

1 **Social network centrality predicts dietary decisions in a wild bird population**

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12

13 **SUMMARY (150 words)**

14 How individuals balance costs and benefits of group living remains central to understanding sociality.
15 In relation to diet, social foraging provides many advantages but also increases competition.
16 Nevertheless, social individuals may offset increased competition by broadening their diet and
17 consuming novel foods. Despite the expected relationships between social behaviour and dietary
18 decisions, how sociality shapes individuals' novel food consumption remains largely untested in
19 natural populations. Here, we use wild, RFID-tracked, great tits to experimentally test how sociality
20 predicts dietary decisions. We show that individuals with more social connections have higher
21 propensity to use novel foods compared to socially-peripheral individuals, and this is unrelated to
22 neophobia, observations, and demographic factors. These findings indicate sociable individuals may
23 offset potential costs of competition by foraging more broadly. We discuss how social environments
24 may drive behavioural change in natural populations, and the implications for the causes and
25 consequences of social strategies and dietary decisions.

26

27 **KEYWORDS**

28 Social Networks, Diet, Social Behaviour, Foraging, Social Structure, Competition.

29

30 **INTRODUCTION**

31 Groups of foraging animals benefit from sociality in many ways ¹, ranging from social foraging
32 allowing complex cooperative hunting ² to other benefits such as learning about how food is
33 distributed or avoiding predators ¹⁻⁵. It is also likely that social learning may help individuals decide
34 which new foods to explore and consume ⁶⁻⁸. Indeed, novel foods pose a challenge to foragers
35 because they can differ from familiar foods in their nutritional quality, and may also contain
36 unfavorable chemicals or defensive toxins ⁹. How individual foragers in the wild differ in their
37 propensity to explore and use novel foods and how individual sociality affects foraging decisions
38 about novel foods remains a central topic in understanding dietary decision making [10].

39 As well as many benefits, foraging in groups also imposes costs through intraspecific competition¹⁰.
40 When resources are limited, there is greater competition between group members¹¹ and this can
41 result in carry-over costs through ‘interference competition’ e.g. fighting for resources, with
42 attendant costs in time and risk of injury¹². This interference competition can reduce the time
43 available to an individual to make decisions about which food items to consume, and can reduce the
44 number of profitable food items encountered while foraging¹³. Exploiting new food sources, in this
45 situation, can alleviate within-group competition through niche partitioning¹⁴⁻¹⁶.

46 When faced with decisions about which new foods to explore and consume, many species exhibit
47 dietary wariness^{17,18}. Dietary wariness is composed of two behavioural processes: neophobia and
48 dietary conservatism¹⁹. Neophobia describes the initial fear/apprehension of novel objects or foods,
49 and is observed in many animal groups, including fish, mammals and birds^{18,20,21}. This aversion is
50 usually brief, and is followed by investigation of the novel food or object²². Once neophobia has
51 waned, some individuals within a population continue to avoid novel food long after the initial
52 exposure, and this is termed dietary conservatism¹⁹. Dietary conservatism is a spectrum: individuals
53 differ in their willingness to consume novel food. Adventurous consumers are those individuals
54 which show little or no hesitation in consuming novel food once neophobia has passed, while
55 conservatively foraging individuals continue to avoid the novel food for extended periods²³.
56 Following this general classification, dietary conservatism has been observed in a wide variety of
57 species, particularly in various studies in birds^{21,24} and fish²⁵⁻²⁷. It is important to consider individual
58 differences in the propensity to eat novel foods when discussing the strategies that animals use to
59 mitigate resource competition during social foraging, as this is of direct relevance for the study of
60 the factors that shape sociality and resource acquisition²⁸.

61 The advent of animal tracking technologies has revolutionised our ability to observe individuals’
62 social foraging associations in the wild²⁹, and animal social networks have now been quantified
63 across a range of animal systems³⁰. Social network analysis provides a framework for quantifying
64 variation in intraspecific sociality³¹ and allows the estimation of various metrics of individuals’ social
65 behaviour³². This provides fine-scale information about an individual’s own social associations, as
66 well as the wider social environment they inhabit³³, who they associate with, when they associate
67 with them and where the associations happen. The ability to quantify social networks within the
68 wild, while simultaneously tracking individuals’ foraging behaviour, presents the opportunity to
69 determine empirically how intraspecific differences in sociality relate to the various aspects of
70 dietary wariness in natural settings.

71 In this study, we use novel food experiments to test individual-level dietary wariness in a RFID-
72 tracked social system of wild great tits (*Parus major*). Using this approach, we are able to examine
73 dietary wariness and novel food usage independently, and use social network analysis to determine
74 how individual sociality predicts individuals’ foraging decisions. A priori we expected that there
75 would be variation in the use of novel foods among foraging great tits. This variation would be
76 driven in large part by underlying propensities to consume novel food, dietary wariness, but also
77 that social network position would have a major role in influencing decisions made by foraging birds.
78 Thus, we were able to directly test the expectation that more social individuals have a greater
79 propensity to eat novel foods, whether that be due to the need to mitigate the potential costs of
80 interference competition or because they have more access to information about the profitability of
81 novel food sources. These potential explanations need not be mutually exclusive. As a consequence
82 these more social individuals should show lower levels of dietary wariness compared to less social
83 individuals. We are able to separate out other elements (observation-related factors and
84 demographic traits) when assessing the relationship between foraging decisions and a suite of social
85 measures. We discuss the implications of these experimental results for understanding how

86 competition shapes social foraging, and the wider insights this may offer into the interplay between
87 individual-foraging decisions and social behaviour.

88

89

90 **RESULTS**

91 During the study, 105 unique RFID tagged great tits were detected: 85 during the baseline data
92 collection period, and 75 and 61 in the first and second experimental trial, respectively. The average
93 number of detections of each RFID tagged individual over the 19-day experiment was 3234 ± 409
94 (mean \pm SE), with a total of 210,579 detections of all individuals during the baseline period and
95 60,727 and 68,311 during the first trial and second trial, respectively. We detected 2393 flocking
96 events for the baseline period, and 767 and 764 for the first and second trial, respectively. The
97 typical group size (i.e. group size encountered by the average individual³⁴ was 6.8 ± 0.03 . The social
98 networks inferred from these flocking events (see Methods) were relatively dense networks within
99 sites (Figure 1), with a total number of unweighted social network connections of 1266 in the
100 baseline period and 892 and 697 for the first and second experimental trials, respectively.

101

102 *Social Centrality and Novel Food Usage*

103 An Individual's propensity to use novel food during each of the experimental trials was significantly
104 predicted by their prior social centrality (Figure 2): the GLMs showed a strong relationship between
105 proportion of novel food usage and the individuals' prior weighted strength for both trials (Trial 1 -
106 Table S2a: Coefficient= 0.529 ± 0.235 , $t=2.25$, $p=0.028$, $p_{\text{rand}}=0.01$. Trial 2 - Table S2b: Coef=
107 0.467 ± 0.150 , $t=3.11$, $p=0.003$, $p_{\text{rand}}=0.012$). None of the other individual characteristics in the models
108 (age, sex, immigrant status, previous feeder usage) were significant predictors of novel food usage
109 (Table 2). The first experimental site had a strong colour preference for red over green when each
110 colour was novel (Figure 2), the first trial had a reduced novel food usage for site 1 (initially using
111 green novel food) over site 2 (using red novel food) and the reverse effect for the second trial when
112 the novel food colours were swapped (Trial 1 - Table S2a: Coef= 3.40 ± 0.71 , $t=4.8$, $p<0.001$. Trial 2 -
113 Table S2b: Coef= -1.59 ± 0.27 , $t= -5.96$, $p<0.001$). This apparent effect of colour preference persisted
114 through all of the models (See Supplementary Tables).

115

116 Supplementary analysis which considered two alternative measures of centrality ('average edge
117 weight' and 'eigenvector centrality') confirmed the findings that prior social network position
118 significantly predicted novel food usage. (Figure S1; Table S3-S4). The average edge weight was
119 significantly related to the proportion of novel food usage across both trials (Trial 1 - Table S3a:
120 Coef= 16.5 ± 7.2 , $t=2.28$, $p=0.027$, $p_{\text{rand}}=0.022$. Trial 2 - Table S3b: Coef= 15.9 ± 4.5 , $t=3.5$, $p=0.001$,
121 $p_{\text{rand}}=0.004$) as was eigenvector centrality (Trial 1 - Table S4a: Coef= 1.74 ± 0.76 , $t=2.29$, $p=0.026$,
122 $p_{\text{rand}}=0.05$. Trial 2- Table S4b: Coef= 1.71 ± 0.58 , $t=2.93$, $p=0.005$, $p_{\text{rand}}=0.012$). A further line of
123 supplementary analysis confirmed the importance of using network centrality as a robust measure
124 of sociality, as novel food usage was not significantly related to more basic social measures (Figure
125 S2; Table S5-S6) that simply quantified an individual's average flock size (Trial 1 - Table S5a; Coef=
126 0.049 ± 0.17 , $t=0.29$, $p=0.77$, $p_{\text{rand}}=0.68$. Trial 2 - Table S5b; Coef= -0.14 ± 0.15 , $t=-0.92$, $p=0.36$,
127 $p_{\text{rand}}=0.23$) or their total number of flock mates (Trial 1 - Table S6a; Coef= 0.036 ± 0.048 , $t=0.75$,
128 $p=0.45$, $p_{\text{rand}}=0.18$. Trial 2 - Table S6b; Coef= 0.0565 ± 0.0385 , $t=1.47$, $p=0.15$, $p_{\text{rand}}=0.10$.)

