

1 **Food preference and copying behaviour in zebra finches, *Taeniopygia guttata***

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15

16 **ABSTRACT**

17 As a social species zebra finches might be expected to copy the food choices of more
18 experienced conspecifics. This prediction has been tested previously by presenting observers
19 with two demonstrator birds that differ in some way (e.g., sex, familiarity), each feeding on a
20 different colour food source. However, if the observer subsequently exhibits a preference, it
21 is unclear whether it has copied the choice of one demonstrator or avoided the choice of the
22 other. Furthermore, this choice may actually be influenced by pre-existing preferences, a
23 potential bias that is rarely tested. Here we examine whether apparent copying or avoidance
24 can be explained by pre-existing preferences. In Experiment 1, observers had the opportunity
25 to watch a conspecific forage from one of the two differently coloured food hoppers. In
26 Experiment 2, the observers did not have this opportunity. In both experiments observers
27 were subsequently tested for their food hopper preference and all but one preferred one
28 colour over the other. In Experiment 1 some observers showed evidence for copying, while
29 others seemed to avoid the colour preferred by the demonstrator. In Experiment 2 females
30 generally preferred the white hopper. Pre-existing colour preferences could, therefore,
31 explain the apparent copying/avoidance we observed.

32

33 **Keywords:** Avoidance; Colour preference; Copying; Food choice; Social learning; Zebra
34 finch

35 1. INTRODUCTION

36 Zebra finches *Taeniopygia guttata* have served as a laboratory model for studying a range of
37 psychological processes (Healy et al. 2010), most notably vocal learning (e.g., Immelman
38 1969; Slater et al. 1988; Mello and Clayton 1994) and mate choice (e.g., Adkins-Regan 2002;
39 Riebel 2009). In addition to being vocal learners and perhaps because zebra finches are a
40 highly social species (Zann 1996), it has been assumed that they should copy each other's
41 food choices (Giraldeau et al. 1990). Surprisingly, however, only a handful of studies have
42 reported that zebra finches do, indeed, follow conspecifics' food preferences and then only
43 under some circumstances: zebra finch females copy food colour choice of demonstrators
44 when they are male while males copy food colour choices of demonstrators of either sex
45 (Benskin et al. 2002; Katz and Lachlan 2003). The decision as to which male to choose
46 appears to depend on details such as colour of leg band and familiarity: males and females
47 prefer the demonstrator's food colour when the male demonstrator wears a red leg-band but
48 not when he wears a green leg-band (Benskin et al. 2002) while males will also copy the food
49 colour choice of familiar, but not unfamiliar, male demonstrators (Benskin et al. 2002).
50 Furthermore, zebra finches will also discriminate among demonstrators based on the size of
51 the brood in which those demonstrators were reared: male observers copied males that were
52 reared in large broods while female observers copied females from broods of a size similar to
53 their own (Riebel et al. 2012). There appears to be little consistency in the variable by which
54 demonstrators differ and on which choice is based, suggesting there are a number of specific,
55 complex conditions under which social learning may occur in this social species (Laland
56 2004).

57 There is also an alternative explanation for these data. In all of these previous studies,
58 observers were presented with two demonstrators, where one demonstrator fed from a food
59 source of one colour and the other demonstrator fed from the alternate food source. By

60 showing conspecifics feeding from both colours to an observer, however, does not allow the
61 experimenter to distinguish whether subsequent observer colour preferences are due to the
62 observer copying the choice of one demonstrator or to avoiding the choice of the other
63 demonstrator. Furthermore, it is not clear whether pre-existing biases would not explain the
64 data just as well. As recent research shows that zebra finches have pre-existing colour
65 preferences for both nesting material and food colour (Muth and Healy, 2011; 2012; Muth et
66 al. 2013; Rosa et al. 2012) it remains unclear whether apparent copying behaviour found in
67 previous studies might be explained by individuals' pre-existing colour preferences because
68 preferences for colour in absence of social demonstration were not assessed.

69 Therefore, here we examined firstly, whether zebra finches copy a demonstrated food
70 option when that item is offered in the presence of a non-demonstrated item option. We
71 presented male and female observer zebra finches with only one male or female
72 demonstrator, which ate from only one of two differently coloured hoppers, to test whether
73 hopper colour preferences shown by zebra finches are due to copying or to avoidance of the
74 colour choice of conspecific demonstrators (Experiment 1). Secondly, we tested whether or
75 not zebra finches have pre-existing colour preferences for food hoppers (Experiment 2).

