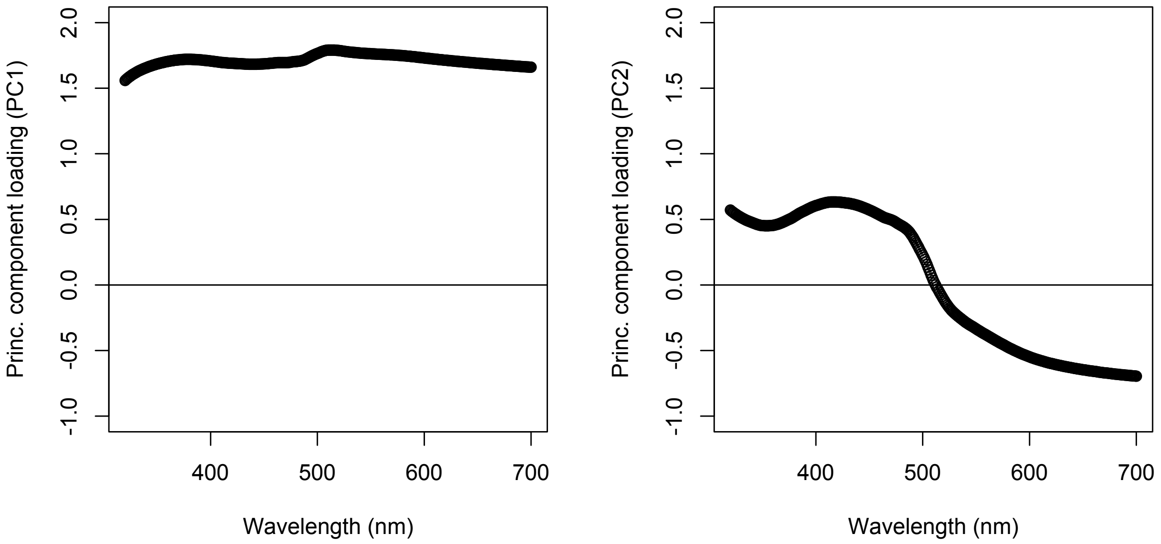


Fig. A2. Loadings of the first two Principal components on wavelengths from 320 to 700 nm. These two Principal components accounted for 96.9% of variation in spectral data. PC1 can be interpreted as brightness (positive loadings across the whole spectrum), whereas PC2 can be interpreted as hue (positive loadings in short wavelengths and negative loadings in long wavelengths, with a transition at around 500 nm).