129 *Novel Food Neophobia and Social Centrality*

130 The majority of individuals (92%) recorded during the experimental trials were detected on the novel
131 food feeder during the trial, indicating that complete neophobia (unwillingness to try the novel food
132 at all) was extremely rare. Furthermore, 95% of those that were detected using the novel food
133 feeder during the trial were recorded using it on the first day of the trial, again indicating that
134 neophobia generally was not a persistent barrier to novel food usage.

135 However, we also aimed to examine whether any individual variation in initial avoidance of the novel
136 food (i.e. neophobia) was related to individuals' network position. By using the very first record of
137 each bird during the experimental trial, we found that whether or not individuals perched on the
138 novel food feeder hole when they first arrived at the experimental trial was not significantly related
139 to social network centrality in either the first trial (Figure 3a – Coef=0.29±0.41, t=0.7, p=0.48,
140 $p_{\text{rand}}=0.29$, Table S7a) or the second trial (Figure 3b - Coef=-0.55±0.57, t=-0.96, p=0.34, $p_{\text{rand}}=0.28$,
141 Table S7b). Although only 30% of individuals immediately tried the novel food when first arriving at
142 the experimental trials, none of the individual characteristics included in the GLM were predictive of
143 which individuals perched on the novel food feeder hole as they first arrived during the experiment
144 (Table S7).

145 In line with this result, supplementary analysis also showed that network strength was not related to
146 the amount of time taken for each individual to first land on the feeding perch of the novel food in
147 each trial (Table S8;S9). This was true when time was quantified as the time of day they were first
148 recorded on the novel food (Table S8), or when quantified as the total elapsed foraging time since
149 they were first detected at the site during the trial (Table S9).

150 As a direct assessment of whether the relationship between sociality and proportional usage of
151 novel food exists regardless of any neophobia, we also found that prior network strength
152 significantly predicted the proportion of novel food (over familiar food) that individuals used after
153 they had first tried the novel food feeder (Figure 4; Table S10) i.e. after any neophobia was
154 overcome and only dietary conservatism was active. Again, this was true for both the first trial
155 (Figure 4a - Coef=0.55±0.25, t=2.15, p=0.037, $p_{\text{rand}}=0.006$, Table S10a) and second trial (Figure 4b -
156 Coef=0.53±0.168, t=3.17, p=0.003, $p_{\text{rand}}=0.010$, Table S10b), and the site/colour preference effect
157 was again evident (Figure 4;Table S10).

158

159 **DISCUSSION**

160 By quantifying wild great tit social networks, and tracking their behaviour in experimental trials
161 aimed at testing dietary decisions, we found that individuals' prior social network centrality
162 predicted their subsequent propensity to use novel food, and that this was unrelated to various
163 measures of neophobia. This link between individual sociality (as measured as social network
164 position) and dietary decision making has important implications for understanding how different
165 behavioural strategies influence resource acquisition, and for understanding the emerging
166 consequences of these strategies and decisions ¹⁵.

167 Through measuring the sociality of individuals using social network analysis, we were able to
168 quantify the individual level of sociality with this generalisable and powerful approach ³⁵. Specifically,
169 we measure individuals' own social propensity and experienced social environment using metrics
170 that take into account their general sociality ('strength' Figure 2), their average bond strength to
171 others ('edge weight' Figure S1a;b), and the social centrality of their associates ('eigenvector

172 centrality' Figure S1c;d). This approach outperforms simpler methods of attempting to measure
173 sociality³⁶ when making wider inferences e.g. using estimates of group size (Figure S2a;b) or number
174 of group members (Figure S2c;d). Here, the positive relationship between network centrality and
175 novel food usage in this free-living system of socially foraging individuals supports the expectation
176 that competition in social environments can predict foraging strategies in natural populations.
177 Specifically, individuals that are very social may be able to offset the competitive costs of reduced
178 resources by using other food sources. Furthermore, our approach allowed us to demonstrate that
179 this effect of prior social network centrality on subsequent novel food usage was unlikely to be due
180 to more social birds just generally being more exploratory in this experimental context or less averse
181 to approaching the novel-looking food presented here, as there was no significant relationship
182 between individuals' social centrality and their delay in approaching the novel food. Thus, it would
183 appear that highly social great tits which may experience a more competitive social environment
184 (i.e., due to having more social ties) may be alleviating the potential costs of competition by foraging
185 more broadly. These findings could be explained by optimal foraging theory³⁷⁻⁴⁰ which states that
186 individuals' foraging decisions should maximise their net rate of energy intake given their
187 environment, as the more socially central great tits (i.e., those potentially experiencing a more
188 competitive social environment) may be more likely to expand their diets by consuming novel food .

189

190 Our findings that birds showing the highest degree of dietary conservatism (i.e. those eating least
191 novel food) held the least central network positions, may suggest that these individuals generally
192 experience a reduced level of competition compared to those willing to eat the novel food. In a
193 previous study investigating dietary conservatism and competition in wild-caught captive blue tits
194 (*Cyanistes caeruleus*)⁴¹, a high proportion of individuals displayed a strong aversion to the novel
195 food presented to them when foraging alone, i.e. dietary conservatism, preferring to forage only on
196 familiar food. However, with the introduction of a second individual this aversion was quickly
197 overcome, resulting in consumption of novel food. These findings support our own finding which
198 suggest that less social individuals may not experience the same level of competition felt by their
199 more social conspecifics, and thus they may not have to resort to exploiting a novel food source in
200 order to forage efficiently. Furthermore, it could also be argued that these conservative foragers
201 were demonstrating resource partitioning behaviour i.e. reducing dietary overlap with their more
202 social counterparts by excluding this novel food source from their diet⁴². This kind of behaviour has
203 been demonstrated in other social species, where 'specialised' individuals exist. For example,
204 Sheppard, Inger et al.¹⁶ found that individual banded mongooses (*Mungos mungo*) with
205 substantially narrower resource niches compared to other members of their social group
206 experienced reduced intraspecific competition through niche partitioning. There are many other
207 instances where individual resource-level specialisation has been examined^{14,15,43} and where
208 competition has been implicated in driving this resource use variation among individuals of the same
209 population⁴⁴. Here our results suggest that a potential mechanism regulating these kinds of
210 processes might be linked to social network position. Those more conservatively foraging individuals
211 with fewer foraging social ties, and therefore experiencing a less competitive social environment, do
212 not have to risk expanding their diet to include foods of unknown profitability. In contrast, those
213 with more social ties and therefore more potential competitors can expand their diets and include
214 novel food to mitigate the potential effects of any intraspecific competition for themselves.

215 The positive effect of social centrality on novel food exploitation may also have consequences for
216 considering the evolution of conspicuous prey defences. Novel conspicuous prey are expected to
217 suffer high initial attack risk from naïve predators^{20,53} and our results support this idea: Adventurous

218 foragers `attacked` novel food. This makes the initial evolution of conspicuous prey types
219 paradoxical. However, just as birds use social information to find novel food (as specified above),
220 individuals may also transmit social information about prey defences, which can aid the evolution of
221 aposematism^{54,55}. If more social individuals attack novel prey (as suggested here), they may provide
222 information about prey defences to others, and influence how this social information spreads in the
223 predator population. Further research into the fine-scale interactions between dietary wariness and
224 social learning may be valuable for understanding the evolution of conspicuous prey types.

225 *Conclusion*

226 By monitoring wild great tit activity at experimental feeders, we showed that socially central
227 individuals are more likely to use novel food than less social individuals. This finding suggests that
228 individuals experiencing a more social associations may be more likely to incorporate novel food
229 resources. Our results also suggest the relationship between social centrality and novel food usage is
230 unlikely to be due to individuals' initial aversion to first using this new food resource. Therefore,
231 variation in exploratory behaviour in this context, or differences in access to new social information
232 (i.e. variation in discovery rates of the feeders), appear to be improbable drivers of link between
233 sociality and novel food usage. Further expansions of the investigation into social behaviour and
234 individual dietary decisions may now provide insights into topics such as the competition, foraging,
235 sociality, and even the evolution conspicuous prey defences.

236

237 LIMITATIONS OF STUDY

238 Although the results of the experiment show a clear link between social network centrality and novel
239 food usage, it is also important to highlight limitations of this and areas for future development.

240 Firstly, while this focus primarily considers competition-driven elements of the relationship between
241 sociality and novel food use, it is important to consider that social information often shapes foraging
242 decisions. Indeed, information about the profitability and nutritional value of the food may be
243 transmitted to group members through social facilitation⁴⁵ or local enhancement¹. For example,
244 prior work within our great tit population has demonstrated that individuals use social information
245 to locate new foraging locations, and that more central individuals are most likely to learn the
246 location of new resources faster^{46,47}. The relationship between social centrality and information also
247 appears in other species, such as the acquisition of information in social groups of wild baboons
248 (*Papio ursinus*;⁴⁸). In this study, it is unlikely that social network position shaped the propensity for
249 individual great tits to find the novel food (as it remained in a set location), and also unlikely that it
250 shaped their propensity to try the novel food (as there is no significant relationship between social
251 centrality and timing of using the novel feeder). However, it may be the case that social influence
252 potentially played a role in the extent to which individuals exploited the novel food following
253 discovery of it. For instance, McMahon, Conboy et al.⁴⁹ showed that conservatively foraging
254 domestic chicks (*Gallus gallus domesticus*) were more willing to consume novel food when they
255 were able to see conspecifics consuming novel food, essentially treating conspecifics as sources of
256 social influence. As such, more socially central great tits may be more likely to be socially associated
257 with others using the novel food resource (simply due to having more social ties) and thus more
258 likely to increase usage of the novel food themselves. On the other hand, less social individuals with
259 fewer social ties may experience less social influence for using the novel food (due to having fewer
260 links to others in general). Indeed, individuals displaying this dietary conservatism may be simply
261 more efficient at exploiting foods with which they are familiar and therefore remain more rigid in

262 their foraging decisions.⁵⁰ Others have also shown that individuals with higher network centrality
263 may tend to have a more proactive personality⁵¹ and that these individuals could also be important
264 in the spread of information because they move more between groups⁵².

