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3 **Colour Preferences of UK Garden Birds at Supplementary Seed Feeders**

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Abstract

Supplementary feeding of garden birds has benefits for both bird populations and human wellbeing. Birds have excellent colour vision, and show preferences for food items of particular colours, but research into colour preferences associated with artificial feeders is limited to hummingbirds. Here, we investigated the colour preferences of common UK garden birds foraging at seed-dispensing artificial feeders containing identical food. We presented birds simultaneously with an array of eight differently coloured feeders, and recorded the number of visits made to each colour over 370 30-minute observation periods in the winter of 2014/15. In addition, we surveyed visitors to a garden centre and science festival to determine the colour preferences of likely purchasers of seed feeders. Our results suggest that silver and green feeders were visited by higher numbers of individuals of several common garden bird species, while red and yellow feeders received fewer visits. In contrast, people preferred red, yellow, blue and green feeders.

Introduction

It has been estimated that 20-30% of people in more developed areas of the world provide wild birds with additional food (supplementary feeding) at some point in the year (typically during the winter months) [1,2]. In the UK, approximately 60% of households with gardens provide food for birds [3], estimated at 12.6 million households [1], 7.4 million of which use bird feeders [4]. As a result the UK wild bird feeding industry was estimated as being worth £210m per annum [5], and the wild bird care market rose 15% in value between 2014 and 2015 [6]. Levels of bird feeding vary enormously across society [7], but

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35   the importance of the connection between people and nature to human well-being in urban

36   environments is well established [8]. People feed birds because it gives them a sense of

37   personal wellbeing, although the underpinning emotions, experiences and personal

38   perceptions of the people feeding birds are certainly more complex than such a simplistic

39   statement might suggest [9]. Some people (those involved in avian monitoring or research)

40   feed birds in order to attract them for capture, measurement and subsequent release.

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42   During the northern hemisphere winter natural food resources are at their lowest

43   level of availability [10] and a bird's thermodynamic costs are at their highest [11]. Over

44   winter survival is thus highly dependent upon the characteristics and availability of food

45   supply [10]. Gaining enough energy each day to ensure overnight survival is particularly

46   important for small passerines: individuals in the tit family (Paridae) can lose up to 10% of

47   their body weight overnight in winter [12]. Supplementary feeding may off-set the effects of

48   winter resource depletion [13] and in many cases a winter feeding station may be the most

49   abundant and dependable food source in a particular area [14]. Supplementary feeding has

50   been recorded as having a number of other benefits to birds, including larger clutch sizes

51   (house sparrows *Passer domesticus* [15]), better body condition and more rapid recovery

52   from injury (Carolina chickadee *Parus carolinensis*, tufted titmice *Parus bicolor* and white-

53   breasted nuthatch *Sitta carolinensis* [16]).Supplementary feeding increases both the range

54   of species and number of individuals visiting gardens [1,17] and increases abundance at a

55   landscape scale [1]. In the UK, for example, supplementary feeding has been implicated in

56   population increases of both house sparrow and starling (*Sturnus vulgaris* [18]) and may be

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57   important in the evolution of 'new' migration strategies amongst over-wintering blackcap

58   (*Sylvia atricapilla* [19]).

59

60   In order that the benefits of supplementary feeding to both birds and the people

61   who feed them are realised it is essential that food be provided in a way that makes it

62   accessible to birds. In the case of the seed based foods provided to passerines

63   supplementary feeding most often involves the use of commercially available tubular seed

64   dispensers. These feeders commonly consist of a transparent plastic tube through which

65   seeds are visible to birds and coloured metal or plastic lids, bases, perches and feeder ports.

66   Here, we report an investigation into whether the colour of these metal or plastic parts

67   affected the number of birds choosing to feed at a particular feeder. For a feeder to attract

68   larger numbers of birds, something likely to be seen as preferable by those that purchase

69   feeders, the colour should be attractive or neutral to either a particular target species, or

70   seed feeding birds more generally. A feeder the colour of which birds avoid would not be an

71   effective feeder.

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73   Birds have excellent colour vision and exhibit the ability to distinguish and choose

74   between different colours and shades [e.g. 20-22]. Here, we focus on colour preferences in

75   relation to foraging. Multiple studies report preferences of birds for food items of a

76   particular colour. Great tits (*Parus major*) blue tits (*Cyanistes caeruleus*) and Eurasian

77   nuthatches (*Sitta europaea*) all preferred uncoloured (natural) peanuts over those that had

78   been dyed white [23]. Willson et al. [24] reviewed a number of studies demonstrating that

79   frugivorous birds prefer black or red grapes or cherries over other colours such as green and

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80   yellow, but point out that preference for colour here is confounded by preference for other

81   factors associated with colour, such as ripeness, size and nutritional value [24]. Other

82   studies have used artificial or novel foods dyed different colours and found colour-based

83   preferences [24-26]. Wilson et al [24] reported a preference for red, and avoidance of

84   yellow in three species of frugivorous bird, while North Island robins (*Petroica longipes*)

85   preferred yellow and avoid blue and brown [26] for example.