76

77 **2. METHODS**

78 *2.1 Subjects*

79 The subjects were 85 adult zebra finches (42 male, 43 female) that were bred at the
80 University of St Andrews (23 male, 20 female), the University of Glasgow (16 male, 17
81 female), or obtained from a local pet store (3 male, 6 female). All birds were housed in cages
82 of same-sex individuals (8 - 26 individuals per cage, cage size either $140 \times 71 \times 122$ or $100 \times$
83 50×50 cm) and kept on a 14:10 light:dark cycle with temperature at $\sim 20^\circ\text{C}$ and humidity at
84 $\sim 50\%$. When not in the experiment birds were given free access to mixed seed, vitamin-

85 supplemented water, cuttle bone, oystershell, and vitamin block. At the end of the
86 experiment, the birds were returned to single-sex group housing in the bird facility at the
87 University of St Andrews.

88 All birds were tested between 04 March 2013 and 27 April 2013. All work described
89 here is in accordance with ASAB ethical guidelines and was approved by the University of St
90 Andrews Animal Welfare and Ethics Committee.

91

92 *2.2 Apparatus*

93 The experiments were carried out in two test rooms. Each test room contained a
94 demonstrator cage, an observer cage, and stock cages of same-sex zebra finches (2 of each
95 sex) located either 150 or 180 cm across the room from the experimental cages so that test
96 birds were not visually or acoustically isolated from conspecifics.

97 The cages (100 × 50 × 50 cm) for the demonstrator and observer birds were identical
98 except for the perch arrangement and the position of the coloured experimental food hoppers
99 (see Fig. 1). Each cage contained two food and two water bowls, a cuttlefish bone and a
100 vitamin block. A distance of 30 cm separated the demonstrator cage from the observer cage.
101 A white opaque barrier between the cages prevented visual, but not vocal, interaction
102 between the birds. The demonstrator cage contained three perches, two of which were
103 located on the side of the cage that faced the observer cage. The observer cage contained six
104 perches, two on each side of the cage and two on the back of the cage. During the
105 observation and test phases (described below) coloured food hoppers (one black, one white,
106 wrapped in coloured opaque electrical tape) were attached to each cage. Each cage contained
107 two bird box cameras (SpyCameraCCTV, Bristol, UK) connected to a laptop computer.

108 Food was provided to the birds in the stock cages in the experimental room in
109 transparent grey bowls, not food hoppers. These same grey transparent food bowls were used

110 in the observer and demonstrator cages before the experimental trial started. The birds that
111 served as observer in Experiment 1 and as controls in Experiment 2 were not housed in the
112 stock cages in the experimental room and did not view any experimental trials. In the stock
113 cages for observer and control birds' food was delivered in metal, green, clear and white
114 bowls on the floor of the cage and transparent food hoppers attached to the side of the cage.

115

116 *2.3 EXPERIMENT 1*

117 *2.3.1 Procedure*

118 Each trial lasted approximately 24 hours. Between 14:30 and 15:30 hr on Day 1, one bird
119 was placed in the demonstrator cage and another bird was placed in the observer cage. At
120 this time, the opaque barrier was in place so the demonstrator and observer birds were not in
121 visual contact with one another, but both could see birds in the stock cages across the room.
122 On Day 2, food was removed from both cages for two hours, starting two hours after light
123 onset. Cage floor trays were replaced with clean ones so that birds could not eat spilled food
124 during this time.

125 There were two phases in each trial: the observation phase followed by the test phase.
126 The observation phase began after the two-hour food deprivation period. During the
127 observation phase, one black and one white food hopper were attached to the demonstrator
128 cage on the side of the cage facing the observer cage (Fig. 1) Only one food hopper
129 contained seeds. During the 30-minute observation phase the opaque barrier between the
130 demonstrator and observer cage was removed.

131 For the test phase, which occurred at the end of the 30 minute observation period, the
132 opaque barrier was returned and one black and one white food hopper, each containing seed,
133 were attached to the back of the observer cage (Fig. 1). The test phase lasted 60 minutes. At
134 the end of the test phase both birds were returned to their stock cages, food cups were

135 returned to the experimental cages, and a new bird was placed in each cage for testing the
136 following day. The colour and location of the black and white food hoppers were
137 counterbalanced across all conditions and the birds' behaviour during the observation and test
138 phases was recorded via the cameras to be scored at a later date.

139 68 adult zebra finches, 34 males (18 from St Andrews, 13 from Glasgow, 3 from local
140 store) and 34 females (15 from St Andrews, 15 from Glasgow, 4 from local store) were used
141 in Experiment 1. A different demonstrator bird was used on all but two trials; two birds (one
142 male and one female, both from Glasgow) were used as a demonstrator in two trials each.
143 Birds were pseudo-randomly assigned to the following four experimental groups: (1) female
144 demonstrator with male observer (n = 9); (2) male demonstrator with female observer (n = 8);
145 (3) female demonstrator with female observer (n = 9); and (4) male demonstrator with male
146 observer (n = 9).