265 Secondly, the experimental design was limited to two specific colours (red and green) chosen for
266 'creating' the novel food (dye peanut). Indeed, an additional finding of our experiments was a
267 preference for red novel food over green novel food in this context, as the birds generally preferred
268 the familiar food (standard peanut granules) to a much larger extent when the alternative option
269 was green food compared to when the alternative was red food. Although colour preferences for
270 food are context dependent in birds⁵⁶, a general preference for red food over green has been
271 reported previously in relation to dietary decision making, such as captive blue tits and great tits
272 preferring red almond flakes over green⁵⁶, and captive domestic chicks (*Gallus gallus domesticus*)
273 generally preferring red coloured food over green⁵⁷ but with other colour preferences varying
274 depending on the types of foods offered⁵⁸ or experiences prior to being given a colour preference
275 test⁵⁹.

276 Addressing these limitations in future research would now be beneficial, particularly in examining
277 how social influence over longer-time periods may govern novel food usage, and by assessing
278 relative novel food preference across a range of contexts and different colours/food types.

279

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285

286 **AUTHOR CONTRIBUTIONS**

287 Conceptualisation: KM BCS & JAF. Data Collection and Experimental Design: KM & JAF. Data Analysis:
288 KM & JAF. Results Interpretation: All Authors. Initial Draft Writing: KM & JAF. Revised Draft Writing:
289 All Authors.

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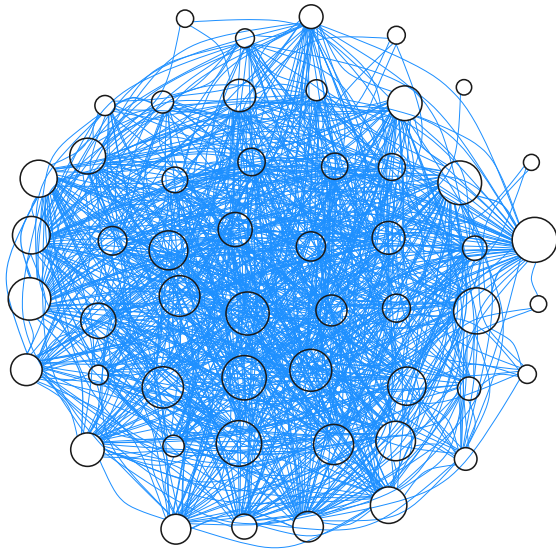
291 **DECLARATION OF INTERESTS**

292 The authors declare no conflict of interests

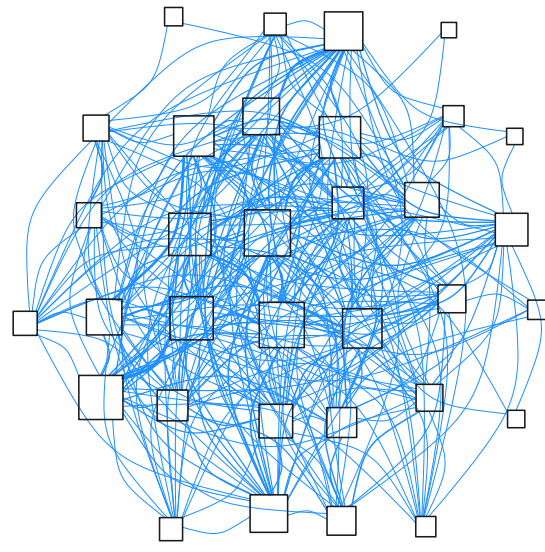
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294 **FIGURE LEGENDS**

(a)



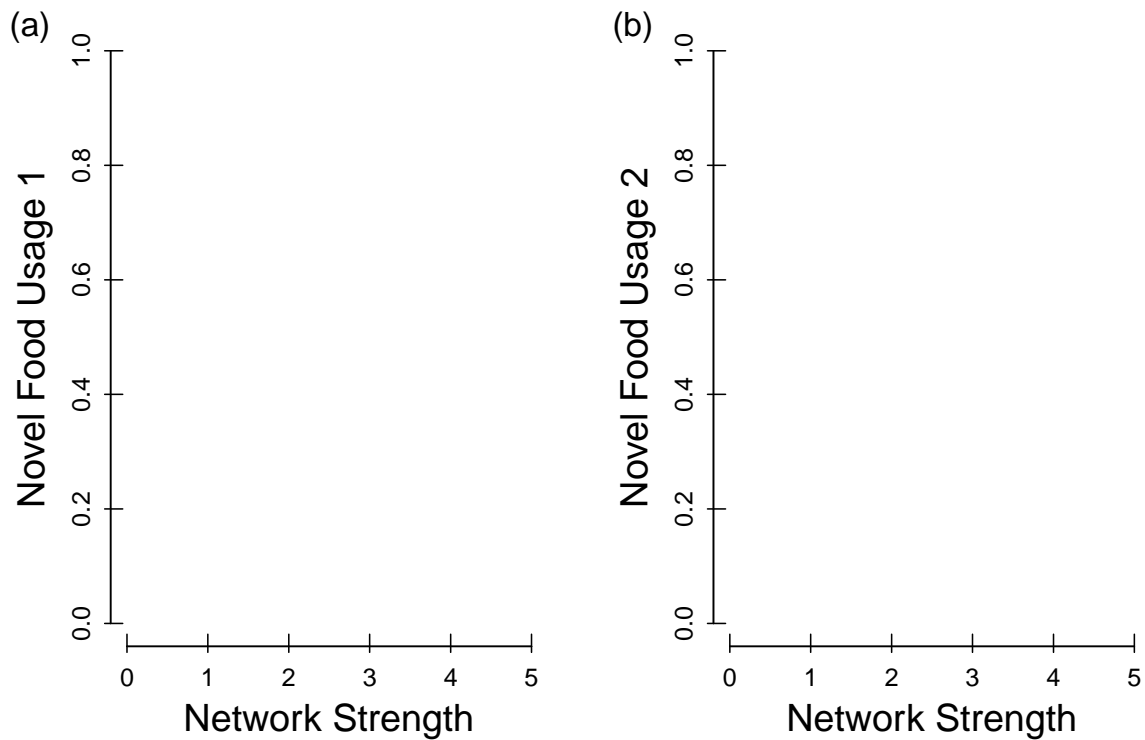
(b)



295

296 **Figure 1. Social networks at the experimental sites.** Site 1 (Figure 1a) and experimental site 2
297 (Figure 1b) in the baseline period. The nodes (points) represent the individuals and the edges (lines)
298 show the social connections between them. The size of the nodes and their shading indicates an
299 individual's network centrality (large dark nodes = high strength, small light nodes = low strength)
300 and are positioned using spring layout forced into a best-fit filled circle. The thickness of the lines
301 shows the weighted social bond between dyads where thick lines indicate strongly connected
302 individuals and thin lines show weak connections (the edge thickness is standardised by total sum of
303 social connections with the network). Although site 1 (Figure 1a) appears to be denser than site 2
304 (Figure 1b), the actual network densities (percentage of potential realised links) are very similar (70%
305 and 63% respectively), and the main visual difference comes from higher number of individuals in
306 site 1 (nodes=52) resulting in more connections (connections=931) than site 2 (nodes=33 ,
307 connections=335).

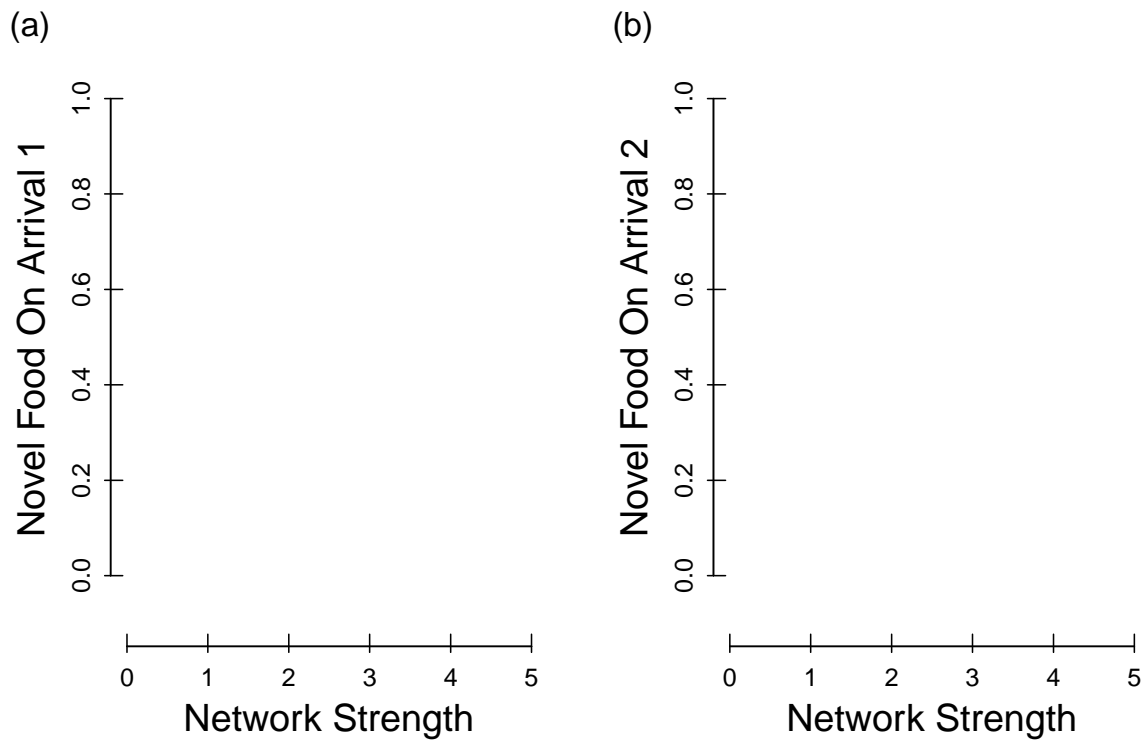
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309

310 **Figure 2. Social centrality and novel food use.** Prior social centrality (network strength – x axis) and
311 subsequent novel food usage (proportion of novel food usage – y axis) for the (a) first trial, and (b)
312 second trial. The point positions show the individual data points, point colour shows the colour of
313 the novel food (red or green dyed peanut), point shape shows which experimental site the individual
314 was at (site 1 round, site 2 square), and point size indicates weight of the data point i.e. the total
315 number of detections (at both the novel, and familiar food feeder). The lines show the GLM fit, and
316 the surrounding polygons show the associated standard error around this estimate, with the red
317 lines showing the fit for the red novel food site, the green line showing the fit for the green novel
318 food site, and the black line denoting the overall fit. See Table S2 for full model details.