86

87   Preferences for colour associated with supplementary feeders, rather than food,

88   have exclusively focused on the preferences of hummingbirds (Trochillidae) at feeders

89   designed to provide sugar syrup. While hummingbird-pollinated flowers tend to be red

90   [27,28], and birds tend to prefer red-pigmented flowers over those lacking red pigments (e.g.

91   [29-31], reviewed in [28]), experimental studies on feeders do not show a consistent

92   preference for any particular colour (e.g. [32-34], reviewed in [28]). Instead, factors such as

93   location [35,36], previous experience [37-39] and nectar quality [35,39] appear to be more

94   important in determining choice. We have been unable to find any peer-reviewed studies of

95   the impact of seed dispensing feeder colour on bird feeding behaviour. One anecdotal

96   report [40] suggested that work carried out by the British Trust for Ornithology

97   demonstrated colour-based preferences for birds visiting seed and peanut feeders, namely

98   that blue seed feeders are preferred during the summer, while silver feeders are preferred

99   in winter (although goldfinches preferred green), and red peanut feeders are preferred over

100   other colours. The primary aim of our research was to investigate the effect of feeder colour

101   on the feeding preferences of wild birds. As an additional aim we investigated the level to

102   which birds and the humans who feed them agreed on their preferred feeder colour, an

103   important consideration for those who make and sell feeders and those who use them.

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Methods

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Bird colour preference

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107   To explore the effect of colour on the number of visits by birds, we recorded bird

108   visit rates to 8 different coloured feeders at three sites on 78 sampling days during the

109   winter/spring of 2014/15 (November 2014 to May 2015).

110   Data were collected at Tophill Low Nature Reserve (Driffield, East Yorkshire TA

111   075,492), The University of Hull Botanic Garden (Cottingham, East Yorkshire TA 050,329)

112   and a suburban garden in Otley (West Yorkshire SE 195,472). These sites were chosen due

113   to accessibility and the presence of existing artificial feeders with regular avian visitors. The

114   feeders used (Natures Feast Royal Seed Feeders, Westland Horticulture) were of

115   transparent tubular design with metal lids, two metal ports and two straight metal perches.

116   The metal parts of each feeder were painted a single colour using Hammerite Metal Paint.

117   The proprietary colours used were *Smooth Black, Smooth Blue, Smooth Dark Green, Smooth*

118   *Red, Smooth White, Smooth Yellow, Hammered Silver* and Purple (achieved by mixing

119   *Smooth Blue, Smooth Red* and *Smooth White* at a ratio of 3:2:1). Analysis of the feeder

120   colours can be found in the section below. Throughout the experiment the feeders were

121   filled with "Nature's Feast High energy No Mess 12 Seed Blend" (Westland Horticulture, UK).

122   At each site the feeders were suspended in a line from a metal cross-bar, 30 cm

123   apart from one another and 1.5m above the ground. At any time, one feeder of each of the

124   8 colours used was available (see supporting information: Fig S1). The order of the feeders

125   along the cross-bar was changed after every 30 minute observation period according to a

126   pre-determined random pattern to control for any preferences based on feeder position

127   rather than colour. Feeders were filled at the beginning of each observation period and

128   cleaned thoroughly every 14 days. During each data collection session the numbers of

129   feeding visits by birds to each of the feeders in the array were recorded over 30 minutes. A

130   feeding visit was defined as a bird landing on the perch and taking food from the feeder port.

131   Birds were identified to species level, but as it was not possible to distinguish between

132   individuals of the same species, each visit to the feeders was counted as an independent

133   data point. All observations periods were video recorded (Sony Handycam HDR-CX240E)

134   mounted on a tripod approximately 10m from the feeders. Identification and counting of

135   birds either took place in real-time in the field or later using the video recordings (where the

136   number of visits was too high to allow for accurate real-time recording).

137   Data were collected across a total of 370 observation periods (Otley: 208; Tophill; 26

138   Botanic Gardens: 136), and a total of 7535 visits to the feeders were recorded (table 1).

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140   **Table 1:** Summary of data, showing the total number of visits by each species at each site,

141   and the number of sample periods in which that species was observed at least once.