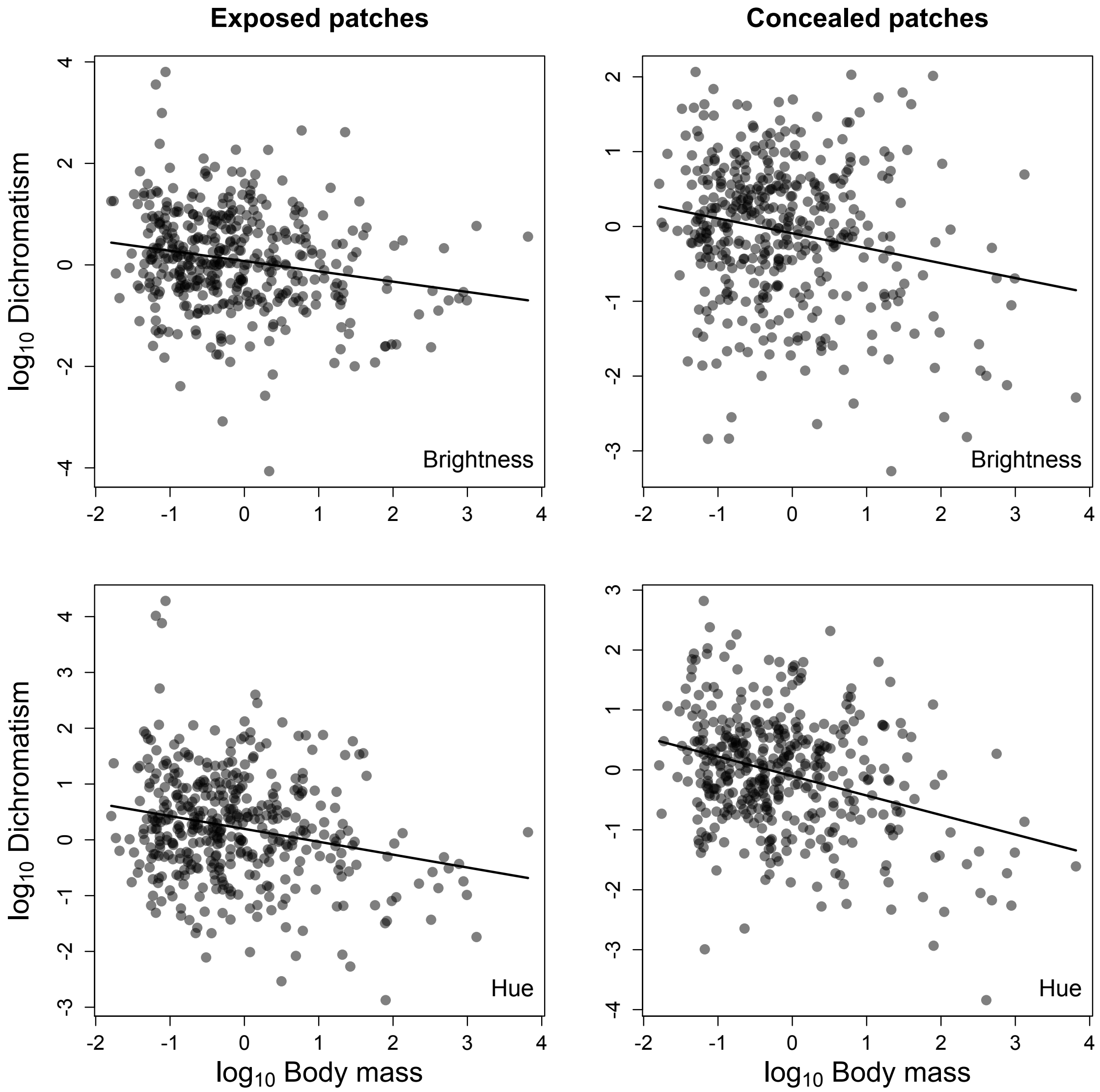


Fig. A3. Relationships between sexual dichromatism in brightness (PC1) and hue (PC2) and adult body mass, shown separately for plumage patches that are exposed (crown, mantle, cheek) or concealed (breast, belly) during incubation. Depicted are residuals from PGLS models controlling for other variables shown in Tables 2 and 3.

Appendix 2

Choosing an index to express relative strength of “Wallacean” selection on males vs. females

To quantify relative strength of selection by predators on inconspicuousness of incubating parents, we calculated the DIFFERENCE between male and female parental care as male attentiveness (zero in species with female-only incubation) minus female attentiveness (Fig. A 1). Since we were interested in the difference in sex-specific incubation behavior regardless of which sex cared more, we used the absolute value of the difference between male and female attentiveness (Fig. A1) . This value thus indicates divergence in parental roles during incubation and potentially the strength of natural selection on males vs. females while sitting on the eggs. We note that our method assumes linear effect with the same slope of predator exposure on male and female coloration (other things being equal). Then the difference between male vs female attentiveness is linearly and exactly related to dichromatism.

The logic of the difference index is more apparent from the following figure (Fig. A4). Consider two species: in one, the male incubates 1% of time and the female 51% of time (red color). In the second, the male incubates 25% and the female 75% (blue color). In both cases, the difference is 50% points (on the x-axis). This translates into the same difference in coloration, i.e. dichromatism (on the y-axis; thick red and blue lines have the same length). No other index we were able to think of has this desirable property.

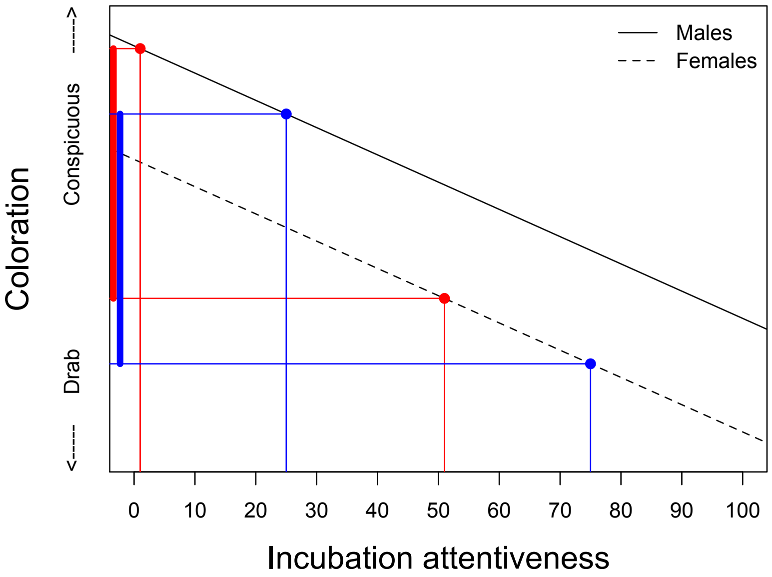


Fig. A4. Schematic illustration of the logic of using the difference between male and female attentiveness, together with difference between male and female coloration (dichromatism). See text for details.

