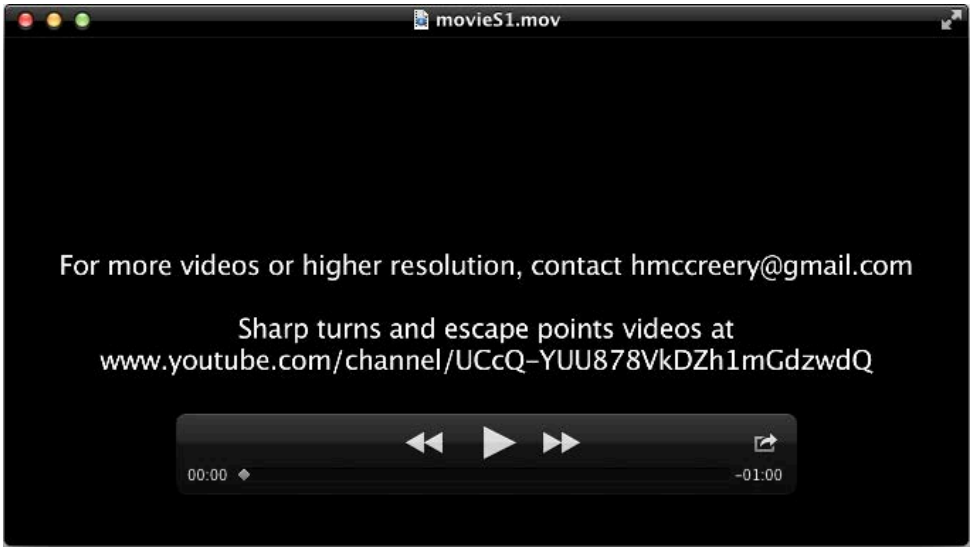
Supplementary information



Movie S1: **Videos of trials for the examples shown in Fig. 2, panels A and C.** For higher resolution and additional videos, including an extended version of this video and videos of sharp turns and escape points, go to https://youtu.be/vN4P8tq5DVw, https://youtu.be/-gz3tUbTpdU, or https://youtu.be/LcYkzdDh10Q, respectively.

Journal of Experimental Biology • Supplementary information

Table S1: Results of model selection for speeds.

Predictors	ΔAIC
Full model: Which.Obstacle + In.Obstacle? + Interaction + Random effect of trial nested within colony	16.4
Which.Obstacle + In.Obstacle? + Random effect of trial nested within colony	6.43
Which.Obstacle + Random effect of trial nested within colony	367
In.Obstacle? + Random effect of trial nested within colony	**0**
Random effect of trial nested within colony only	362

Table S2: Details of best-fit model for speeds. All coefficients are reported for square-root-transformed data.

		Value
	Intercept	0.662
Random effects on intercept	Variance among colonies	0.018
	Variance within trials	0.011
Fixed effect	In.Obstacle?Yes (Coefficient acts on speeds while navigating obstacle)	-0.065

Table S3: Details of model results for Bayesian analysis of backward runs. Posterior means are shown and 95% credible intervals in parentheses.

	Wall	**Cul-de-sac**	**Trap**
$\boldsymbol{\beta}$	0.0019 (-0.15 – 0.15)	0.14 (0.07 – 0.20)	-0.22 (-0.26 – -0.19)
$\boldsymbol{\alpha_i}$ **mean**	-0.39 (-0.64 – -0.14)	-0.58 (-0.74 – -0.42)	-0.58 (-0.72 – -0.44)
$\boldsymbol{\alpha_i}$ **standard deviation**	0.42 (0.25 – 0.65)	0.27 (0.16 – 0.44)	0.29 (0.20 – 0.42)
$\boldsymbol{\theta}$ **(scale parameter)**	36 (28 – 44)	11 (9.7 – 12)	33 (31 – 36)

Supplementary information continues on the next page.