Species	Thwaite Gardens	Tophill Low	Otley	Total	Sample periods

Blue tit *Cyanistes caeruleus*	810	1824	629	3263	108
Great tit *Parus major*	833	1564	13	2410	38
House sparrow *Passer domesticus*	-	-	701	701	58
Coal tit *Periparus ater*	311	116	109	536	48
Robin *Erithacus rubecula*	171	12	105	288	75
Starling *Sturnus vulgaris*	-	-	172	172	13
Greenfinch *Chloris chloris*	-	1	135	136	21
Marsh tit *Poecile palustris*	-	16	-	16	3
Long tailed tit *Aegithalos caudatus*	2	3	-	5	2
Bullfinch *Pyrrhula pyrrhula*	5	-	-	5	3
Goldfinch *Carduelis carduelis*	-	3	-	3	1
Total	2132	3539	1864	7535	370

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Human colour preference

145   To assess the preferences of likely purchasers of bird feeders, we collected data in a

146   garden centre (Hornsea Garden Centre, Sigglesthorne, Hornsea, UK) where similar feeders

147   were sold (3 days, 8 2-hour sample periods) and at the University of Hull Science Festival (1

148   day as a single sample period). At each venue we explained to adult volunteers that we

149   were investigating the choices made by birds and people but we did not provide any

150   information on actual bird preferences (supporting information: Fig S2). People were shown

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151   the coloured feeders used in the study and asked simply to indicate (by placing a token in an

152   appropriately coloured container) which they would be most likely to buy for their own

153   garden. Containers were emptied and tokens counted at the end of each sample period. In

154   total, 587 'votes' were cast during the poll.

155

Data analysis

157   All analysis was carried out using R v3.2.3 [41]. The total number of visits (across all

158   species, to give a measure of the overall preference for particular colours) to the feeders

159   were analysed using a generalised linear mixed effects model with a Poisson error

160   distribution (as appropriate for count data). Observation period and site were added as

161   random effects to account for non-independence of visits to feeders displayed at the same

162   time, and overall differences in bird populations at a given site. An observation-level

163   random effect was included to account for overdispersion in the data [42]. Re-leveling the

164   data within the model allowed for all pairwise comparisons between colours to be made,

165   and p-values were corrected for multiple testing across pairwise comparisons using the false

166   discovery rate control method [43]. The same analysis was used for the number of visits for

167   each species with more than 100 total visits to the feeders (see supplementary tables S1-S5),

168   to evaluate whether different species had different colour preferences. Preferences

169   expressed by visitors to the garden centre and science festival were also analysed using the

170   same methodology.

171

Feeder colour analysis

173   To objectively describe the colour of the feeders, photographs of the feeder lids

174   were taken in RAW format using a Canon Powershot G12 camera. Lids were placed into a

175   light tent (EZCube, Ventura, CA, USA) under daylight spectrum illumination with a white

176   reflectance standard (Ocean Optics, Dunedin, FL, USA).

177   Images were processed using the Image Calibration and Analysis Toolbox [44] plugin

178   for ImageJ 1.50i [45]. After using the toolbox to linearise and standardise the image against

179   the white standard, a patch on each feeder that was approximately the same distance and

180   orientation as the reflectance standard and free from specular reflections, was selected, and

181   the mean camera-specific RGB values of the patch were recorded (16-bit colour depth).

182   To summarise the luminance independent colour measures, RG and BY ratios were

183   calculated (RG = (R-G)/(R+G); BY = B–((R+G)/2)/ B+((R+G)/2); Fig 1A). These ratios describe

184   the redness versus greenness (RG), and blueness versus yellowness (BY) of a stimulus and

185   approximate human and potential avian opponent colour channels [46]. Additionally,

186   luminance ((R+G+B)/3) is shown in Fig 1B. As the camera was not UV sensitive and had not

187   been characterised (i.e. the spectral sensitivity of each sensor measured), it was not

188   possible to measure reflectance in the UV range or transform the RGB values into avian