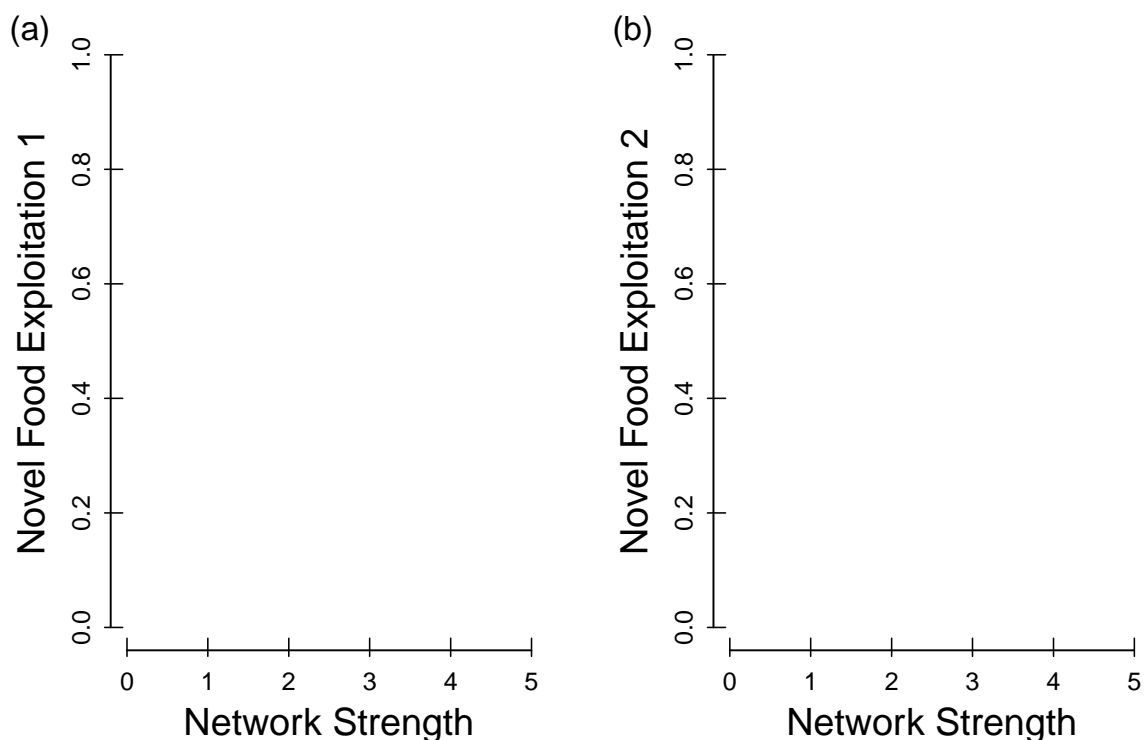
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320

321 **Figure 3. Social centrality and trying novel food on arrival.** Social Prior social centrality (network
322 strength – x axis) and probability of individuals trying the novel food upon arrival at the (a) first trial,
323 and (b) second trial. The point positions show the individual network strength and whether they
324 immediately tried the novel food (top) or not (bottom), point colour shows the colour of the novel
325 food (red or green dyed peanut), and point shape shows which experimental site the individual was
326 at (site 1 circles or site 2 squares). The lines show the GLM fit, and the surrounding polygons show
327 the associated standard error around this estimate, with the red lines showing the fit for the red
328 novel food site, the green line showing the fit for the green novel food site, and the black line
329 denoting the overall fit. See Table S7 for full model details.

330



331

332 **Figure 4. Social centrality novel food exploitation after first use.** Prior social centrality (network
333 strength – x axis) and subsequent novel food exploitation (proportion of novel food usage – y axis)
334 after they had overcome any neophobia for the (a) first trial, and (b) second trial. The point positions
335 show the individual data points, point colour shows the colour of the novel food (red or green dyed
336 peanut), point shape shows which experimental site the individual was at (site 1 or site 2), and point
337 size indicates weight of the data point i.e. the total number of detections (at both the novel, and
338 familiar food feeder). The lines show the GLM fit, and the surrounding polygons show the associated
339 standard error around this estimate, with the red lines showing the fit for the red novel food site,
340 the green line showing the fit for the green novel food site, and the black line denoting the overall
341 fit. See Table S10 for full model details.

342

343 **STAR METHODS**

344 **RESOURCE AVAILABILITY**

345 **Lead Contact**

346 Further information and requests for resources relating to this manuscript should be directed to and
347 will be fulfilled by Keith McMahon (keith.mcmahon@biology.ox.ac.uk)

348 **Materials availability**

349 This study did not generate new unique reagents.

350

351 **Data and Code availability**

352 Data have been deposited at <https://datadryad.org/stash/dataset/doi:10.5061/dryad.3tx95x6fw> and
353 are publicly available as of the date of publication. DOIs are listed in the key resources table.

354 All original code has been deposited at <https://zenodo.org/records/10793956> and is publicly
355 available as of the date of publication. DOIs are listed in the key resources table.

356 Any additional information required to reanalyze the data reported in this paper is available from
357 the lead contact upon request.

358

359 **EXPERIMENTAL MODEL AND STUDY PARTICIPANT DETAILS**

360 This study did not use experimental model animals, experimental in-vivo animals, human
361 participants, plants, microbe strains, cell lines, or primary cell cultures.

362

363 **METHOD DETAILS**

364 ***Study System***

365 Wytham Woods, Oxford, United Kingdom (51° 46' N, 1° 20' W) is home to a long-term study
366 population of wild great tits⁶⁰. These birds are captured and tagged with British Trust for Ornithology
367 rings (as adults and as nestlings) during the spring as they breed in the intensively-monitored nest
368 boxes⁶⁰, and immigrant birds are captured during the winter during regular mist-netting sessions
369 throughout the woodland. As well as recording standard morphological information during capture,
370 since 2007, all captured great tits have also been fitted with radio-frequency identification (RFID)
371 tags. Each RFID tag possesses a unique ID code which allows automated recording of the times and
372 locations of individuals' occurrence at feeding stations over the winter. Each feeding station consists
373 of a feeding tube with a feeding hole that is equipped with an RFID antenna which successfully
374 records >99% of RFID tagged individuals visits to feeders^{61,62}. The feeding stations are set >1m from
375 the ground and surrounded by 1m³ wire mesh that protects the equipment from grey squirrels and
376 provides multiple perching points for the birds. These RFID feeding stations allow the recording of
377 individual feeder usage (see Methods: Experiment data) and also the inference of flock structures
378 and arising social networks (see Methods: Social network data). The antennae scan for RFID-tagged
379 individuals 16 times per second from pre-dawn until post-dusk (i.e. over the entirety of the great tits'
380 foraging hours).

381 The study was conducted at two separate sites within Wytham Woods, approximately 1km apart,
382 and both sites with similar levels of vegetation cover. Within the timeframe of the study, this 1km
383 distance between sites effectively ensures two separate local populations; of the 105 birds recorded
384 as part of this study, only one individual was observed at both sites (see Supplementary Methods
385 S1). Previous work has estimated that >80% of locally-occurring great tit individuals are RFID tagged
386 ⁵¹.

387 ***Social Network Data***

388 Prior to beginning the experimental trials, we gathered detailed baseline information regarding
389 individuals' usage of a familiar food, and their social connections to one another. From 11/01/2018
390 to 22/01/2018 an RFID feeding station containing non-coloured granulated peanut was placed at
391 each site. Granulated peanut is a familiar food source which is commonly used by great tits in
392 Wytham Woods and the surrounding area, as well as throughout the UK ⁶³

393 Each RFID station automatically recorded the unique identity of each individual detected along with
394 the associated time-stamp. Because these birds forage in loose fission-fusion flocks⁶¹, this produced

395 a temporal data stream made up of bursts (as flocks arrive and feed) interspersed with intermittent
396 quiet periods^{64,65}. These bursts of activity (the flocking events) were detected automatically (without
397 the need for subjective specifications) using a Gaussian Mixture Model (GMM – an unsupervised
398 learning algorithm)⁶⁵ which returns a group-by-individual matrix³¹ specifying which individuals were
399 detected within each of these flocking events. Following this, social networks can be derived for any
400 desired time period by applying the widely used ‘Simple Ratio Index’ (SRI)⁶⁶ to the ‘groups’ (i.e.
401 flocking events) observed within that time period, derived as a proportion of flocking events in
402 which the focal dyad (A and B) were seen together as $Flocks_{A,B}/(Flocks_A+Flocks_B-Flocks_{A,B})$, where
403 $Flocks_A$ is the number of flocks that individual A was seen in, irrespective of the observation of B. In
404 this way, a weighted, symmetrical, social network was produced for all three periods of the study
405 (baseline, experiment 1, and experiment 2).

