

1 **SUPPLEMENTARY MATERIAL: NEGOTIATION OF COOPERATIVE**
2 **BEHAVIOUR IN A SOCIAL BIRD**

3

4 **Bell¹, M.B.V., Radford², A.N. , Smith³, R.A., Thompson⁴, A.M., & Ridley^{4,5}, A.R.**

5

6 **Supplementary feeding experiments: effect on interval between sentinel bouts and**
7 **sentinel bout duration**

8 Trial discarded if, during either sentinel bout, the sentinel flew away; if another bird
9 started preening the sentinel; if another bird started a sentinel bout before the focal bird
10 came down. We also discarded trials if, at any point between the start of the first sentinel
11 bout and the end of the second bout, the majority of the group stopped foraging or flew
12 away; if the sentinel or any other animal (con- or heterospecific) gave an alarm call; if we
13 detected a predator; if the focal group started to chorus or if the focal group encountered
14 another group. We started all trials at least 5 min after the last group disturbance, and
15 performed trials within 2 hours of dawn to minimise the effect of changes in state due to
16 natural foraging.

17

18 **Supplementary feeding experiments: effect on sentinel and forager call rate**

19 Trial discarded if: the sentinel came down at any time during the trial, if the focal bird
20 flew away, stopped foraging or became a sentinel itself; if we heard an alarm call, by any
21 babbler or heterospecific; if we saw a predator; if the focal group began to chorus; if the
22 focal group encountered another group; or if the majority of the focal group stopped
23 foraging. For details of routine forager calling see Radford & Ridley 2007; Radford &
24 Ridley 2008).

25

26 **Relationship between sentinel call rate during first minute of a bout and bout**
27 **duration**

28 We only recorded sentinels if the majority of the group were foraging on the ground and
29 there had been no disturbance for at least 5 min. We abandoned recordings if the majority
30 of the group stopped foraging or flew away; if the sentinel or any other bird (con- or

31 heterospecific) gave an alarm call; if we detected a predator; if the focal group started to
32 chorus or if the focal group encountered another group.

33

34 **Effect of information about the state of collaborators on individual contributions to**
35 **sentinel behaviour.**

36

37 *Sentinels responding to foragers:*

38 Trials abandoned if playback did not start within 10sec of the start of the sentinel bout; if
39 the sentinel or any bird started investigating the speaker (1 instance); if another bird
40 started a sentinel bout or started to preen the sentinel; if the majority of the group stopped
41 foraging or flew away; if the sentinel or any other bird (con- or heterospecific) gave an
42 alarm call; if we detected a predator; if the focal group started to chorus or if the focal
43 group encountered another group.

44

45 *Foragers responding to sentinels & foragers responding to other foragers:*

46 Trials abandoned if playback did not start within 10sec of the previous sentinel bout
47 ending; if any bird started investigating the speaker; if the majority of the group stopped
48 foraging or flew away; if any bird (con- or heterospecific) gave an alarm call; if we
49 detected a predator; if the focal group started to chorus or if the focal group encountered
50 another group.

51

52 **Statistical analysis**

53 Paired comparisons performed in Minitab 15. All tests 2-tailed and data tested for
54 normality before appropriate parametric or non-parametric tests applied. Linear mixed
55 model performed in Genstat 8.1 (Lawes Agricultural Trust, Rothamsted, Harpenden,
56 UK). Because the analysis involved repeated recordings of the same individuals, we
57 included a random term which allowed the analysis to take account of repeated measures
58 (Schall 1991), estimating the variance components using the Restricted Maximum
59 Likelihood (REML) method. We sequentially dropped all potential explanatory terms
60 until only terms whose elimination would have significantly reduced the explanatory
61 power of the model remained. The significance of a term was derived by dropping it from

62 the final model (if it was part of the final model), or adding it to the final model and then
63 dropping it (if it was not part of the final model) (after Crawley 2002). We tested all two-
64 way interactions. We present the effect sizes of all terms – these are parameter estimates
65 from the models and can be interpreted as the change in y per unit change in x . For
66 categorical variables, such as sex, one level of the factor is set at 0, and the effect is
67 relative to that factor level.

68

69 **REFERENCES**

70

71 Crawley MJ 2002 *Statistical computing* (Wiley, Chichester, UK).

72

73 Radford, A.N. & Ridley, A.R. 2007 Individuals in foraging groups may use vocal cues
74 when assessing their need for antipredator vigilance. *Biology Letters* **3**, 249-252.