189   colour space [44].
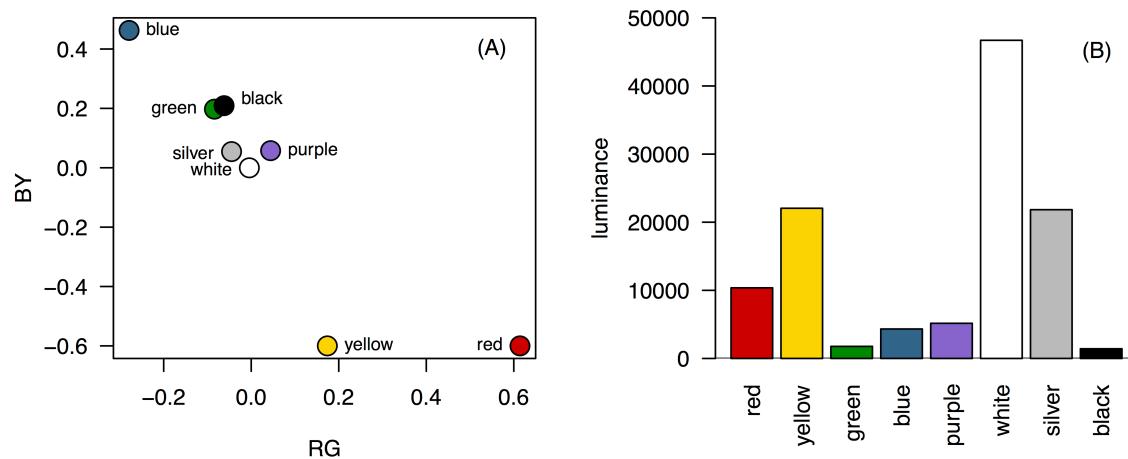
Fig 1: Analysis of feeder colour. (A) RG and BY ratios, and (B) luminance for the 8 different feeder colours

Ethical statement

Experiments were approved by the University of Hull's School of Biological, Biomedical and Environmental Sciences and Faculty of Science and Engineering ethical review committees before commencement. All avian work was observational, and carried out at locations where supplementary feeding of birds already occurred and would continue after data collection was completed. Permission to carry out fieldwork was granted by the University of Hull (Thwaite Gardens), Richard Hampshire (Tophill Low Reserve Warden) and Mark Rothery (Otley site owner). The field studies did not involve endangered or protected species. All participation in the human colour preference was entirely voluntary and the purpose of the experiment was explained to the participants either verbally or via an A4 poster displayed near the stand (Fig S2). Written consent was not obtained to ensure participation was simple and to maximise the number of participants, and approved by the

206   institutional review boards above. No data on the participants (other than their choice of

207   colour) was collected.

208

Results

Bird colour preference

211   There was a significant effect of feeder colour on the number of visits to the feeders

212   ($F_{7, 875}$=6.120, p < 0.001; Fig 2A). Birds made significantly more visits to the silver feeder and

213   significantly fewer visits to the red and yellow feeders than any other colour (all p<0.05;

214   table 2). Green was visited significantly more often than any other colour except silver, but

215   there was no difference in the number of visits to blue, purple, white and black.

216

217   **Table 2: Pairwise comparisons of visits to feeders.**

218   *Please see end of document for table 2 (landscape format)*

219   The cells above the diagonal show the z- and p-values, while the estimate ± standard error is

220   below the diagonal. Significant p-values are highlighted in bold. Adjusted p-values following

221   false discovery rate control are presented.

222

223   For blue tits (Fig 2B, supporting table S1), there was a significant effect of colour on

224   number of visits ($F_{7, 749.73}$=4.3575, P < 0.001). Yellow and red were the least visited colours,

225   and were visited with similar regularity (table S1, p > 0.05). Yellow was visited significantly

226   less than all other colours except white ($p > 0.050$), while visits to red were not different

227   from white or green ($p > 0.05$). There were no differences in the number of visits between

228   the other colours ($p > 0.05$; table S1).

229   For great tits (Fig 2C, table S2), there was a significant effect of colour on number of

230   visits ($F_{7,259} = 2.671$, $p = 0.011$). There were significantly fewer visits to yellow than to all

231   other colours except red ($p < 0.05$ in all cases), while red was visited significantly less often

232   than green ($p = 0.017$). There were no other significant pairwise differences (table S2).

233   For coal tits, there was a significant overall effect of colour on visits ($F_{7,329}=3.796$, $p < 0.001$),

234   but no significant pairwise comparisons were found after correction for multiple testing (Fig

235   2D; table S3).

236   For house sparrows, there was a significant effect of colour on visits ($F_{7,399} = 11.139$,

237     $P < 0.001$). The yellow feeder was visited significantly less often than all other colours (Fig

238   2E, table S4, $p < 0.05$ in all cases), and red was visited less often than blue, green, silver and

239   black ($p < 0.05$). White and purple were visited less often than blue, green and black ($p <$

240   0.05) which were the colours visited most (although not significantly more than silver; table

241   S4)

242   For robins, there was a significant effect of colour on visits ($F_{7, 518}=3.1033$, $p = 0.003$;

243   Fig 2F). Black, the most visited colour, was visited significantly more often than purple and

244   white ($p < 0.05$, table S5), the least visited colours, but no other pairwise comparisons were

245   significant.