406 In these social networks, the individuals are represented as the network ‘nodes’, and the social
407 connections between them as the network ‘edges’, and the weight of these edges are the dyadic
408 association scores (as specified in the dyadic association matrix). These weights denote the strength
409 of the social affiliation between each of the dyads⁶⁵.

410 This approach to calculating social networks has been extensively used for this population and
411 methodological examination of this system has found that the GMM approach outperforms other
412 potential methods of identifying associations^{64,65}. Large-scale observational studies have shown that
413 the derived social networks are consistent across time⁶⁷ and contexts⁶², and linked to other
414 processes such as mating^{68,69}, territory acquisition^{62,70}, and information flow⁷¹. Furthermore,
415 detailed experimental tests have confirmed the social network’s consistency^{72,73}, and its relation to
416 biologically meaningful outcomes⁷⁴⁻⁷⁶.

417 We quantified individuals’ social network centrality from the weighted social networks. A common
418 and intuitive metric of social network centrality is weighted strength, which is the sum of the focal
419 individual’s social connections to all other individuals, and is a consistent and repeatable measure of
420 social phenotype in this population⁶⁷. We also calculated two other measures of social centrality,
421 namely (i) ‘average edge weight’ which measures the typical strength of an individual’s social bonds
422 by taking the mean weight of their non-zero dyadic social association scores, and (ii) ‘eigenvector
423 centrality’ which measures their position within the wider network by summing the social
424 connections of their associates, and thus represents the sociability of their social associates.

425 As well as computing these social metrics, we also calculated for each individual the mean size of the
426 flocking events (i.e. the grouping events automatically identified from the feeder co-occurrence
427 records) they occurred in (i.e. their average group size), and the number of unique individuals they
428 were seen with, across all observations. In this way, we were able to separate the influence of
429 individuals’ social network metrics from simpler social measures (see Methods; Statistical Analysis).

430

431 **Experiment Data**

432 Each of the experimental trials were carried out after 12 days of baseline data collection. The same
433 general protocol was used at both sites. The first novel food experimental trial took place
434 immediately after the baseline data collection. The single clear-plastic tube RFID feeder (containing
435 familiar food) was swapped for two clear-plastic tube RFID feeders at either side of the original
436 feeder position, within 1m of one another. One of these RFID feeders contained the familiar peanut
437 granules, while the other feeder contained peanut granules which were made novel by dyeing them
438 either green or red, under standardised methods⁴¹, for details see supplemental materials section 3.

439 Both feeders were made of transparent plastic to allow the birds to see the colour of the food This
440 experimental trial ran for four days, recording all visits by RFID tagged birds to each of the feeders.

441 Following this first experimental trial, a second novel food experimental trial was then carried out, in
442 which the feeder containing the novel food was swapped to contain different coloured novel food.
443 In the first experimental trial, the novel food RFID feeder at Site 1 was filled with red-dyed granules
444 while the novel food RFID feeder at Site 2 contained green-dyed granules. In the second
445 experimental trial. This was switched so that the novel food RFID feeder at Site 1 was filled with
446 green-dyed granules while the novel food RFID feeder at Site 2 contained red-dyed granules. In both
447 trials, familiar coloured food was provided in the other feeder at each site. The second experimental
448 trial was carried out for four days (the same length as the first trial), and all visits by RFID tagged
449 birds to the feeders were recorded.

450 During the experimental trials, we also aimed to reduce any additional influences on the birds'
451 feeding behaviour that may be caused by either human presence causing disturbance, or through
452 positional effects of feeder placement. We ensured that all required activity at the feeders (i.e.
453 placement changes and associated device checks) were carried out when the great tits were not
454 using the feeders (i.e. after dusk). Even though the familiar-food feeder and the novel food feeder
455 were next to one another (>1m apart), we also aimed to reduce any remaining fine-scale positioning
456 effects by swapping the feeders' positions every other day during the experiment (see Table S1).

457

458 ***Quantification and Statistical Analysis***

459 *Novel Food Usage*

460 For each of the experimental trials, we examined how prior social centrality (i.e. their network
461 centrality before the experiments began) was related to subsequent usage of novel food during the
462 trials. As we aimed to consider individuals' relative use of the novel food, rather than just their total
463 feeder use in general, we treated the proportion of their total activity which took place on the
464 feeder containing novel food as a measure of individual propensity to use novel food. Therefore, we
465 carried out logistic regressions for each of the trials separately, whereby the response variable in the
466 generalised linear model (GLMs) was set as a binomial variable with the number of detections on the
467 novel food feeder as 'successes' and the number of detections on the familiar food feeder during the
468 trial as 'fails'. In this way, the total feeder usage, and also confidence in their propensity (i.e.
469 strength of their bias/preference) to use novel vs familiar food, was considered directly within the
470 response variable. Because GLMs with binomial error-distributions are vulnerable to over-dispersion,
471 we used a quasi-binomial error distribution, which removed this issue of over-dispersion. The
472 models were set to include fixed effects of the factors that could potentially be related to individual
473 novel food usage propensity. We specified the primary explanatory variable of interest as social
474 network centrality (weighted strength) prior to the experimental trial. For each trial, the social
475 centrality used for the analysis were derived from the period immediately before the trial. As such,
476 for the model assessing the novel food usage during the first trial, individual social centrality
477 calculated from the network directly before the trial began (i.e. during the baseline data collection
478 period) was used. For the model assessing the second trial, weighted strength during the period
479 directly before the second trial began (i.e. during the first trial data collection period) was used. We
480 also aimed to account for other variables that may affect novel food usage, and included site (i.e.
481 which of the two areas the individual was detected in), sex (whether they were male or female), age
482 (specified as either adult, or juvenile), and immigratory status (whether they had arrived in the

483 Wytham Woods study area that year or not) as explanatory variables in the model. In order to
484 directly consider individual differences in feeder usage, we also included the number of detections
485 on the feeders in the period prior to the experimental trial.

486 Although social centrality was set as weighted network strength in the main models, we also
487 quantified it using other commonly used network metrics (see Methods *Social Network Data*).
488 Therefore, we ran supplementary models using other common measures of social network centrality
489 (average edge weight, eigenvector centrality) calculated from the period prior to the trial, while the
490 rest of the model structure remained the same. Furthermore, it is also possible that other more
491 basic measures of sociality (i.e. non-network based metrics) might act as potential explanatory
492 variables (see Methods *Social Network Data*). To test this, we ran the same models again using each
493 of the simple individual-level social metrics (i.e. not based on networks) obtained from the period
494 prior to the experimental trial (average size of the flocking events they were observed in, and
495 number of unique individuals they were seen with).

496 *Neophobia*

497 Individual variation in the observed usage of novel food in the experimental trials could potentially
498 be due to differences in the propensity to first approach the novel food (i.e. avoidance/neophobia)
499 rather than variation in propensity to use the food once any potential neophobia is overcome. We
500 considered this directly by employing the same models as described above, but instead of setting
501 proportional novel food usage as the response variable, we used a binary variable of whether or not
502 they were detected on the feeding perch of the novel food feeding station when they first arrived at
503 the feeding site during the experimental trial. We used a GLM with a quasi-binomial error
504 distribution, and fitted the same fixed effects of the main models (prior social centrality, individual
505 sex, age, immigrant status, experimental site, and prior number of feeding detections).

506 Another measure of neophobia is the latency to first approach the novel food (as opposed to the
507 'likelihood of using the novel food upon the first visit' as described above). Therefore, we also
508 calculated two related temporal measures of individual novel food neophobia; 'time to use the novel
509 food since the experiment began', and 'time to use the novel food since the individual was first
510 detected during the experimental trial (i.e. time since they first landed on either feeder during the
511 experiment)'. We set each of these in turn as response variables in the same model structure as
512 described above, but using a gaussian-error distribution instead of binomial due to the distribution
513 of these response variables.

514 After modelling how the explanatory variables were related to measures of novel food neophobia,
515 we also re-assessed the models examining novel food usage propensity but only considering
516 individuals' behaviour once any neophobia had been overcome i.e. once the individual had already
517 approached and used the novel-food feeder; Specifically, we re-calculated each individual's
518 proportional usage of novel and familiar foods but this time only within the time-period following
519 their first detection on the perch of the novel food feeder. Following the primary model structure,
520 we fitted this as the response variable in a GLM with binomial error-structure (with the novel food
521 usage as 'successes' and familiar food usage as 'fails'), along with the explanatory variables (as
522 stated previously) to examine how this predicted novel food usage once individuals had already used
523 the novel food feeder. We additionally evaluated how model structure related to the observed
524 results using randomisations (see below).

525 *Network Randomisations*

526 Individuals' positions within social networks are dependent on one another³¹. Social network data,
527 by definition, violates the assumption of the independence of data points made under the standard
528 maximum likelihood statistical tests. Therefore, network randomisations are commonly used when
529 estimating the statistical significance of observed parameters computed from standard tests³¹. Such
530 randomisation techniques allow the creation of null models using a given permutation procedure,
531 and from these null models the same parameters can be re-calculated using the permuted data
532 (instead of the observed data) to provide the distribution of this parameter that is expected given
533 the underlying network structure, and the non-independence of data. More broadly, null models
534 based on permutations of the observed data can also act as an additional, and intuitive, test of
535 significance of observed statistics across various contexts. We employed a hierarchical node
536 attribute permutation procedure controlling for space and time⁶² whereby individuals were
537 randomly reassigned the attributes (response variable of consideration) of another node individual
538 in the same area during the same period of consideration as themselves. Following this, we re-ran
539 the models and stored the estimated effect size (Coefficient) of each of the predictor variables on
540 the permuted response variable, while keeping everything else in the model the same (i.e.
541 maintaining the exact distributions of all the variables, and the covariance between the predictor
542 variables). By running 10,000 of these permutations, we generated the null distribution of the effect
543 size parameter for each model's predictor variables and calculated the significance of the observed
544 data test statistics by comparing it to these null distributions. In this way, the p-value (p_{rand})
545 represents each observed statistic's position within the corresponding null distribution, whereby
546 $p_{\text{rand}} < 0.05$ indicates that the observed statistic lays outside of the 95% range of the null distribution
547 for this predictor variable (i.e. below the bottom 2.5% or above the top 97.5%, i.e. it detects a
548 significant effect).