147

148 *2.4 EXPERIMENT 2*

149 *2.4.1 Procedure*

150 In Experiment 2, two cages were set up 30 cm apart, both laid out in the same way as for the
151 observer cage in Experiment 1 (see Fig. 1). We followed the same procedure as in
152 Experiment 1, except that during the observation phase both birds remained without food for
153 30 minutes, thus preventing them from acquiring social information about each other's food
154 hopper preferences. We tested a total of 18 birds, 9 male (5 from St Andrews, 3 from
155 Glasgow, 1 from local store) and 9 female (5 from St. Andrews, 2 from Glasgow, 2 from
156 local store) in Experiment 2. None of the birds used in Experiment 2 were used in
157 Experiment 1 with the exception of one male from a local store that was used as a
158 demonstrator in Experiment 1 after being tested in Experiment 2.

159

160 *2.5 Scoring and Statistical analysis*

161 From the video recordings of each trial the number of pecks delivered to each food
162 hopper by the demonstrator and the observer was measured and the latency in seconds, from
163 the start of the trial until the first peck at a feeder. To quantify food hopper colour preference
164 we calculated the following measures for Experiment 1: (1) for each demonstrator, the
165 proportion of pecks delivered to the hopper containing seed, and (2) for each observer bird
166 the proportion of pecks delivered to the food hopper colour used by the demonstrator.

167 We first ran tests to determine if demonstrators behaved differently towards the
168 different coloured feeders and if male and female demonstrators behaved differently from one
169 another because previous research has indicated that feeding activity of demonstrators affects
170 observer behaviour (Katz and Lachlan, 2003). We conducted independent *t*-tests to test for
171 differences in the proportion of pecks delivered by the demonstrators to the feeder that
172 contained seed (1) when the demonstrated feeder was black or white, (2) when the
173 demonstrator was a male or a female, and (3) when the demonstrator/observer pair was
174 mixed-sex or same-sex.

175 We used the binomial test for dichotomous data to determine whether the proportion
176 of responses differed significantly from no-preference (i.e., 0.5) for each observer. Each
177 observer could then be classified as (1) having preferred the same colour food hopper as the
178 demonstrator, (2) having preferred the hopper colour that was opposite to that of the
179 demonstrator, or as (3) having no preference. Based on these three classifications we then
180 used univariate ANOVAs to test for differences in demonstrator behaviour for each category
181 of observers. This would allow us to examine whether observers were likely to behave
182 according to differences in demonstrator behaviour. We carried out one-sample Wilcoxon
183 signed-rank tests on the proportion of responses by the observer to the colour of feeder used
184 by the demonstrator (in Experiment 1) or to the black feeder (in Experiment 2). For

185 Experiment 1 we conducted a chi-square test to test for differences in observers' behaviour
186 (preferring the same or the opposite colour food hopper that was preferred by the
187 demonstrator) according to the colour of the feeder (black or white). This allowed us to test
188 if observer behaviour was due to the colour preference of the demonstrator. All the results
189 that we report are means \pm standard error.

190 We scored preference for Experiment 2 as described for Experiment 1 but we scored
191 all of the data according to proportion of pecks to the black feeder. We used the binomial test
192 for dichotomous data to determine whether the proportion of responses differed significantly
193 from no-preference (i.e., 0.5) for each observer. Each observer bird could then be classified
194 as (1) having preferred the black hopper, (2) having preferred the white hopper, or as (3)
195 having no preference. We carried out one-sample Wilcoxon signed-rank tests on the
196 proportion of responses by the observer to the black hopper.

197

198 **3. RESULTS**

199 *3.1 EXPERIMENT 1*

200 Across all trials (N = 35, one trial per observer) one demonstrator and three observers did not
201 feed, leaving the total number of trials for each experimental group as follows: (1) female
202 demonstrator/male observer (n = 8), (2) male demonstrator/female observer (n = 7), female
203 demonstrator/female observer (n = 8), and male demonstrator/male observer (n = 8). One
204 female demonstrator had seed in the black hopper but pecked exclusively at the white hopper
205 (total pecks = 92, proportion of pecks to white = 1.0), so we scored this trial as if the white
206 hopper had been demonstrated.

207

208 *3.1.1 Demonstrator performance*

209 Although demonstrators preferentially pecked at the food hopper that contained seed
210 (proportion of pecks 0.96 ± 0.010), they allocated a significantly greater proportion of pecks
211 to the baited food hopper when the hopper colour was white (0.988 ± 0.009) than when it was
212 black (0.931 ± 0.020 , Independent-samples t -test: $t_{29} = -2.545$, $P = 0.017$). Male and female
213 demonstrators did not differ in the proportion of pecks they made to the baited food hopper
214 (male: 0.969 ± 0.011 ; female: 0.951 ± 0.022 , Independent-samples t -test: $t_{29} = 0.738$, $P =$
215 0.467). Male and female demonstrators did not differ in the proportion of pecks delivered to
216 the baited food hopper when demonstrating to a different-sex observer (i.e., female
217 demonstrator/male observer or male demonstrator/female observer, 0.960 ± 0.065) or same-
218 sex observer (i.e., male demonstrator/male observer or female demonstrator/female observer,
219 0.960 ± 0.072 , Independent-samples t -test: $t_{29} = 0.002$, $P = 0.999$).