246   There was no significant effect of colour on visits for greenfinch ($F_{7,140}$ = 1.3.383, p = 0.217)

247   or starling ($F_{7,84}$ = 1.232, P =0.294), and no other species was recorded more than 100 times

248   during the sample period, so their preferences have not been analysed.

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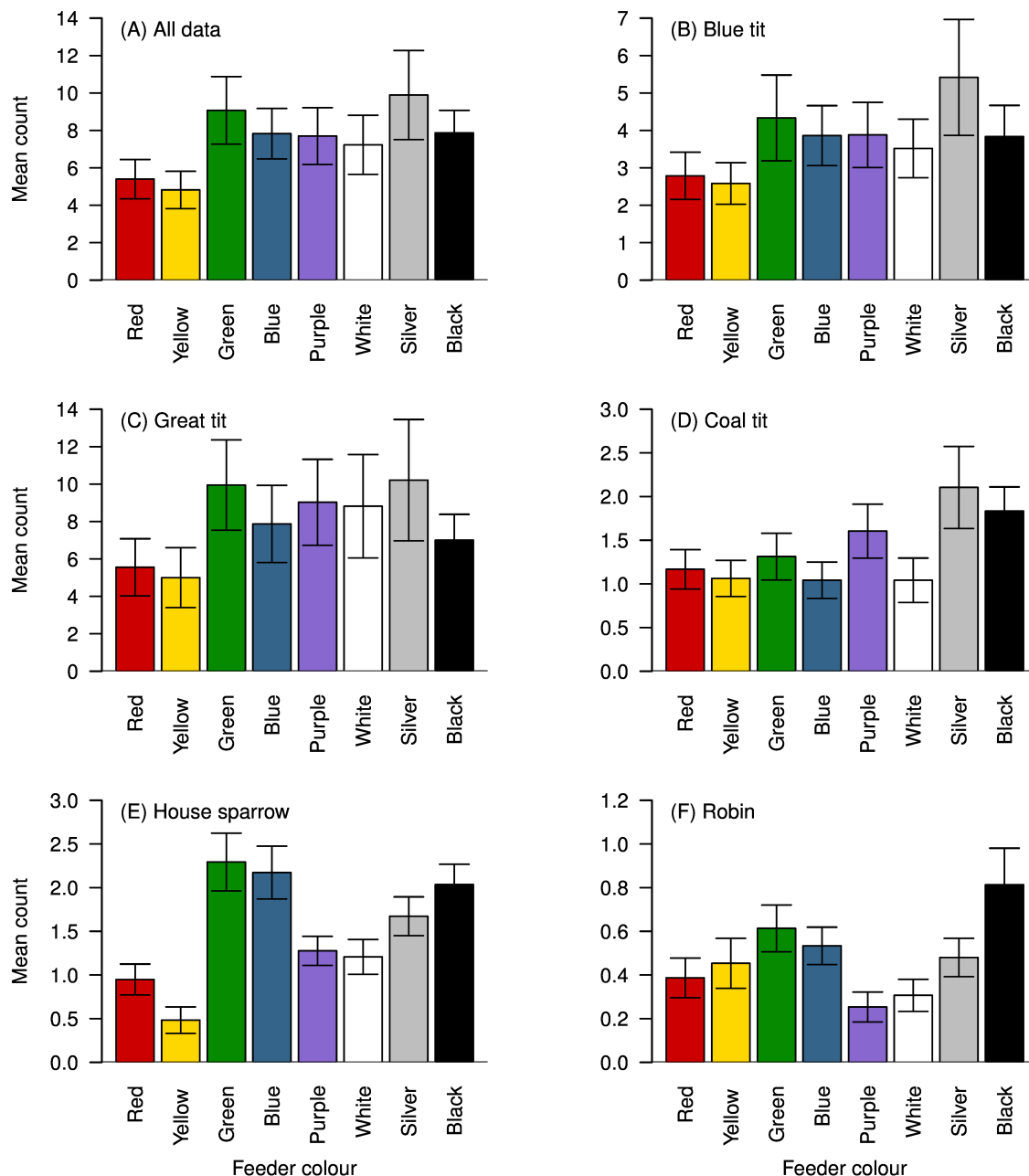
250   **Fig 2: Bird colour preferences.** Mean numbers of visits per observation period to feeders of

251   each colour, for (**A**) all species combined, (**B**) Blue tit *Cyanistes caeruleus* (**C**) Great tit *Parus*

252 *major* (**D)** Coal tit *Periparus ater* (**E)** House sparrow *Passer domesticus* and **(F)** Robin

253 *Erithacus rubecula*. Error bars represent +/- 1 S.E.