549

550

551

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752 **Supplementary Information: Social network centrality shapes dietary decisions in a wild**
753 **bird population**

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764 **SUPPLEMENTARY INFORMATION CONTENT:**

765 **(1) Supplementary Figures**

766 **-Figure S1. Social centrality metrics and novel food usage**

767 **-Figure S2. Basic social measures and novel food usage**

768 **(2) Supplementary Tables**

769 **-Table S1. Summary of experimental procedure**

770 **-Table S2. Full model output: Social network strength and novel food usage**

771 **-Table S3. Full model output: Average edge weight and novel food usage**

772 **-Table S4. Full model output: Eigenvector centrality and novel food**

773 **-Table S5. Full model output: Mean gathering event size and novel food usage**

774 **-Table S6. Full model output: Unique flockmates and novel food usage**

775 **-Table S7. Full model output: Social network strength and first feeder used**

776 **-Table S8. Full model output: Social network strength and time delay to use novel food**

777 **-Table S9. Full model output: Social network strength and overall time delay to use novel food**

778 **-Table S10. Full model output: Social network strength and exploitation**

779 **(3) Supplementary Methods S1 Procedure of dyeing peanut granules, related to STAR METHODS.**

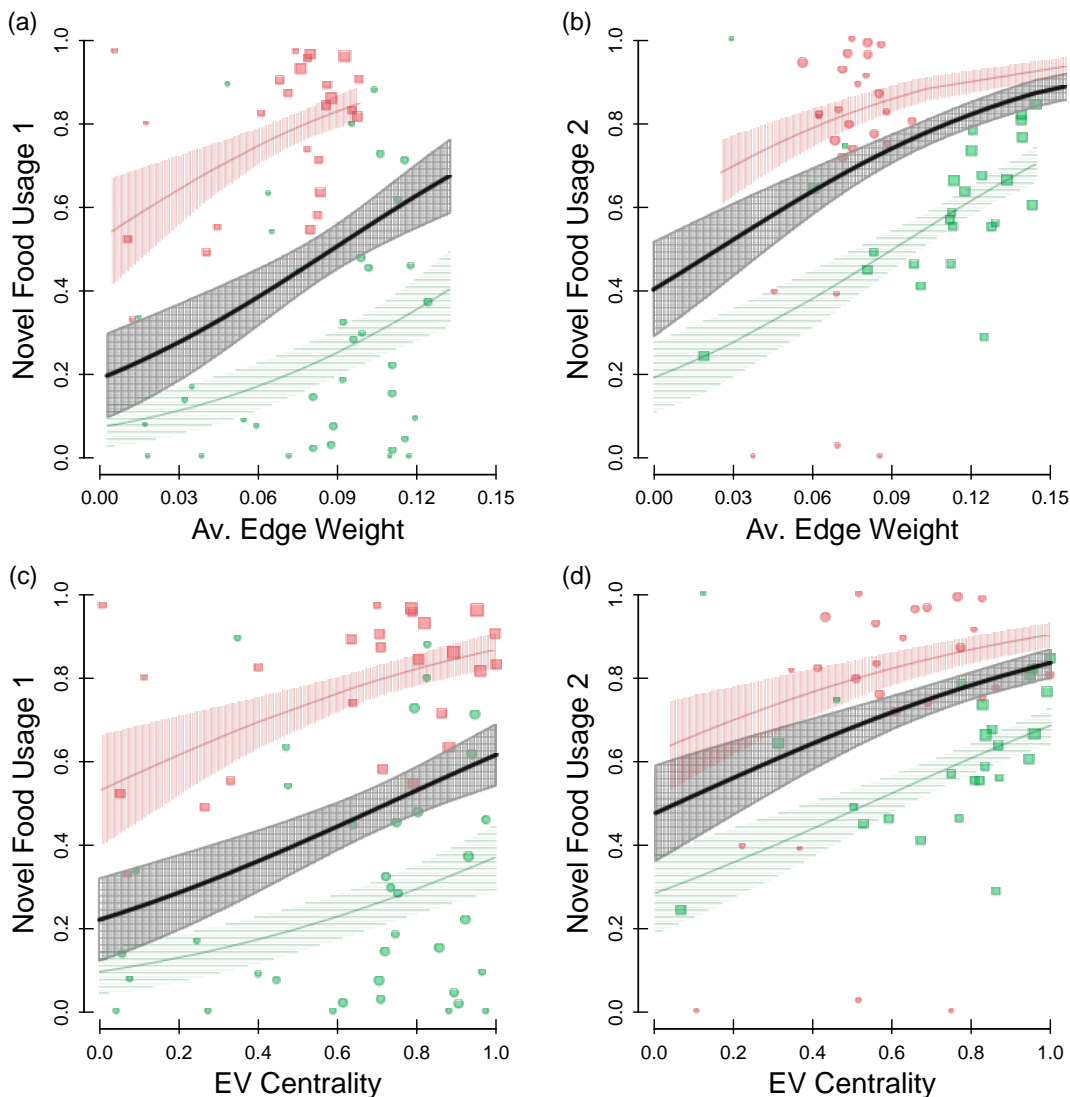
780 The green dye for the food was prepared by mixing O'Brien's (Citywest, Dublin 24, Ireland) liquid
781 green 90 food colouring in the ratio of 5 ml dye to 500 ml water. This solution was then mixed with
782 500 g of kibbled peanut. The mixture was placed in an oven at 50°C for 20–30 min until dry. This was
783 repeated with O'Brien's Christmas Red for the red dyed peanut.

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785 **SUPPLEMENTARY FIGURES**

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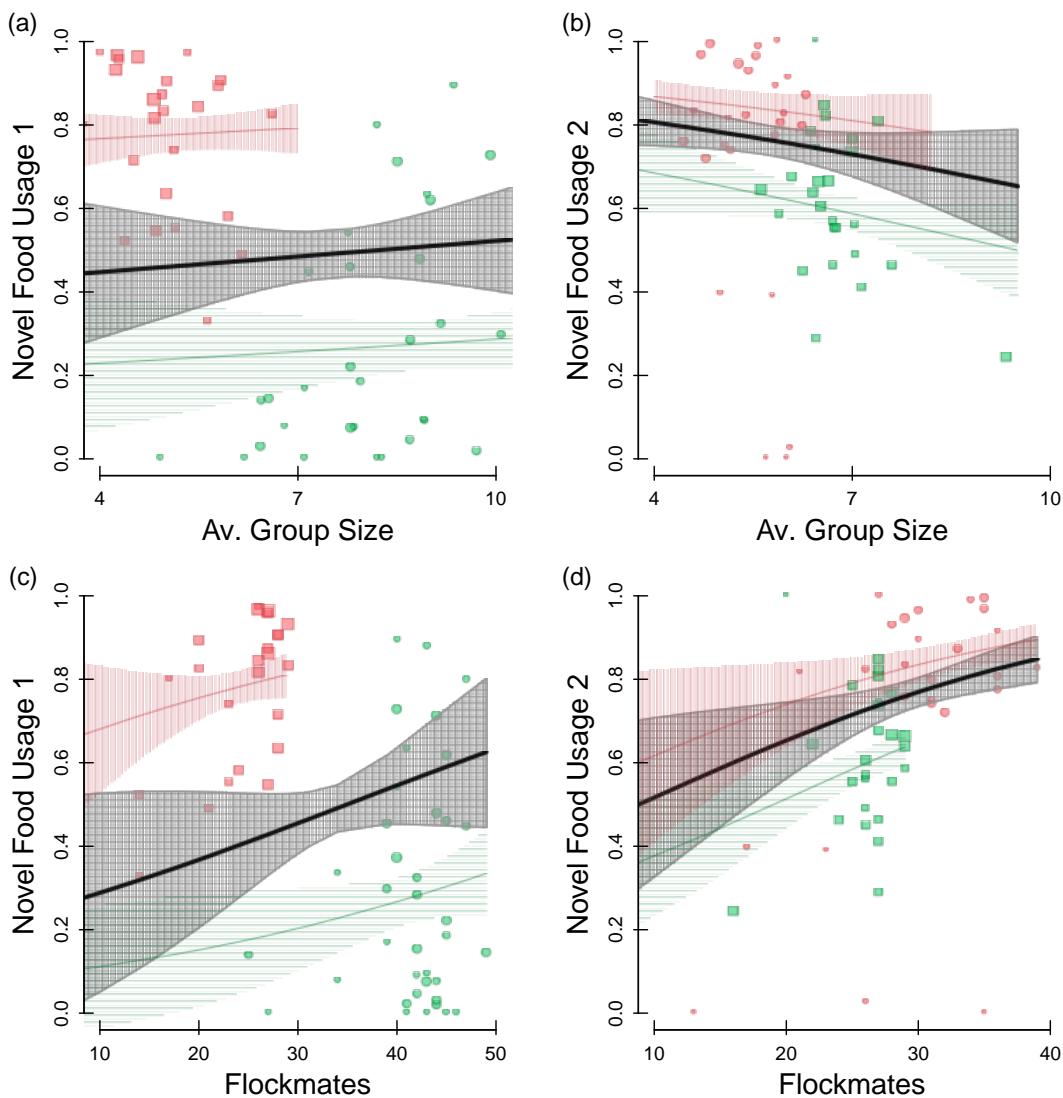


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789 **Figure S1: Social centrality metrics and novel food usage, related to Figure 2.** Prior social centrality
790 (x axis), as measured as (a-b) Average edge weight and (c-d) eigenvector centrality, and subsequent
791 novel food usage (proportion of novel food usage – y axis) for the (a,c) first trial, and (b,d) second
792 trial. The point positions show the individual data points, point colour shows the colour of the novel
793 food (red or green dyed peanut), point shape shows which experimental site the individual was at
794 (site 1 or site 2), and point size indicates weight of the data point i.e. the total number of detections
795 (at both the novel, and familiar food feeder). The lines show the GLM fit, and the surrounding
796 polygons show the associated standard error around this estimate, with the red lines showing the fit
797 for the red novel food site, the green line showing the fit for the green novel food site, and the black
798 line denoting the overall fit. See Table S3 & S4 for full model details.