220

221 *3.1.2 Observer performance*

222 *3.1.2.1 Individual data.*

223 All birds preferred one coloured food hopper over the other. Across all trials (31
224 total, one per subject), using proportion of pecks (range: 81-620 pecks) as the behavioural
225 measure, 24 birds' preference scores differed significantly from 0.5. The binomial test could
226 not be performed on the remaining seven birds because these individuals exclusively ate from
227 only one food hopper colour (i.e., preference = 1.0) so these individuals clearly deviated from
228 chance performance. Overall birds did not choose the same hopper colour as demonstrators:
229 51.61% (16/31) of the observer birds preferred the food hopper colour from which the
230 demonstrator ate and 48.38% (15/31) preferred to eat from the food hopper colour that was
231 not the colour of hopper from which the demonstrator ate (Wilcoxon signed-rank test, $W =$
232 256.5 , $N = 31$, $P = 0.867$).

233

234 3.1.2.2 Group data.

235 For males observing female demonstrators, seven of eight birds preferred the food
 236 hopper colour of the demonstrator (Fig. 2, panel a), and one preferred the food hopper colour
 237 that was not that demonstrated (Wilcoxon signed-rank test, $W = 28.5$, $N = 8$, $P = 0.141$). For
 238 females observing males, two of seven birds preferred the food colour hopper of the
 239 demonstrators (Fig. 2, panel b) and five preferred the food hopper colour that was not that
 240 demonstrated (Wilcoxon signed-rank test, $W = 9.5$, $N = 7$, $P = 0.443$). For the females
 241 observing females, four of eight birds preferred the food hopper colour of the demonstrator
 242 (Fig. 2, panel c) while the other four preferred the food hopper colour that was not that
 243 demonstrated (Wilcoxon signed-rank test, $W = 15.5$, $N = 8$, $P = 0.726$). For the males
 244 observing males, three of eight birds preferred the food hopper colour of the demonstrator
 245 (Fig. 2, panel d) while five preferred the food hopper colour that was not that demonstrated
 246 (Wilcoxon signed-rank test, $W = 15.0$, $N = 8$, $P = 0.674$). Across all birds, in the 16 trials
 247 where observer birds preferred the colour choice of demonstrator birds, 11 demonstrators ate
 248 from white and five ate from black food hoppers. A chi-square test indicated that overall,
 249 birds were more likely to prefer the colour used by the demonstrator if the demonstrator fed
 250 from the white, compared to the black feeder (Chi-square test: $\chi^2_{31} = 3.88$, $P = 0.049$, see Fig.
 251 3).

252 The choices of the observers, whether they preferred the colour of the demonstrator
 253 (i.e., copy) or preferred the opposite colour (i.e., avoid), cannot be explained by differences in
 254 demonstrator behaviour: demonstrators' proportion of pecks delivered to the demonstrated
 255 colour (copy 0.970 ± 0.017 , avoid 0.951 ± 0.018 , ANOVA: $F_{1,29} = 0.627$, $P = 0.435$);
 256 demonstrators' latency to feed (copy 303.25 ± 90 , avoid 438.8 ± 93 , ANOVA: $F_{1,29} = 1.103$,
 257 $P = 0.302$); or demonstrators' number of pecks to the demonstrated colour (copy 226 ± 25 ,
 258 avoid 178 ± 26 , ANOVA: $F_{1,29} = 1.730$, $P = 0.199$).

259

260 *3.2 EXPERIMENT 2*

261 Across all trials (N = 18, one per bird), using proportion of pecks (range: 151-636) as the
262 behavioural measure, six birds' preference scores were significantly different from 0.5. One
263 bird had no preference for feeder colour. The binomial test could not be performed on the
264 remaining 11 birds because these individuals exclusively ate from only one food colour so
265 these individuals clearly deviated from chance performance (see Fig. 4, panels a and b).
266 Seven of eight females preferred the white feeder, and one female had no preference. Six of
267 nine males preferred the white feeder, while three males preferred the black feeder. A
268 Wilcoxon signed-rank test indicated that, as a group, females preferred the white feeder to the
269 black one (Wilcoxon signed-ranks test: $W = 1$, $N = 9$, $P = 0.01$), while males, as a group, did
270 not prefer one colour hopper over the other (Wilcoxon signed-ranks test: $W = 14$, $N = 9$, $P =$
271 0.299).