Supplementary figures

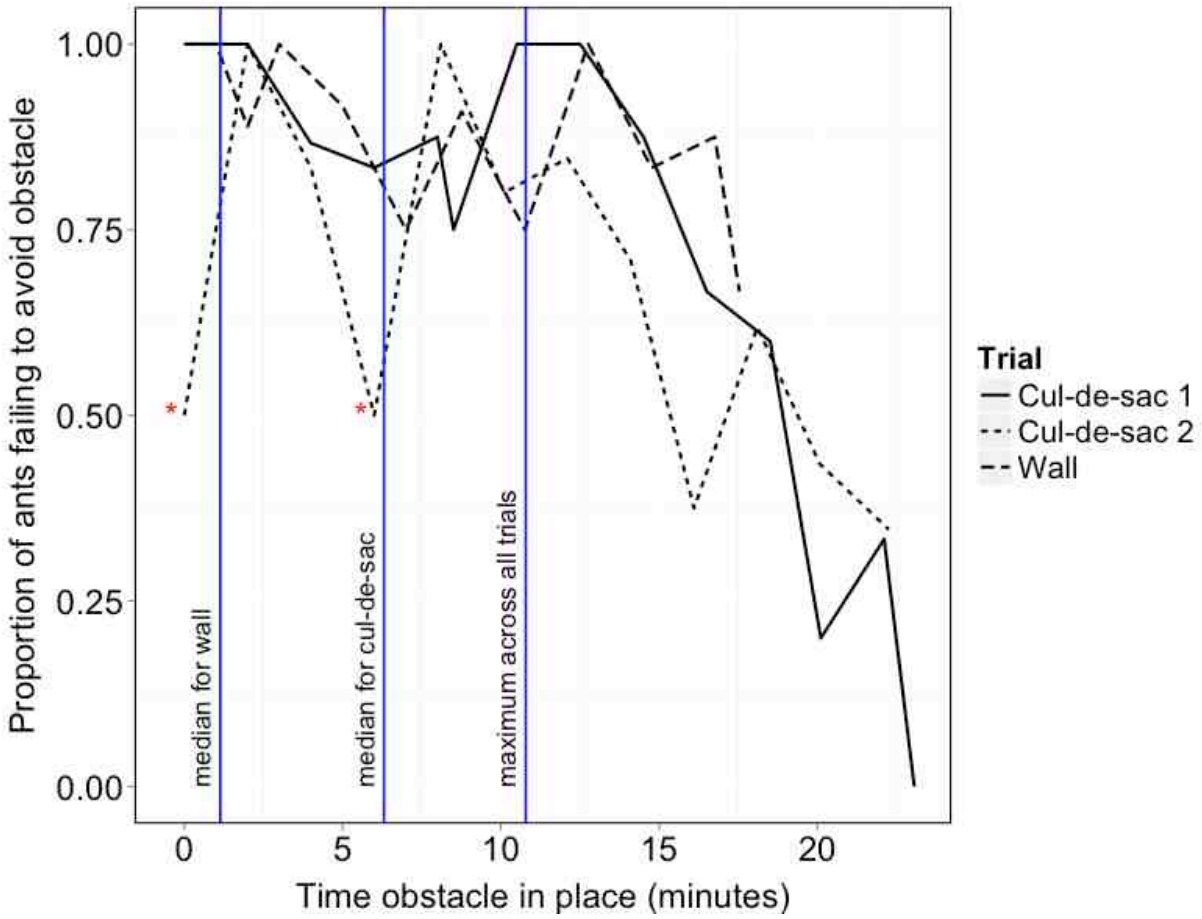


Fig. S1: **Response of individual ant paths to obstacles over time.** Obstacles were placed in the path of ants returning from sugar water baits. Shown here are the proportions of ants forced to navigate the obstacle because they failed to avoid it, measured in 10 second increments every two minutes. The "Cul-de-sac 2" trial had low traffic for the first several minutes; the two points marked with red asterisks each represent just 1 ant hitting the obstacle and 1 ant avoiding. The other data points in the Cul-de-sac 2 trial were based on an average of 15.7 ants per data point, while there were an average of 10.7 ants and 8.5 ants per data point, respectively, for the Wall trial and Cul-de-sac 1. Vertical lines show the median and maximum lengths of time obstacles were in place during trials for our main experiments. Our trials did not last long enough to be substantially affected by avoidance cues.