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802 **Figure S2: Basic social measures and novel food usage, related to Figure 2.** Average group size is the
803 average size of the flocking event that the individual was observed in, and flockmates is the total
804 number of unique individuals the individual was observed occurring with in at least one flocking
805 event. Prior basic measures (x axis), as measured as (a-b) Average group size and (c-d) number of
806 flockmates, and subsequent novel food usage (proportion of novel food usage – y axis) for the (a,c)
807 first trial, and (b,d) second trial. The point positions show the individual data points, point colour
808 shows the colour of the novel food (red or green dyed peanut), point shape shows which
809 experimental site the individual was at (site 1 or site 2), and point size indicates weight of the data
810 point i.e. the total number of detections (at both the novel, and familiar food feeder). The lines show
811 the GLM fit, and the surrounding polygons show the associated standard error around this estimate,
812 with the red lines showing the fit for the red novel food site, the green line showing the fit for the
813 green novel food site, and the black line denoting the overall fit. See Table S5 & S6 for full model
814 details.

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816 **SUPPLEMENTARY TABLES**

817 **Table S1: Summary of experimental procedure, related to Figure 1.** The study protocol at each of
818 the sites, showing the phase of the study and food-types used over the data-collection days and the
819 fine-scaling positioning of the feeders within the feeding sites.

Site	Phase	Day	Food Type	Position
1	Baseline	1-12	Familiar	Mid
	Trial 1	13-14	Familiar	Side 1
			Green	Side 2
		15-16	Familiar	Side 2
			Green	Side 1
	Trial 2	16-17	Familiar	Side 2
			Red	Side 1
		18-19	Familiar	Side 1
			Red	Side 2
	2	Baseline	1-12	Familiar
Trial 1		13-14	Familiar	Side 2
			Red	Side 1
		15-16	Familiar	Side 1
			Red	Side 2
Trial 2		16-17	Familiar	Side 2
			Green	Side 1
		18-19	Familiar	Side 1
			Green	Side 2

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823 **Table S2: Social network strength and novel food usage model outputs, related to Figure 2.** Output
824 of GLMs assessing the relationship between individuals' propensity to use novel food (response
825 variable) and individuals' prior network strength (Figure 2 - Main Text), along with the other fitted
826 explanatory variables. Each column holds the test statistics for (A) experimental trial 1 and (B)
827 experimental trial 2. Each row gives the result for each explanatory variable, with 'Sex' in relation to
828 female birds, Age in relation to adult birds, Immigrant status in relation to residents, and the
829 'Strength' as weighted network degree directly prior to each experimental trial (see Methods) and
830 'Observations' as the number of records.

831

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-3.4250	0.9927	-3.4502	0.0011	0.001	0.3557	0.4499	0.7908	0.4333	0.001
<i>Sex (Male)</i>	0.2716	0.2789	0.9736	0.3346	0.530	0.2671	0.2011	1.3281	0.191	0.396
<i>Sex (Unk)</i>	-0.2357	1.0475	-0.225	0.8228	0.752	-0.1956	0.3889	-0.503	0.6175	0.772
<i>Age (Juv)</i>	0.4943	0.2612	1.8928	0.0637	0.242	0.2943	0.1902	1.5469	0.1291	0.366
<i>Immigrant</i>	0.2481	0.3388	0.7322	0.4672	0.656	0.2103	0.2233	0.9418	0.3514	0.546
<i>Site</i>	3.4020	0.7086	4.801	0.0001	0.016	-1.592	0.2672	-5.9592	0.0001	0.150
<i>Strength</i>	0.5285	0.2347	2.2517	0.0284	0.010	0.4668	0.1500	3.1114	0.0033	0.012
<i>Observations</i>	0.0000	0.0001	-0.091	0.9278	0.972	0.0001	0.0001	-0.087	0.9310	0.968

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836 **Table S3: Average edge weight and novel food usage model outputs, related to Figure 2 and Figure**
 837 **S1.** Output of GLMs assessing the relationship between individuals' propensity to use novel food
 838 (response variable) and individuals' average edge weight (Figure S1a;S1b), along with the other
 839 fitted explanatory variables. Each column holds the test statistics for (A) experimental trial 1 and (B)
 840 experimental trial 2. Each row gives the result for each explanatory variable, with 'Sex' in relation to
 841 female birds, Age in relation to adult birds, Immigrant status in relation to residents, and the 'Edge'
 842 as average non-zero edge weight directly prior to each experimental trial (see Methods) and
 843 'Observations' as the number of records.

844

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-2.8021	0.7216	-3.8833	0.0001	0.0001	0.2123	0.4475	0.4745	0.6375	0.002
<i>Sex (Male)</i>	0.2257	0.2763	0.817	0.4175	0.642	0.2974	0.1978	1.5033	0.1399	0.348
<i>Sex (Unk)</i>	-0.446	1.0028	-0.4447	0.6583	0.532	-0.0812	0.3914	-0.2074	0.8367	0.922
<i>Age (Juv)</i>	0.4891	0.261	1.8738	0.0664	0.25	0.3282	0.1876	1.7499	0.0871	0.302
<i>Immigrant</i>	0.1774	0.3361	0.5279	0.5997	0.754	0.2717	0.2216	1.2261	0.2267	0.436
<i>Site</i>	2.55	0.3977	6.4116	0.0001	0.236	-1.8735	0.2753	-6.8054	0.0001	0.006
<i>Edge</i>	16.4625	7.2095	2.2835	0.0264	0.022	15.9091	4.5385	3.5053	0.0011	0.004
<i>Observations</i>	0.0001	0.0001	0.18	0.8578	0.91	0.0001	1E-04	-0.2065	0.8374	0.928

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849 **Table S4: Eigenvector centrality and novel food usage model outputs, related to Figure 2 and**
850 **Figure S1.** Output of GLMs assessing the relationship between individuals' propensity to use novel
851 food (response variable) and individuals' eigenvector centrality (Figure S1c;S1d), along with the
852 other fitted explanatory variables. Each column holds the test statistics for (A) experimental trial 1
853 and (B) experimental trial 2. Each row gives the result for each explanatory variable, with 'Sex' in
854 relation to female birds, Age in relation to adult birds, Immigrant status in relation to residents, and
855 the 'Eigenvector' as weighted eigenvector centrality directly prior to each experimental trial (see
856 Methods) and 'Observations' as the number of records.

857

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-2.4432	0.5825	-4.1941	0.0001	0.001	0.3543	0.4713	0.7517	0.4562	0.001
<i>Sex (Male)</i>	0.2578	0.2787	0.9249	0.3591	0.554	0.2684	0.2051	1.3089	0.1973	0.396
<i>Sex (Unk)</i>	-0.3282	1.0023	-0.3274	0.7446	0.652	-0.2009	0.3947	-0.5091	0.6132	0.758
<i>Age (Juv)</i>	0.5059	0.2616	1.934	0.0584	0.226	0.2866	0.1923	1.4901	0.1433	0.384
<i>Immigrant</i>	0.2423	0.3395	0.7138	0.4784	0.656	0.2187	0.2278	0.9598	0.3424	0.538
<i>Site</i>	2.3106	0.3414	6.7671	0.0001	0.718	-1.4989	0.2714	-5.5235	0.0001	0.302
<i>Eigenvector</i>	1.7357	0.7585	2.2881	0.0261	0.05	1.7099	0.5834	2.9307	0.0053	0.012
<i>Observations</i>	0.0000	0.0001	-0.3856	0.7013	0.818	0.0000	1E-04	-0.0523	0.9585	0.988

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863 **Table S5: Mean gathering event size and novel food usage model outputs, related to Figure 2 and**
 864 **Figure S2.** Output of GLMs assessing the relationship between individuals' propensity to use novel
 865 food (response variable) and individuals' average flock size (Figure S2a;S2b), along with the other
 866 fitted explanatory variables. Each column holds the test statistics for (A) experimental trial 1 and (B)
 867 experimental trial 2. Each row gives the result for each explanatory variable, with 'Sex' in relation to
 868 female birds, Age in relation to adult birds, Immigrant status in relation to residents, and the 'Flock
 869 size' as mean number of individuals within each flocking event the individual was observed in
 870 directly prior to each experimental trial (see Methods) and 'Observations' as the number of records.