There is one alternative that could have been used: the proportion of incubation by the sex that incubates the most (so the range would be from 0.5 to 1.0, giving an asymmetric index analogous to our absolute difference in attentiveness between the sexes). However, this index has two drawbacks:

1) For certain scenarios, it does not capture the strength of "Wallacean" selection: imagine two species, both with female-only incubation – nest attentiveness would be 40% in the first one and 80% in the second one. This index would give the value of 1 in both cases (since male would not help at all in both). However, we do expect stronger selection on the female in the second species, which has to spend 2x more time by sitting on the eggs – and indeed, this is captured by our difference index, giving the value of 40 in the first case and 80 in the second case.

2) The distribution of this index would be extremely skewed, precluding its use as a predictor in statistical analyses (Fig. A4). On the contrary, our DIFFERENCE index had ac ceptable distribution (see Fig. A1)

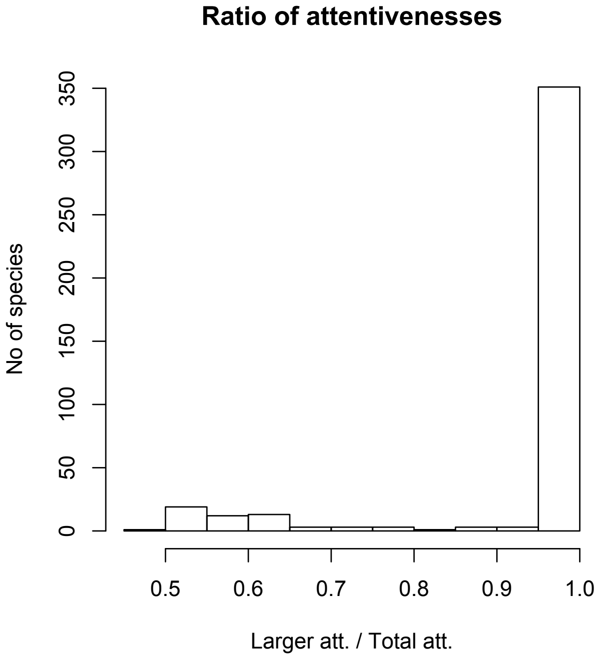


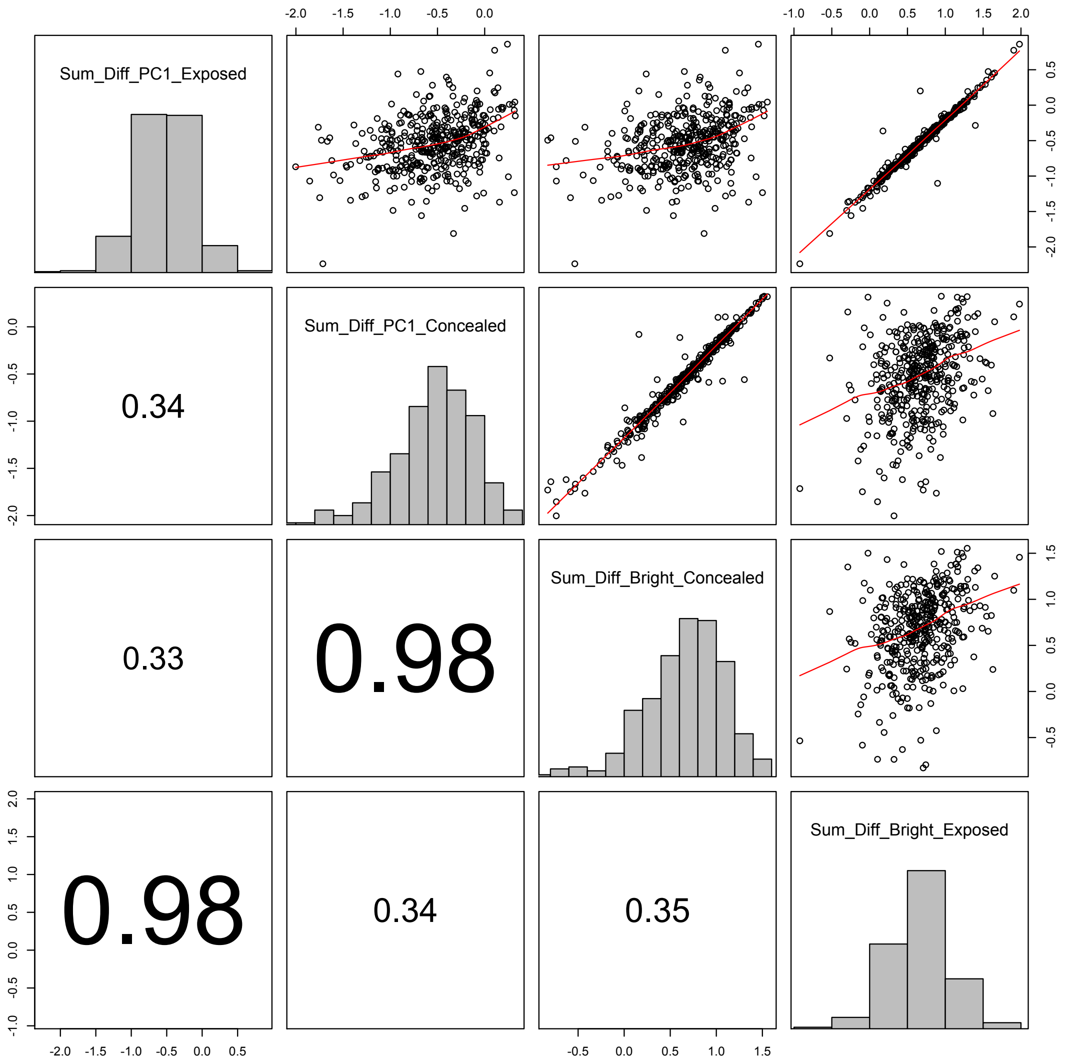
Fig. A5. Distribution of the proportion of incubation by the sex that incubates the most.