75

76 Radford, A.N. & Ridley, A.R. 2008 Close calling regulates spacing between foraging
77 competitors in the group living pied babbler. *Anim. Behav.* **75**, 519-527.

78

79 Schall R. 1991 Estimation in generalised linear models with random effects. *Biometrika*
80 **78**, 719-727.

81

82

83

84

85

86

87

88

89 **Table 1:** linear mixed model investigating the relationship between surveillance call rate during the first minute of sentinel bouts and
 90 the eventual duration of those bouts. Data came from 94 recordings of 25 birds in 8 groups, response variable log transformed.
 91

explanatory terms	Wald statistic (χ^2)	effect size	s.e.	d.f.	p	
Call rate in first minute (calls/min)	24.5	-0.015	0.0031	1	<0.001	
Sentinel age	12.75	0.1	0.028	1	<0.001	
Dominance status of sentinel (Dom, Sub)	12.01	Dom	0.0	1	<0.001	
		Sub	-0.33	0.095		
Habitat type (Open, Grass, Thicket)	4.85	Open	-0.20	0.10	2	0.088
		Grass	-0.042	0.086		
		Thicket	0.0			
Wind (Weak, Strong)	2.35	Strong	0.15	0.11	1	0.31
		Weak	0.063	0.071		
Sex of sentinel (M,F)	0.52	M	-0.04	0.089	1	0.77
		F	0.0			
Group size	0.04	-0.002	0.010	1	0.84	
Sentinel height	0.0	0.00	0.020	1	0.97	
Random term	Estimated variance	s.e.				
Individual	0.62	0.75				

92
 93

94 **Table 2:** summary of playback experiments conducted.

95

Call type	Simulated state	Played to	Speaker position	Group	Individual recorded	Individual recorded sex	Individual recorded status	Focal individual	Focal individual sex	Focal individual status
Forager	Normal	Sentinel	Ground	HOG	XXXX	M	DOM	GRML	F	SUB
	Satiated	Sentinel	Ground	HOG	XXXX	M	DOM	GRML	F	SUB
Forager	Normal	Sentinel	Ground	HOG	CLYM	F	SUB	XXXX	M	DOM
	Satiated	Sentinel	Ground	HOG	CLYM	F	SUB	XXXX	M	DOM
Forager	Normal	Sentinel	Ground	HAR	MXYB	F	DOM	MWTW	M	DOM
	Satiated	Sentinel	Ground	HAR	MXYB	F	DOM	MWTW	M	DOM
Forager	Normal	Sentinel	Ground	HAR	MWTW	M	DOM	MXYB	F	DOM
	Satiated	Sentinel	Ground	HAR	MWTW	M	DOM	MXYB	F	DOM
Forager	Normal	Sentinel	Ground	INF	TMPT	F	SUB	YMPY	M	DOM
	Satiated	Sentinel	Ground	INF	TMPT	F	SUB	YMPY	M	DOM
Forager	Normal	Sentinel	Ground	INF	OMRY	F	DOM	TMPT	F	SUB
	Satiated	Sentinel	Ground	INF	OMRY	F	DOM	TMPT	F	SUB
Forager	Normal	Sentinel	Ground	INF	YMPY	M	DOM	OMRY	F	DOM
	Satiated	Sentinel	Ground	INF	YMPY	M	DOM	OMRY	F	DOM
Forager	Normal	Sentinel	Ground	OSD	TMBY	M	DOM	MCSL	F	DOM
	Satiated	Sentinel	Ground	OSD	TMBY	M	DOM	MCSL	F	DOM
Forager	Normal	Sentinel	Ground	OSD	MCSL	F	DOM	TMBY	M	DOM
	Satiated	Sentinel	Ground	OSD	MCSL	F	DOM	TMBY	M	DOM
Forager	Normal	Sentinel	Ground	OSD	RPMT	F	SUB	XXXX	F	SUB
	Satiated	Sentinel	Ground	OSD	RPMT	F	SUB	XXXX	F	SUB
Forager	Normal	Sentinel	Ground	OSD	OOPM	M	SUB	RPMT	F	SUB
	Satiated	Sentinel	Ground	OSD	OOPM	M	SUB	RPMT	F	SUB
Forager	Normal	Sentinel	Ground	RNB	MYTC	M	DOM	RMPL	F	DOM
	Satiated	Sentinel	Ground	RNB	MYTC	M	DOM	RMPL	F	DOM
Forager	Normal	Sentinel	Ground	RNB	RMPL	F	DOM	MYTC	M	DOM

Bell et al. Negotiation of sentinel behaviour

	Satiated	Sentinel	Ground	RNB	RMPL	F	DOM	MYTC	M	DOM
Forager	Normal	Sentinel	Ground	RNB	HMYT	UNK	SUB	MCRY	F	SUB
	Satiated	Sentinel	Ground	RNB	HMYT	UNK	SUB	MCRY	F	SUB
Forager	Normal	Sentinel	Ground	SHA	MOOO	M	SUB	RGGM	M	DOM
	Satiated	Sentinel	Ground	SHA	MOOO	M	SUB	RGGM	M	DOM
Forager	Normal	Sentinel	Ground	SOX	BTMT	M	DOM	XXXX	F	DOM
	Satiated	Sentinel	Ground	SOX	BTMT	M	DOM	XXXX	F	DOM
Forager	Normal	Sentinel	Ground	SOX	LMCP	M	SUB	BTMT	M	DOM
	Satiated	Sentinel	Ground	SOX	LMCP	M	SUB	BTMT	M	DOM
Forager	Normal	Sentinel	Ground	XHO	PMPY	M	DOM	XXYM	F	DOM
	Satiated	Sentinel	Ground	XHO	PMPY	M	DOM	XXYM	F	DOM
Forager	Normal	Sentinel	Ground	XHO	XXYM	F	DOM	PMPY	M	DOM
	Satiated	Sentinel	Ground	XHO	XXYM	F	DOM	PMPY	M	DOM
Sentinel	Normal	Whole group	Tree	HAR	MWTW	M	DOM	GROUP		
	Satiated	Whole group	Tree	HAR	MWTW	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	HOG	XXXX	M	DOM	GROUP		
	Satiated	Whole group	Tree	HOG	XXXX	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	INF	YMPY	M	DOM	GROUP		
	Satiated	Whole group	Tree	INF	YMPY	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	OSD	TMBY	M	DOM	GROUP		
	Satiated	Whole group	Tree	OSD	TMBY	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	SHA	RGGM	M	DOM	GROUP		
	Satiated	Whole group	Tree	SHA	RGGM	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	RNB	MYTC	M	DOM	GROUP		
	Satiated	Whole group	Tree	RNB	MYTC	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	SOX	BTMT	M	DOM	GROUP		
	Satiated	Whole group	Tree	SOX	BTMT	M	DOM	GROUP		
Sentinel	Normal	Whole group	Tree	XHO	PMPY	M	DOM	GROUP		
	Satiated	Whole group	Tree	XHO	PMPY	M	DOM	GROUP		

Bell et al. Negotiation of sentinel behaviour

Forager	Normal	Whole group	Ground	HAR	MWTW	M	DOM	GROUP		
	Satiated	Whole group	Ground	HAR	MWTW	M	DOM	GROUP		
Forager	Normal	Whole group	Ground	HOG	XXXX	M	DOM	GROUP		
	Satiated	Whole group	Ground	HOG	XXXX	M	DOM	GROUP		
Forager	Normal	Whole group	Ground	INF	TMPT	F	SUB	GROUP		
	Satiated	Whole group	Ground	INF	TMPT	F	SUB	GROUP		
Forager	Normal	Whole group	Ground	OSD	RPMT	F	SUB	GROUP		
	Satiated	Whole group	Ground	OSD	RPMT	F	SUB	GROUP		
Forager	Normal	Whole group	Ground	SHA	MOOO	M	SUB	GROUP		
	Satiated	Whole group	Ground	SHA	MOOO	M	SUB	GROUP		
Forager	Normal	Whole group	Ground	RNB	RMPL	F	DOM	GROUP		
	Satiated	Whole group	Ground	RNB	RMPL	F	DOM	GROUP		
Forager	Normal	Whole group	Ground	SOX	BTMT	M	DOM	GROUP		
	Satiated	Whole group	Ground	SOX	BTMT	M	DOM	GROUP		
Forager	Normal	Whole group	Ground	XHO	RBTM	UNK	SUB	GROUP		
	Satiated	Whole group	Ground	XHO	RBTM	UNK	SUB	GROUP		

96

97 Note:

98 Individual ‘names’ represent colour ring combinations, with XXXX denoting an un-ringed bird (so the presence of XXXX in more

99 than one group does not indicate that the same bird was present in different groups). .