272

273 *3.2.1 Further analysis of demonstrator behaviour from Experiment 1*

274 In Experiment 1, above, demonstrators delivered a significantly greater proportion of
275 pecks to the baited hopper when that hopper was white compared to black. Given that the
276 females in Experiment 2 preferred the white food hopper in the absence of demonstration,
277 while males did not, we conducted further analyses on the data from Experiment 1.
278 Specifically, we now analysed female and male demonstrator behaviour separately with
279 respect to behaviour towards the baited hopper when that hopper was white versus when the
280 baited hopper was black. We re-ran this analysis separately for female and for male
281 demonstrators and found that the result held for females but did not for males (Fig. 5). That
282 is, female demonstrators allocated a significantly greater proportion of pecks to the baited
283 food hopper when the hopper colour was white (0.998 ± 0.001) than when it was black (0.897

284 ± 0.039 ; Independent-samples t -test: $t_{13} = -2.784$, $P = 0.015$). The male demonstrators did
285 not peck the baited hopper more when it was white (0.976 ± 0.018) compared to black (0.961
286 ± 0.014 , Independent-samples t -test: $t_{14} = -0.702$, $P = 0.494$).

287

288 4. DISCUSSION

289 In Experiment 1, zebra finch observers preferred one coloured food hopper over the other.
290 This colour preference, however, cannot be explained by the colour preference of the
291 demonstrator. In Experiment 2, all but one of the zebra finches without experience watching
292 demonstrators preferred one colour hopper over the other. Furthermore, we found that
293 female zebra finches preferred to feed from white food hoppers while male zebra finches did
294 not.

295 In Experiment 1, we found apparent evidence for copying by some of the birds while
296 the remaining birds' strong preferences could be interpreted as avoidance. Superficially,
297 these data might appear to contrast with the findings of Riebel et al. (2012) whose zebra
298 finches tested (nine, both male and female) *all* copied the food colour choice demonstrated to
299 them, regardless of the colour of hopper demonstrated (black or white). In that experiment,
300 however, Riebel et al. used two demonstrator birds, housed individually, to demonstrate the
301 same food hopper colour choice simultaneously to the observer. In line with the *copy the*
302 *majority* strategy outlined in Laland (2004), two demonstrators both feeding on the same
303 option as in Riebel et al. may have been a strong enough social stimuli to induce copying
304 behaviour in the observer. Our sole demonstrator may not have provided sufficient social
305 information to induce copying behaviour in the observer.

306 The outcome of Experiment 2 suggests that zebra finches have strong individual pre-
307 existing colour preferences. Furthermore, evidence from both experiments show that females
308 strongly preferred white food hoppers. The colour preference would be consistent with

309 Zann's (1996) suggestion that the white colour of the rump of zebra finches, which are highly
310 conspicuous against the background of grass when flocks are foraging in Australia, may serve
311 as a releaser for birds flying overhead to join the foraging group. This visual signal may be
312 particularly salient in a foraging context because zebra finch flocks, which are usually highly
313 vocal, can be uncharacteristically silent. If this joining behaviour of wild zebra finches was
314 conserved across lab bred populations, however, we would have expected our males, in
315 addition to our females, to have preferred the white coloured food hoppers, which they did
316 not. Strong colour preferences in zebra finches have been observed previously within and
317 beyond food (green or purple millet: Rosa et al. 2012; blue nest material preferred to yellow:
318 Muth and Healy 2012), although the reason for such colour preferences is not clear. Specific
319 colour preferences do not, however, appear to be species-typical as Reibel et al. did not
320 observe a female preference for white over black hoppers, hence our use of these colours in
321 our experiments (Reibel et al. 2012).

322 Such strong unexplained pre-existing colour preferences suggest that the best
323 approach might be to assess whether individuals have pre-existing preferences prior to
324 exposure to a demonstration. Indeed, after observing pre-existing preferences led Rosa et al.
325 (2012) to conclude that variation in social learning may not be due to circumstance but to the
326 individual themselves. They found that zebra finches varied in the extent to which their
327 initial preferences changed after viewing a demonstrator interacting with their initially un-
328 preferred option and that the more an individual sampled its environment, presumably
329 acquiring personal (asocial) information while doing so, the less likely that individual was to
330 change its initial preference after viewing a conspecific demonstration. Furthermore,
331 increasing levels of pre-natal stress in Japanese quail (*Coturnix japonica*) appear to result in
332 individuals that are more likely to copy the food colour/location demonstrated to them than

333 are untreated individuals, whereas birds that had been subjected to post-natal stress are more
334 likely to avoid the food colour/location demonstrated to them (Boogert et al. 2013).
335 Taken together, these studies suggest that we should not assume that, even if the species is
336 considered to be social, all individuals *do* copy behaviour of conspecifics. Instead,
337 ontogenetic factors (including those observed by Riebel et al. 2012) may contribute to
338 individual differences in social information use. Such frequency-dependent use of social
339 information is expected if social groups are composed of both individual who are likely to
340 copy behaviour of others (*information scroungers*), and those individuals who avoid the
341 behaviour of the demonstrators (*information producers*: Laland 2004). Coupled with our
342 data, these recent findings suggest that acquisition and/or use of social information is
343 dependent on both the observer and the demonstrator and not just qualities of the
344 demonstrator as is often assumed.