Appendix 3

Robustness of our index of sexual dichromatism

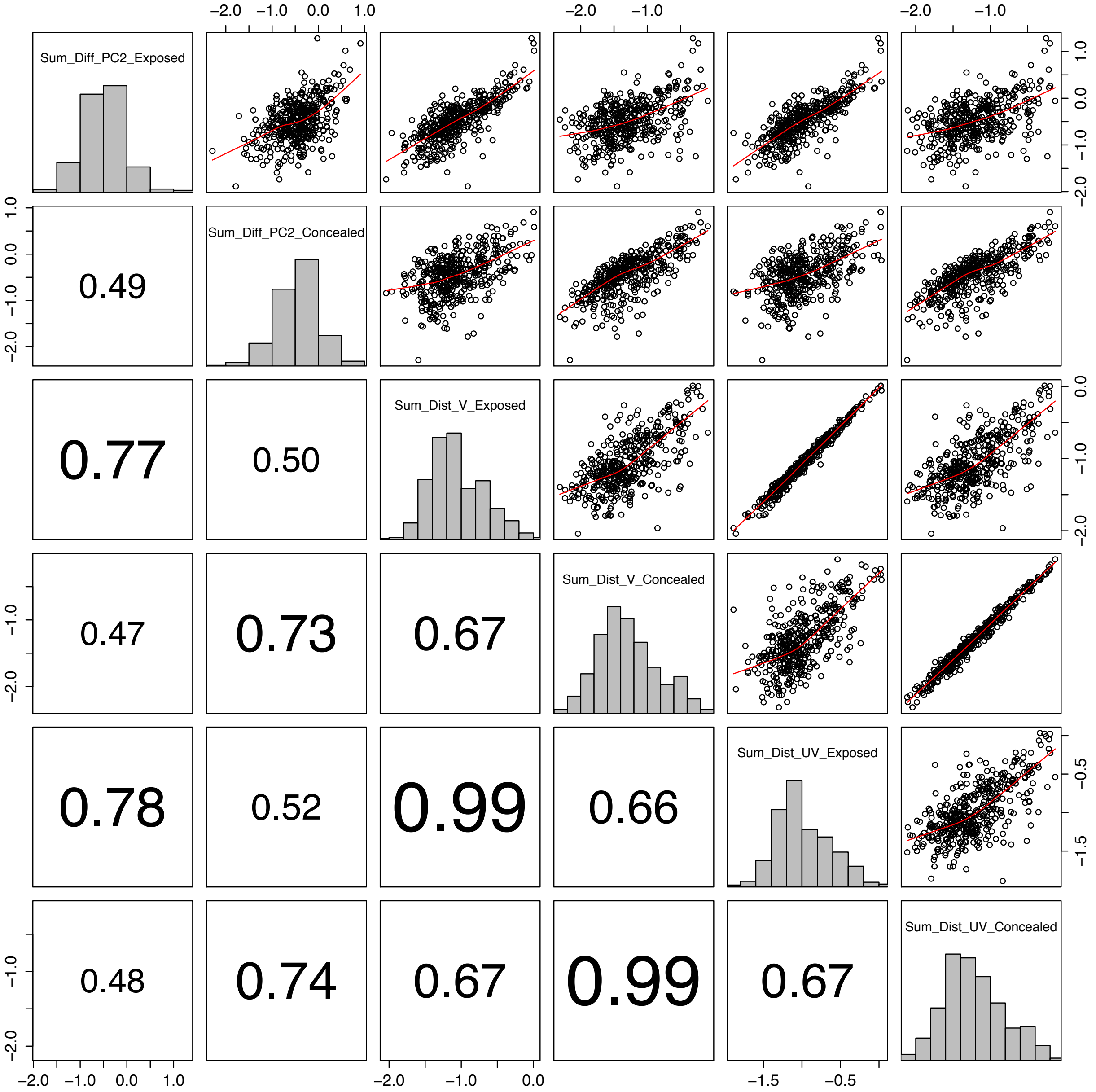
In addition to the PCA-based index of dichromatism described in the main text, we also calculated following two indexes. 1) We calculated overall brightness as the sum of reflectance values across all wavelengths (from 320 to 700 nm), separately for each patch and sex. Then we calculated absolute difference between males and females for exposed and concealed patches as in the main text (see there for details). 2) We calculated Euclidean distance between the male spectrum and the female spectrum in avian tetrahedral color space (Stoddard and Prum 2008, Am. Nat. 171:755-776) in pavo package (Maia et al. 2013, Methods Ecol Evol 4:906-913) for each patch separately. We then summed these distances for exposed (crown, mantle, cheek) and concealed patches (breast, belly) in every species.

Following figure (log10-transformed variables) shows very high correlations (r = 0.98) between the PCA-based dichromatism index of brightness (Sum_Diff_PC1) and dichromatism based on actual brightness (Sum_Diff_Bright) for both exposed and concealed patches. These results confirm that our PCA-based index of dichromatism in brightness was a very good approximation of an index based on real brightness of reflectance spectra.



Following figure (log10-transformed variables) demonstrates relationships among indexes of dichromatism based on color characteristics that ignore brightness. We show that:
i) Correlations between dichromatism based on the visual systems with UV-sensitive (Sum_Dist_UV) vs. V-sensitive (Sum_Dist_V) short wavelength cones are very high (r = 0.99).
ii) Correlations between dichromatism based on PCA-based index of hue (Sum_Diff_PC2) and dichromatism based on distances in the avian visual space (Sum_Dist) are reasonably high for both exposed (r = 0.77 and 0.78) and concealed patches (r = 0.73 and 0.74).

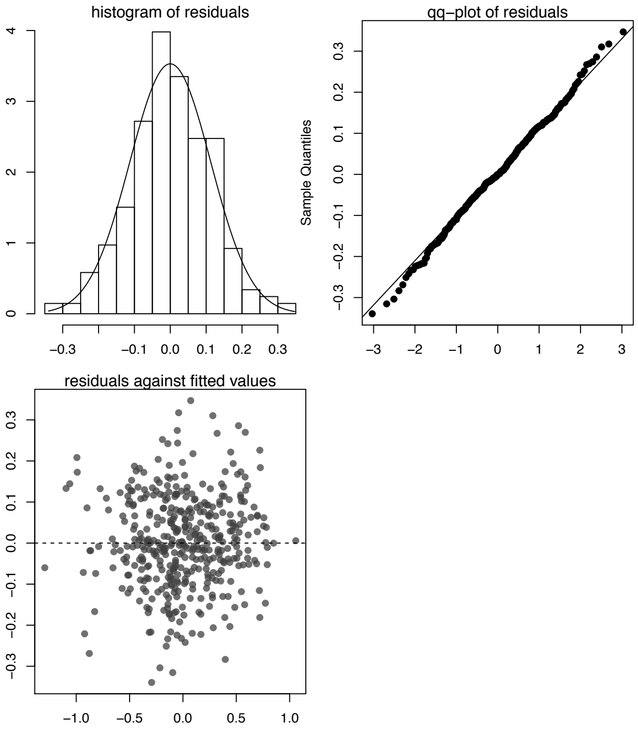
These results show that dichromatism based on PCA-based index of hue is a reasonable approximation of dichromatism based on visual space of a major group of predators using vision to locate nests (i.e. birds).