871

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-1.7901	1.6104	-1.1116	0.2712	0.278	2.2743	0.8448	2.692	0.01	0.422
<i>Sex (Male)</i>	0.1825	0.2921	0.6245	0.5349	0.704	0.0399	0.2023	0.1973	0.8445	0.904
<i>Sex (Unk)</i>	-0.4471	0.9903	-0.4515	0.6535	0.532	-0.476	0.4422	-1.0765	0.2876	0.412
<i>Age (Juv)</i>	0.5458	0.2779	1.9639	0.0547	0.202	0.1677	0.2003	0.8371	0.4071	0.606
<i>Immigrant</i>	0.1904	0.3613	0.527	0.6003	0.732	-0.0225	0.2284	-0.0986	0.9219	0.930
<i>Site</i>	2.1875	0.6794	3.2195	0.0022	0.930	-1.3842	0.3668	-3.7738	0.0001	0.534
<i>Flock Size</i>	0.0487	0.1684	0.2895	0.7733	0.676	-0.1404	0.1526	-0.9199	0.3627	0.232
<i>Observations</i>	0.0001	0.0001	1.1048	0.2741	0.322	0.0000	0.0001	2.3104	0.0256	0.134

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876 **Table S6: Unique flockmates and novel food usage model outputs, related to Figure 2 and Figure**
877 **S2.** Output of GLMs assessing the relationship between individuals' propensity to use novel food
878 (response variable) and their number of unique flockmates (Figure S2c;S2d), along with the other
879 fitted explanatory variables. Each column holds the test statistics for (A) experimental trial 1 and (B)
880 experimental trial 2. Each row gives the result for each explanatory variable, with 'Sex' in relation to
881 female birds, Age in relation to adult birds, Immigrant status in relation to residents, and the
882 'Flockmates' as sum of the number of unique individuals seen in the same flocking events as
883 themselves directly prior to each experimental trial (see Methods) and 'Observations' as the number
884 of records.

885

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-2.7682	1.9309	-1.4337	0.1574	0.028	-0.2265	1.2268	-0.1846	0.8544	0.001
<i>Sex (Male)</i>	0.2176	0.2875	0.7568	0.4525	0.628	0.1025	0.2014	0.5089	0.6134	0.732
<i>Sex (Unk)</i>	-0.3795	1.0127	-0.3747	0.7093	0.596	-0.4656	0.4018	-1.1587	0.2528	0.416
<i>Age (Juv)</i>	0.5626	0.2698	2.0855	0.0418	0.184	0.1811	0.1966	0.9212	0.362	0.576
<i>Immigrant</i>	0.3196	0.3807	0.8396	0.4048	0.564	0.0231	0.2252	0.1025	0.9188	0.960
<i>Site</i>	2.6957	0.9638	2.7968	0.0071	0.344	-1.1998	0.3843	-3.1216	0.0032	0.874
<i>Flockmates</i>	0.0361	0.0479	0.7535	0.4544	0.180	0.0565	0.0385	1.4674	0.1494	0.100
<i>Observations</i>	0.0000	0.0001	0.3305	0.7423	0.740	0.0000	0.0001	1.4246	0.1613	0.326

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890 **Table S7: Social network strength and first feeder used model outputs, related to Figure 3.** Output
 891 of GLMs assessing the relationship between whether individuals are first detected on the novel food
 892 feeder when they first arrive at the experimental trial and their prior network strength (Figure 3 -
 893 Main Text), along with the other fitted explanatory variables. Each column holds the test statistics
 894 for (A) experimental trial 1 and (B) experimental trial 2. Each row gives the result for each
 895 explanatory variable, with 'Sex' in relation to female birds, Age in relation to adult birds, Immigrant
 896 status in relation to residents, and the 'Strength' as weighted network degree directly prior to each
 897 experimental trial (see Methods) and 'Observations' as the number of records.

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	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-0.667	1.2864	-0.5185	0.6064	0.85	1.1073	1.3439	0.824	0.4146	0.074
<i>Sex (Male)</i>	0.4993	0.8285	0.6026	0.5496	0.51	-0.7047	0.7176	-0.982	0.3317	0.402
<i>Sex (Unk)</i>	1.2155	1.9456	0.6247	0.535	0.378	-19.37	2168.40	-0.0089	0.9929	0.006
<i>Age (Juv)</i>	-0.0508	0.8543	-0.0595	0.9528	0.98	0.6231	0.7775	0.8015	0.4274	0.448
<i>Immigrant</i>	0.892	1.1421	0.781	0.4386	0.386	-1.4231	1.1392	-1.2492	0.2185	0.196
<i>Site</i>	-0.4084	1.1975	-0.341	0.7345	0.164	1.2332	0.9898	1.246	0.2197	0.088
<i>Strength</i>	0.2896	0.413	0.7012	0.4865	0.29	-0.5507	0.5742	-0.9592	0.3429	0.284
<i>Observations</i>	0.0001	0.0001	-1.9471	0.0573	0.012	0.0000	0.0001	-0.6424	0.5241	0.526

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903 **Table S8: Social network strength and time delay to use novel food, related to Figure 3.** Output of
 904 LMs assessing the relationship between the amount of time taken for each individual to first land on
 905 the feeding perch of the novel food (quantified as time of day they were first recorded on the novel
 906 food), and their prior network strength, along with the other fitted explanatory variables. Each
 907 column holds the test statistics for (A) experimental trial 1 and (B) experimental trial 2. Each row
 908 gives the result for each explanatory variable, with ‘Sex’ in relation to female birds, Age in relation to
 909 adult birds, Immigrant status in relation to residents, and the ‘Strength’ as weighted network degree
 910 directly prior to each experimental trial (see Methods) and ‘Observations’ as the number of records.

911

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	38898	2064	18.84	0.0001	0.334	38958	3802	10.25	0.0001	0.614
<i>Sex (Male)</i>	300	1125	0.2668	0.7908	0.784	1606	2079	0.7727	0.4442	0.468
<i>Sex (Unk)</i>	1439	2871	0.5011	0.6187	0.4	10075	4696	2.1456	0.0379	0.038
<i>Age (Juv)</i>	-2302	1063	-2.1646	0.0356	0.014	-4876	2092	-2.33	0.0248	0.028
<i>Immigrant</i>	519	1452	0.3577	0.7222	0.62	102	2753	0.037	0.9707	0.926
<i>Site</i>	-2875	1696	-1.6956	0.0967	0.276	1929	2575	0.7492	0.458	0.34
<i>Strength</i>	-377	559	-0.6739	0.5038	0.466	-125	1487	-0.084	0.9332	0.944
<i>Observations</i>	0.2099	0.2216	0.9472	0.3485	0.388	-1.5294	1.4881	-1.028	0.3101	0.458

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916 **Table S9: Social network strength and overall time delay to use novel food, related to Figure 3.**

917 Output of LMs assessing the relationship between the amount of time taken for each individual to
 918 first land on the feeding perch of the novel food (quantified as total elapsed foraging time since they
 919 were first detected at the site during the trial – log transformed), and their prior network strength,
 920 along with the other fitted explanatory variables. Each column holds the test statistics for (A)
 921 experimental trial 1 and (B) experimental trial 2. Each row gives the result for each explanatory
 922 variable, with ‘Sex’ in relation to female birds, Age in relation to adult birds, Immigrant status in
 923 relation to residents, and the ‘Strength’ as weighted network degree directly prior to each
 924 experimental trial (see Methods) and ‘Observations’ as the number of records.

925

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	6.3798	1.8885	3.3782	0.0014	0.216	2.4033	2.3087	1.041	0.3038	0.222
<i>Sex (Male)</i>	-0.7159	1.101	-0.6503	0.5186	0.558	1.9838	1.2731	1.5583	0.1267	0.136
<i>Sex (Unk)</i>	-2.2135	2.9084	-0.7611	0.4503	0.224	4.4115	2.9211	1.5102	0.1385	0.076
<i>Age (Juv)</i>	-0.4054	1.0667	-0.3801	0.7055	0.708	-0.7133	1.3014	-0.5481	0.5865	0.64
<i>Immigrant</i>	-1.1519	1.411	-0.8164	0.4182	0.42	1.3764	1.7166	0.8018	0.4272	0.442
<i>Site</i>	-0.3937	1.5755	-0.2499	0.8037	0.028	0.1215	1.5917	0.0764	0.9395	0.472
<i>Strength</i>	-0.7663	0.5415	-1.4151	0.1634	0.118	0.2549	0.9233	0.276	0.7839	0.778
<i>Observations</i>	0.0001	0.0001	3.05	0.0037	0.002	0.0000	0.0001	0.3954	0.6946	0.73

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930 **Table S10: Social network strength and novel food exploitation after first use, related to Figure 4.**

931 Output of GLMs assessing the relationship between individuals' propensity to use novel food after
 932 they had already first tried the novel food feeder (response variable) and individuals' prior network
 933 strength (Figure 4 - Main Text), along with the other fitted explanatory variables. Each column holds
 934 the test statistics for (A) experimental trial 1 and (B) experimental trial 2. Each row gives the result
 935 for each explanatory variable, with 'Sex' in relation to female birds, Age in relation to adult birds,
 936 Immigrant status in relation to residents, and the 'Strength' as weighted network degree directly
 937 prior to each experimental trial (see Methods) and 'Observations' as the number of records.

938

	(A) Experimental Trial 1					(B) Experimental Trial 2				
	Coeff.	SE	T	P	P _{rand}	Coeff.	SE	T	P	P _{rand}
<i>Intercept</i>	-3.5136	1.0769	-3.2627	0.002	0.001	0.4391	0.5057	0.8682	0.3902	0.001
<i>Sex (Male)</i>	0.316	0.3108	1.0167	0.3143	0.508	0.4231	0.2235	1.8928	0.0653	0.210
<i>Sex (Unk)</i>	-0.1159	1.2082	-0.0959	0.924	0.886	-0.0665	0.4319	-0.1539	0.8784	0.948
<i>Age (Juv)</i>	0.5041	0.2892	1.7429	0.0876	0.264	0.3009	0.2112	1.4244	0.1617	0.386
<i>Immigrant</i>	0.2262	0.3783	0.598	0.5526	0.682	0.3363	0.2452	1.3718	0.1774	0.364
<i>Site</i>	3.6381	0.7803	4.6627	0.0001	0.014	-1.8279	0.3112	-5.8741	0.0001	0.158
<i>Strength</i>	0.5483	0.2551	2.1492	0.0366	0.006	0.5324	0.1677	3.1742	0.0028	0.010
<i>Observations</i>	0.0001	0.0001	0.0207	0.9836	0.994	0.0001	1E-04	-0.4635	0.6454	0.802

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