254

Human colour preference

256   There was a significant effect of colour on the preferences observed in our survey

257 ($F_{1,7}$=10.485, P=<0.001; Fig 3a). Pairwise comparisons revealed that red, yellow, green and

258 blue were preferred over purple, white, silver and black (table 3). Fig 3B shows the mean

259 number of visits by birds plotted against the mean number of votes from visitors, and

260 suggests that human and bird preferences do not necessarily align. Colours in the top right

261 of Fig 3B are those that received high visit rates from birds and high numbers of votes from

262 visitors, and we suggest those colours (green and to a lesser extent, blue) may be

263 simultaneously marketable and well-visited by birds. While red and yellow received high

264 numbers of votes from visitors, these are the colours that received the lowest numbers of

265 visits from birds.

266

267 **Table 3: Pairwise comparisons of numbers of votes for each colour.**

268 *Please see end of document for table 3 (landscape format)*

269 The cells above the diagonal show the z- and p-values, while the estimate ± standard error is

270 below the diagonal. Significant p-values are highlighted in bold.
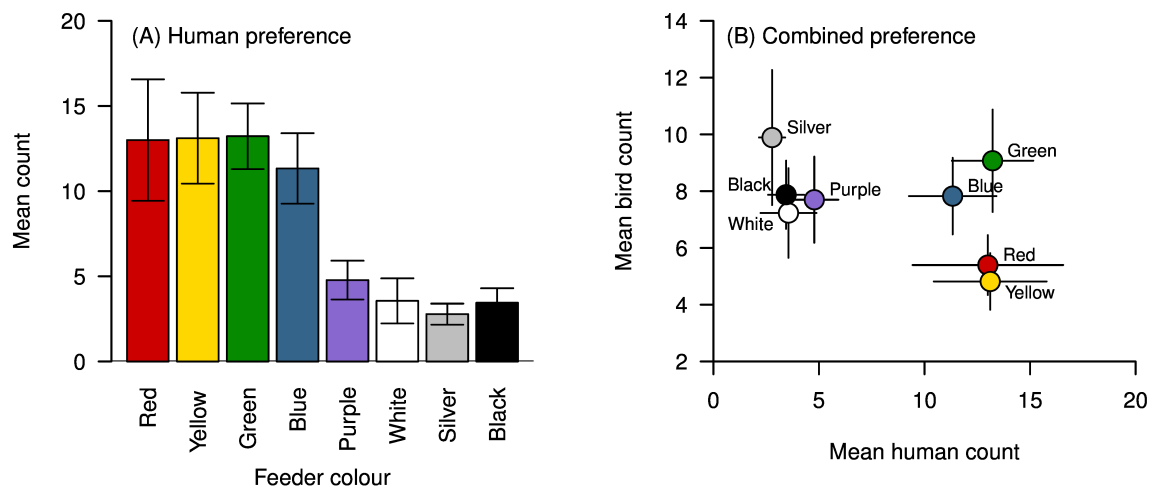
Fig 3: Human colour preferences. (A) Mean number of tokens placed into the container corresponding to each coloured feeder by potential purchasers of bird feeders. **(B)** The combined preferences of potential purchasers (x axis) and visits by all birds (y axis) for each colour feeder. Error bars represent +/- 1 S.E.

Discussion

Overall, birds preferentially visited the silver feeders, followed by green, and made fewer visits to the red and yellow feeders when all feeders were displayed simultaneously. These patterns are likely driven by the preferences of the most abundant species at the feeders (blue tits and great tits), which showed similar preferences to the overall patterns. These patterns contrast with the preferences expressed by the potential purchasers of feeders, who preferred red, yellow, green and blue, but rarely voted for silver. In terms of feeder design, this suggests that green (and to a lesser extent, blue) may be simultaneously marketable and well visited by birds. Our findings also suggest that different species of birds may have different colour preferences, although the total number of visits by some species was too low to evaluate this.

288

289   Silver and green feeders may be preferred over red and yellow for a variety of

290   reasons. Green and silver are common colours for birdfeeders, and familiarity with

291   particular colours may have played a role in determining preferences. In hummingbirds,

292   previous experience of particular colours plays a role in colour choice. Anna's (*Calypte anna*)

293   and rufous (*Salasphorus rufus*) hummingbirds preferentially choose red feeders if captured

294   from red-flowered *Ribes speciousm* plants, but prefer yellow if captured near yellow-

295   flowered *Nicostiana glauca* [38]. Hummingbirds can also be trained to prefer particular

296   colours when that colour is associated with higher quality rewards [31,35,39]. As the seed

297   quality in our feeders was identical, the preferences exhibited by the birds could have been

298   due to our choice of locations where birds were regularly fed, and thus familiar with

299   commonly coloured feeders.

300

301   In contrast, red and yellow are uncommon colours for seed dispensing bird feeders.

302   Neophobia in relation to food colour has been well documented in both birds (e.g. [47-51])

303   and other species [52,53]. Red and yellow are also associated with warning colouration and

304   aposematism, and may be avoided by foraging birds [54,55]. Red and yellow feeders may

305   also be more conspicuous against the background (while green and silver are more cryptic),

306   which may increase perceived predation risk [56]. However, these colours may also make

307   the resource more conspicuous from a distance [57] and thus brightly coloured feeders may

308   be effective in attracting birds to new foraging sites more rapidly: some evidence from

309   Anna's hummingbirds suggests that red feeders placed in novel locations initially attract

310   more birds than other colours [36], but red is a common colour of the nectar resource for

311   this species, and so may not be applicable to seed-feeding birds. Our experiment does not

312   allow us to speculate on whether particular colours would be more or less attractive to birds

313   if put out alone.

314

315   During data collection, we observed (but did not record) multiple events where a

316   competitor displaced feeding individuals from one feeder to another. This may mask feeding

317   preferences as individuals are then recorded at less preferred feeder colours, a limitation of

318   presenting all colours together. The ways in which different options are presented often

319   affects the choices that animals make. Hummingbirds offered a choice between red and

320   yellow-flowered *Mimulus aurantiacus* prefer to feed at the red morph [58], but in a hybrid

321   population where orange morphs occur, visit orange flowers more often than expected by

322   chance, given their prevalence in the population [28]. Preferences between two option may

323   also be affected by the addition of a third option (e.g. if A is preferred over B, and B over C,

324   then A is not necessarily preferred over C), violating the principle that choices are 'rational'

325   and preferences are transitive [59,60]. Evidence suggests that the principle of rational

326   choice is violated by a range of species, including humans (e.g. [61-63]), honeybees (*Apis*

327   *mellifera* [64]), rufous hummingbirds [59,65], starlings [66] and grey jays (*Perisoreus*

328   *canadensis* [64]). By presenting all colours together (and covering a wide range of colour

329   options) we were able to overcome some of these issues associated with animal decision-

330   making.

331

332   Further work is needed to explore interspecific differences in colour preference: for

333   the bird feeder industry, it may be desirable to design and market feeders for particular

334   target species or groups of species - those that are seen as desirable by the people that feed

335   birds. Further questions include whether feeder colour is important for attracting birds to a

336   new feeding site, increasing avian visitor numbers at existing feeding sites, and whether

337   different types of feeders, such as those designed to dispense seeds, peanuts or nyjer seeds,

338   would attract more birds if they were different colours. Finally, other factors, such as

339   distance to cover, or the type and quality of food provided, may be more important in

340   determining the 'success' of a particular feeder than the colour, as in hummingbirds (e.g.

341   [35-39]) or these factors, and others, may trade off with colour in determining the number

342   of visits by birds, as they forage optimally [67].

343

Acknowledgements

350

351 **Supporting information**

352

353 **Fig S1: Birdfeeders in the field.** An example array of filled birdfeeders ready for

354 observations in the field. The colour order (from left to right) is: red, yellow, blue, silver,

355 green, purple, white, black. Colour order was randomised between trials.

356

357 **Fig S2: Poster explaining the project.** A copy of the poster explaining the project, as

358 displayed at the Science Festival and in the garden centre.

359

360 **Table S1: Pairwise comparisons of visits to feeders by blue tits**. The cells above the

361 diagonal show the z- and p-values, while the estimate ± standard error is below the diagonal.

362 Significant p-values are highlighted in bold.

363

364 **Table S2: Pairwise comparisons of visits to feeders by great tits**. The cells above the

365 diagonal show the z- and p-values, while the estimate ± standard error is below the diagonal.

366 Significant p-values are highlighted in bold.

367

368 **Table S3: Pairwise comparisons of visits to feeders by coal tits.** The cells above the diagonal

369 show the z- and p-values, while the estimate ± standard error is below the diagonal.

370 Significant p-values are highlighted in bold.

371

372 **Table S4: Pairwise comparisons of visits to feeders by house sparrows.** The cells above the

373 diagonal show the z- and p-values, while the estimate ± standard error is below the diagonal.