345

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References

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353

- 354 Adkins-Regan, E., 2002. Development of sexual partner preference in the zebra finch: a
355 socially monogamous, pair-bonding animal. *Arch. Sex. Behav.* 31, 21-27.
- 356 Benskin, C.M.H., Mann, N.I., Lachlan, R.F., Slater, P.J.B., 2002. Social learning direct
357 feeding preferences in the zebra finch, *Taniopygia guttata*. *Anim. Behav.* 64, 823-828.
- 358 Boogert, N.J., Zimmer, C., Spencer, K.A., 2013. Pre- and post-natal stress have opposite
359 effects on social information use. *Biol. Letters* 9, 20121088.
- 360 Giraldeau, L. A., Hogan, J. A., Clinchy, M. J., 1990. The payoffs to producer scrounging:
361 What happens when patches are divisible? *Ethology* 85, 132-146.
- 362 Healy, S.D., Haggis, O., Clayton, N.S., 2010. Zebra finches and cognition. *Emu* 110, 242-
363 250.
- 364 Immelman, K., 1969. Song development in the zebra finch and other estridid finches, in:
365 Hinde, R.A. (Ed.), *Bird vocalizations*. Cambridge University Press, Cambridge,
366 England, pp. 61-74.
- 367 Katz, M., Lachlan, R.F., 2003. Social learning of food types in zebra finches (*Taenopygia*
368 *guttata*) is directed by demonstrator sex and feeding activity. *Anim. Cogn.* 6, 11-16.
- 369 Laland, K. N., 2004. Social learning strategies. *Learn. Behav.* 32, 4-14.
- 370 Mello, C.V., Clayton, D.S., 1994. Song-induced ZENK gene expression in the auditory
371 pathways of songbird brain and its relation to the song control system. *J. Neurosci.* 14,
372 6652-6666.
- 373 Muth, F., Healy, S.D., 2011. The role of adult experience in nest building in the zebra finch,
374 *Taneiopygia guttata*. *Anim, Behav.* 82, 185-189.
- 375 Muth, F., Healy, S.D., 2012. Zebra Finches build nests that do not resemble their natal nest.
376 *Avian Biol. Res.* 5, 218-226.

- 377 Muth, F., Steele, S., Healy, S.D., 2013. Colour preferences in nest-building zebra finches.
378 Behav. Proces. 99, 106-111.
- 379 Riebel, K., 2009. Song and female mate choice in zebra finches - a review. Adv. Stud. Behav.
380 40, 197-238.
- 381 Riebel, K., Spierings, M.J., Holveck, M., Verhulst, S., 2012. Phenotypic plasticity of avian
382 social-learning strategies. Anim. Behav. 84, 1533-1539.
- 383 Rosa, P., Nguyen, V., Dubois, F., 2012. Individual differences in sampling behaviour predict
384 social information use in zebra finches. Behav. Ecol. Sociobiol. 66, 1259-1265.
- 385 Slater, P. J. B., Bales, L. A., Clayton, N. S., 1988. Song learning in zebra finches
386 (*Taeniopygia guttata*): Progress and prospects, in: Rosenblatt, J.S., Beer, C., Bosnel,
387 M.S. (Eds.), *Advances in the Study of Animal Behavior*. Academic Press, New York,
388 Vol. 18, pp. 1-34.
- 389 Zann, R.A., 1996. *The zebra finch*. Oxford University Press Inc. New York.

390

Figure captions

391 Figure 1. Scale drawing of top-down view of the demonstrator and observer cages. The
392 dashed line between the cages represents the opaque barrier that was in place at all times
393 except during the observation phase. The food bowls on the front of the cage were removed
394 two hours prior to the start of the observation phase. The location of the coloured food
395 hoppers was counterbalanced between the two perch locations on each trial for both
396 demonstrator and observer birds. During Experiment 1, there was always one demonstrator
397 and one observer cage. During Experiment 2, both cages were set-up as observer cages.

398

399 Figure 2. Proportion of pecks to the demonstrated colour in Experiment 1. Panels a-d, the
400 proportion of pecks by the observer bird to the food hopper colour of the demonstrator (y -
401 axis) and the different experimental groups (x -axis). Filled circles represent when the
402 demonstrator fed from the black food hopper and open circles represent when the
403 demonstrator fed from the white feeder. The square represents the mean proportion of each
404 group \pm the 95% confidence interval. Triangles represent proportions that are not statistically
405 different from 0.5 (no preference).

406

407 Figure 3. Proportion of pecks according to hopper colour in Experiment 1. Results for the 31
408 individuals run in Experiment 1. The y -axis indicates the proportion of pecks by the observer
409 bird to the colour eaten by the demonstrator. A score of 0.5 indicates that the observer
410 delivered an equal number of pecks to each coloured hopper. A score above 0.5 indicates
411 that observer was copying the food colour of the demonstrator, while a score below 0.5
412 indicates that the observer was avoiding the food colour of the demonstrator. The filled bars
413 represent trials where the demonstrator food hopper colour was black, and the open bars
414 represent trials where the demonstrator colour was white.