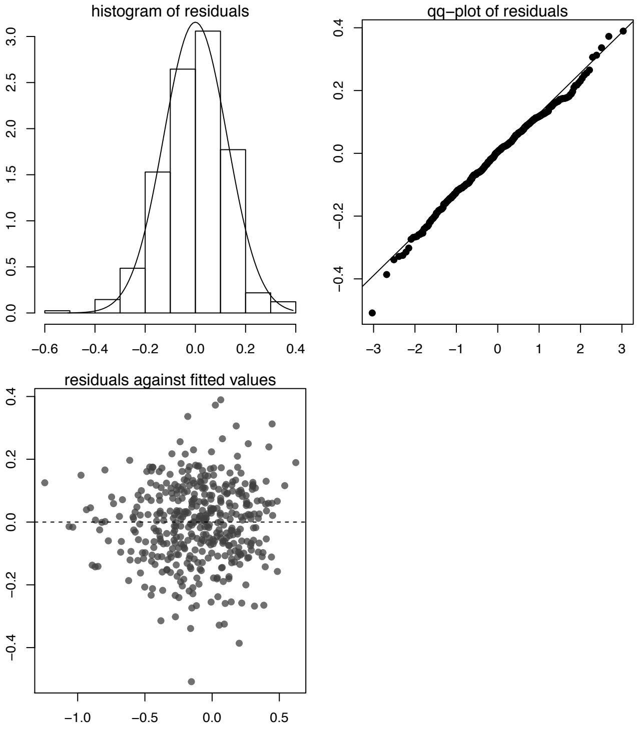
Appendix 4

Plots of residuals from the four main models presented in Tables 1 and 2 in the main text. All residuals had reasonable distribution, despite some species having quite outlying values of dichromatism (especially *Malurus cyaneus*, *M. splendens*, and *Cyanerpes lucidus*). However, apparently after $\log_{10}$-transformation, assumptions of the PGLS models were fulfilled.

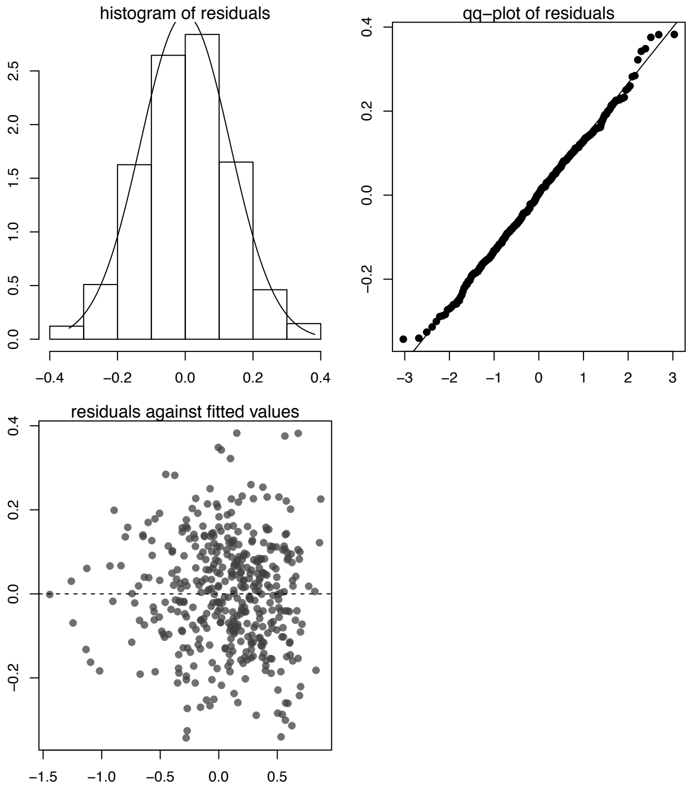
PC1 (brightness), concealed patches:



PC1 (brightness), exposed patches:



PC2 (hue), concealed patches:



PC2 (hue), exposed patches: