

Supplementary Material for:

Collective decision-making appears more egalitarian in populations where group fission costs are higher

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Additional Experimental Details

Day of Testing	Population	Predator Regime
1	Tacarigua	High
3	Arima	High
5	Paria	Low
7	Upper Turure	Low
9	Lower Guanapo	High
11	Upper Guanapo	Low
13	Lower Lopinot	High
16	Upper Lopinot	Low

Statistics

The mean body size and decisions made per second were analysed using linear mixed models (LMMs), the proportion of non-consensus decisions using binomial generalised linear mixed models (GLMM), and the speed of fish, the total number of switches and the number of switches at the front of groups using negative binomial GLMMs. Models investigating the total number of switches and number of switches at the front of groups included cohesion as an additional explanatory variable, as more switches would be expected to occur in more cohesive groups. We also included the decisions made per second as a covariate in this model to assess its relationship with the total number switches in the group.

Binomial GLMMs were run using the function `glmer` in the `lme4` package, and

negative binomial GLMMs using `glmmadmb` in the `glmmADMB` package. The residuals of the LMMs were checked for homoscedasticity by visual inspection of residual-fit and Q-Q plots checked their normality. We tested that the dispersion parameter of the GLMMs was approximately equal to 1 (range 0.5 - 2) using equivalent GLMs without the random term.

Further Discussion

Although supported by theory, our results contrast with one previous empirical study, where guppies from high, but not low, predation environments were observed to differentiate into ‘leader’ and ‘follower’ roles [1]. One explanation for these differences is the different decision-making contexts provided to the fish between these two experiments. The decision in the current study involved a single decision in a novel environment that fish had not experienced before. In the aforementioned study by Ioannou et al. (2017), fish were tasked with making multiple decisions in the same environment over time, and the quantification of how decision-making was distributed between individuals required these multiple decisions [1]. Burns et al. (2012) similarly concluded that leader-follower roles only emerged after mosquitofish (*Gambusia holbrooki*) were trialled in the same decision-making scenario over multiple occasions [2]. Together, these studies suggest that individuals may change their reliance on social information over individual goal-oriented behaviour depending on the context. In novel and uncertain environments, where private information is initially limited and group-fission costs are potentially higher, weighting social cohesion over goal-orientated behaviour appears to be favoured [3,4]. In situations where individuals differ in experience, on the other hand, individuals with greater knowledge or information may then emerge as leaders [5] (but see [6]).

[1] Ioannou CC, Ramnarine IW, Torney CJ, 2017 High-predation habitats affect the social dynamics of collective exploration in a shoaling fish. *Sci Adv* **3**, e1602682

[2] Burns AL, Herbert-Read JE, Morrell LJ, Ward AJ, 2012 Consistency of leadership in shoals of mosquitofish (*Gambusia holbrooki*) in novel and in familiar environments. *PLoS One* **7**, e36567

[3] Dall SR, Giraldeau LA, Olsson O, McNamara JM, Stephens DW, 2005 Information and its use by animals in evolutionary ecology. *Trends Ecol. & Evol.* **20**, 187–193

[4] McDonald ND, Rands SA, Hill F, Elder C, Ioannou CC, 2016 Consensus and experience trump leadership, suppressing individual personality during social foraging. *Sci Adv* **2**, e1600892

[5] Flack A, Pettit B, Freeman R, Guilford T, Biro D, 2012 What are leaders made of? the role of individual experience in determining leader–follower relations in homing pigeons. *Anim. Behav.* **83**, 703–709.

[6] Flack A, Ákos Z, Nagy M, Vicsek T, Biro D, 2013 Robustness of flight leadership relations in pigeons. *Anim. Behav.* **86**, 723–732