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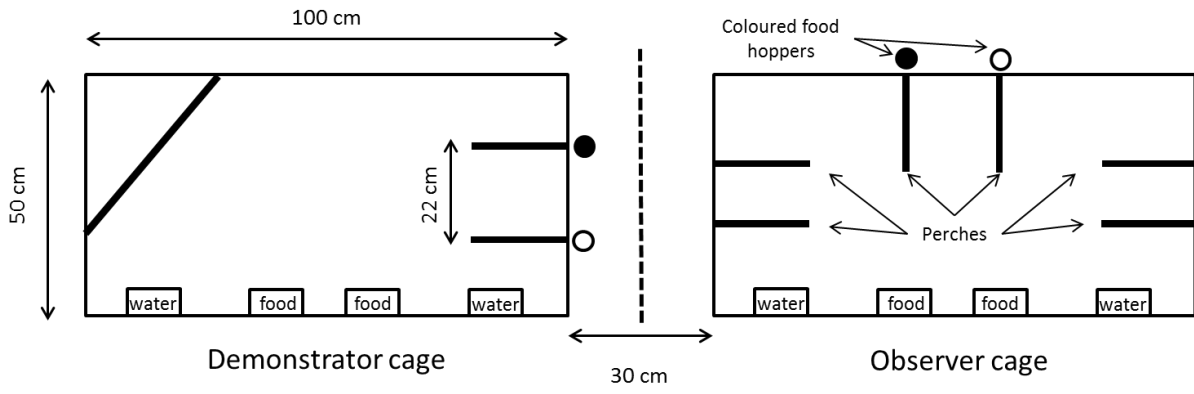
416 Figure 4. Proportion of pecks to the demonstrated colour in Experiment 2. Panels a and b
417 show the proportion of pecks (y -axis) to the black colour food hopper by female and male
418 birds (x -axis). The square represents the mean proportion of each group \pm the 95%
419 confidence interval. Triangles represent proportions that are not statistically different from
420 0.5 (no preference).

421

422 Figure 5. Differences in demonstrator behaviour. The proportion of pecks (y -axis), directed
423 towards the baited food hopper for female and male demonstrators when the baited hopper
424 was white (white bars) and black (black bars; x -axis). The asterisk indicates a significant
425 difference.

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Figure 1.

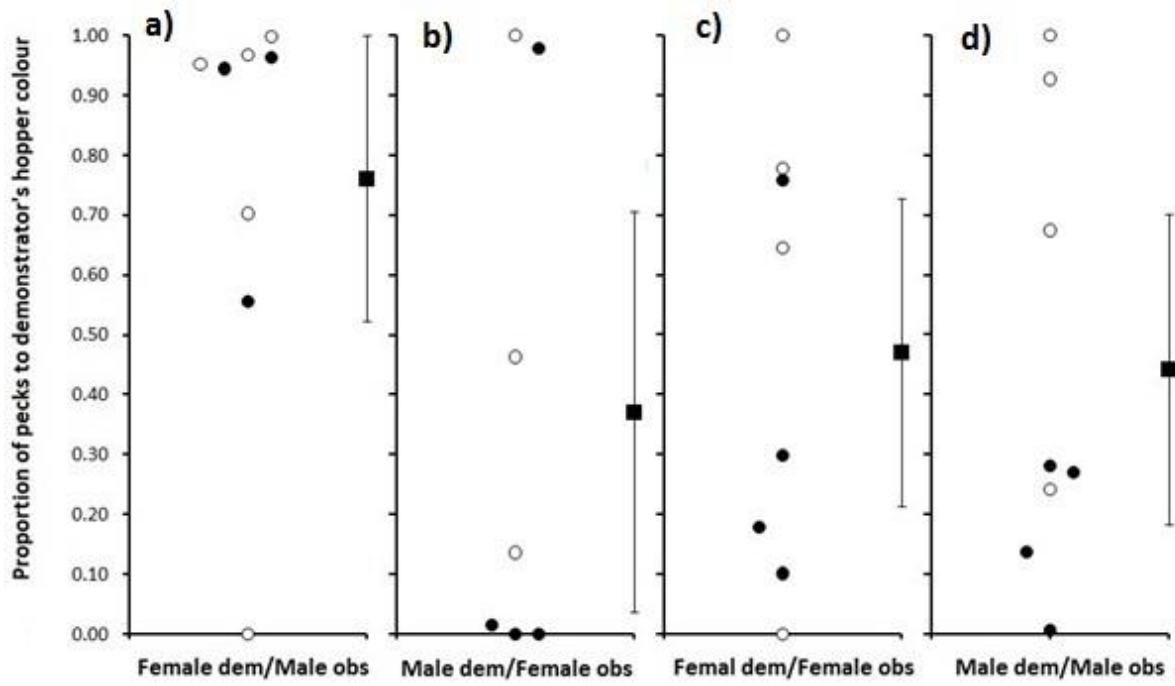


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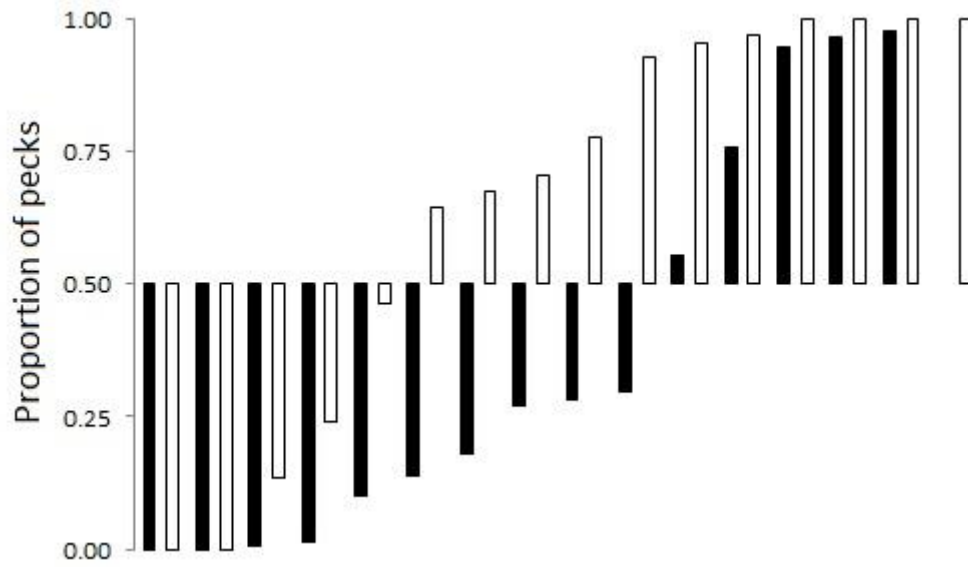
Figure 2.



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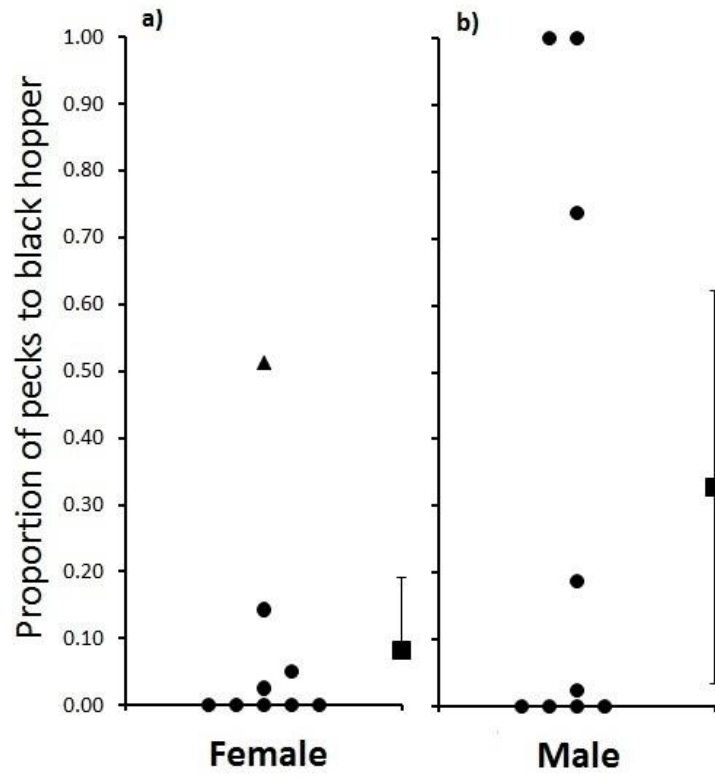
Figure 3.



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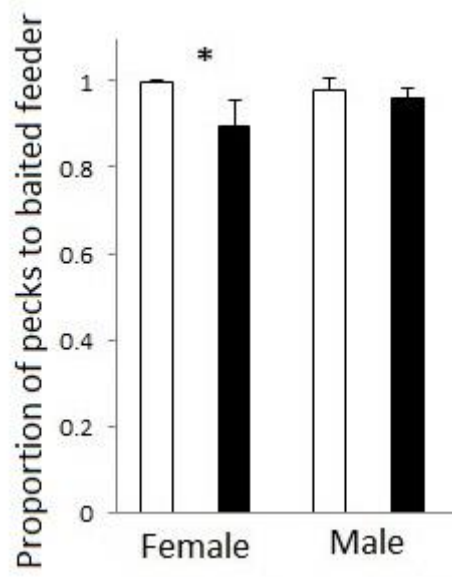
Figure 4.



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Figure 5.



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