374 Significant p-values are highlighted in bold.

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376 **Table S5: Pairwise comparisons of visits to feeders by robins.** The cells above the diagonal

377 show the z- and p-values, while the estimate ± standard error is below the diagonal.

378 Significant p-values are highlighted in bold.

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553 **Table 2:** Pairwise comparisons of visits to feeders.

	Red	Yellow	Green	Blue	Purple	White	Silver	Black
Red	-	z = -2.042 p = 0.052	z = -10.765 **p < 0.001**	z = -7.383 **p < 0.001**	z = -7.129 **p < 0.001**	z = 5.793 **p < 0.001**	z = 12.751 **p < 0.001**	z = -7.614 **p < 0.001**
Yellow	-0.114±0.056	-	z = -12.650 **p < 0.001**	z = -9.440 **p < 0.001**	z = -9.093 **p < 0.001**	z = -7.779 **p < 0.001**	z = -14.586 **p < 0.001**	z = -9.569 **p < 0.001**
Green	-0.519±0.048	-0.633±0.050	-	z = 3.413 **p = 0.001**	z = -3.774 **p < 0.001**	z = -5.128 **p < 0.001**	z = 2.115 **p = 0.046**	z = 3.278 **p = 0.001**
Blue	-0.372±0.050	-0.485±0.051	0.148±0.043	-	z = -0.363 p = 0.743	z = -1.728 p = 0.098	z = 5.512 **p < 0.001**	z = -0.135 p = 0. 892
Purple	-0.355±0.050	-0.469±0.052	-0.164±0.043	-0.016±0.045	-	z = -1.365 p = 0.193	z = 5.870 **p < 0.001**	z = -0.499 p = 0.666
White	0.292±0.050	-0.406±0.052	-0.277±0.044	-0.079±0.046	-0.063±0.046	-	z = -7.212 **p < 0.001**	z = -1.863 p = 0.076
Silver	0.606±0.047	-0.719±0.049	0.086±0.041	0.234±0.042	0.250±0.043	-0.313±0.043	-	z = 5.378 **p < 0.001**
Black	-0.378±0.005	-0.491±0.051	0.142±0.043	-0.006±0.045	-0.022±0.045	-0.085±0.046	0.228±0.042	-

554 The cells above the diagonal show the z- and p-values, while the estimate ± standard error is below the diagonal. Significant p-values are

555 highlighted in bold.

556 **Table 3:** Pairwise comparisons of votes by visitors to the garden centre and science festival.

	Red	Yellow	Green	Blue	Purple	White	Silver	Black
Red	-	z = -0.474 p = 0.810	z = 0.620 p = 0.715	z = -0.182 p = 0.0.887	z = 3.285 **p = 0.003**	z = -4.014 **p < 0.001**	z = -4.234 **p < 0.001**	z = 3.759 **p = 0.001**
Yellow	-0.722±1.522	-	z = 0.146 p = 0.884	z = -0.657 p = 0.718	z = 2.810 **p = 0.011**	z = 3.540 **p = 0.002**	z = 3.759 **p = 0.001**	z = 3.285 **p = 0.003**
Green	0.944±1.522	0.222±1.522	-	z = -0.803 p = 0.659	z = -2.664 **p = 0.015**	z = -3.394 **p = 0.002**	z = -3.613 **p = 0.001**	z = 3.139 **p = 0.004**
Blue	-0.278±1.522	-1.000±1.522	-1.222±1.522	-	z = -3.467 **p = 0.002**	z = -4.197 **p < 0.001**	z = -4.416 **p < 0.001**	z = 3.942 **p < 0.001**
Purple	5.000±1.522	4.278±1.522	-4.056±1.522	-5.278±1.522	-	z = -0.730 p = 0.688	z = -0.949 p = 0.568	z = 0.474 p = 0.810
White	-6.111±1.522	5.389±1.522	-5.167±1.522	-6.389±1.522	-1.111±1.522	-	z = 0.219 p = 0.891	z = -0.255 p = 0.895
Silver	-6.444±1.522	5.722±1.522	-5.500±1.522	-6.722±1.522	1.444±1.522	0.333±1.522	-	z = -0.474 p = 0.810
Black	5.722±1.522	5.000±1.522	4.778±1.522	6.000±1.522	0.722±1.522	-0.389±1.522	-0.722±1.522	-

557 The cells above the diagonal show the t- and p-values, while the estimate ± standard error is below the diagonal. Significant p-values are

558 highlighted in bold.