Fig. S2: **Trajectories of groups of ants navigating the wall for all trials (n = 22).** Warmer colors indicate earlier in time, cooler colors indicate later in the navigation process.

Fig. S3: **Trajectories of groups of ants navigating the cul-de-sac for all trials (n = 19).** Warmer colors indicate earlier in time, cooler colors indicate later in the navigation process.

Fig. S4: **Trajectories of groups of ants navigating the trap for all trials (n = 20).** Warmer colors indicate earlier in time, cooler colors indicate later in the navigation process.

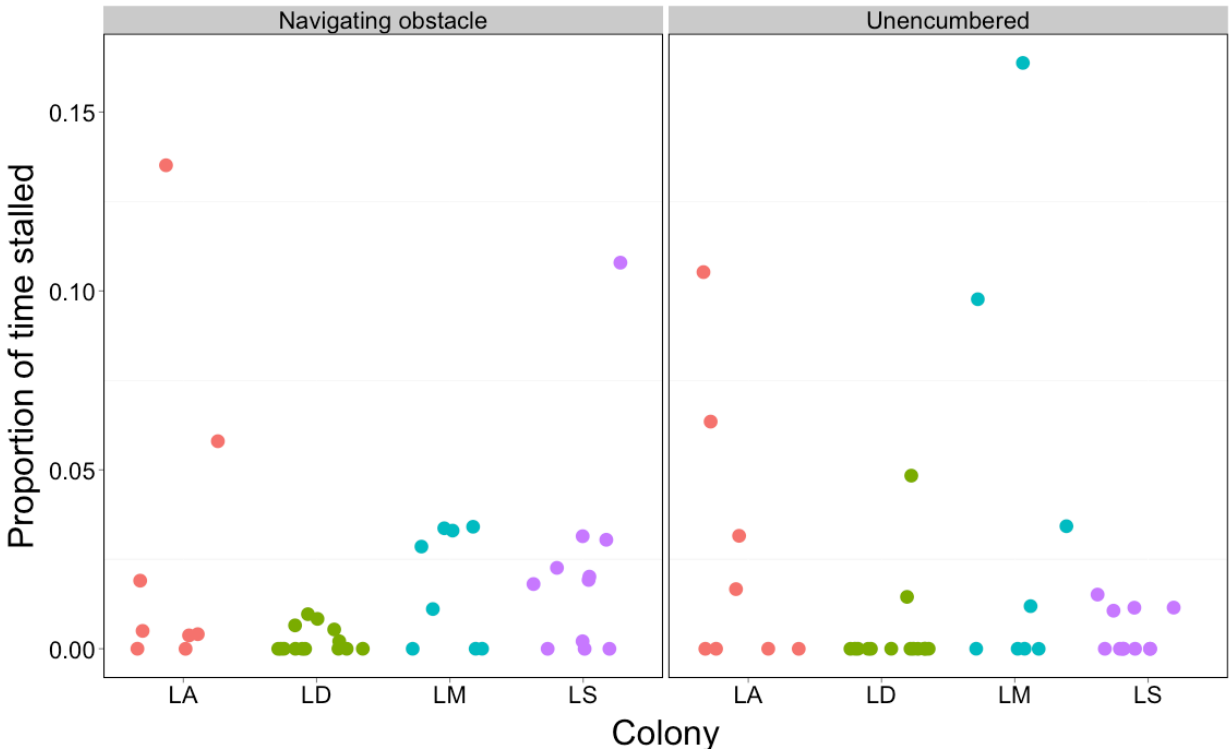


Fig. S5: **Proportions of time stalled in each trial while navigating the obstacle (left panel) and while unencumbered (right panel).** Groups spend approximately equal proportions of time stalled regardless of whether they are obstructed or not. Proportions of time stalled do not substantially differ among colonies. LA and LD are colonies at Arizona State University, LM and LS are colonies at Biosphere 2.

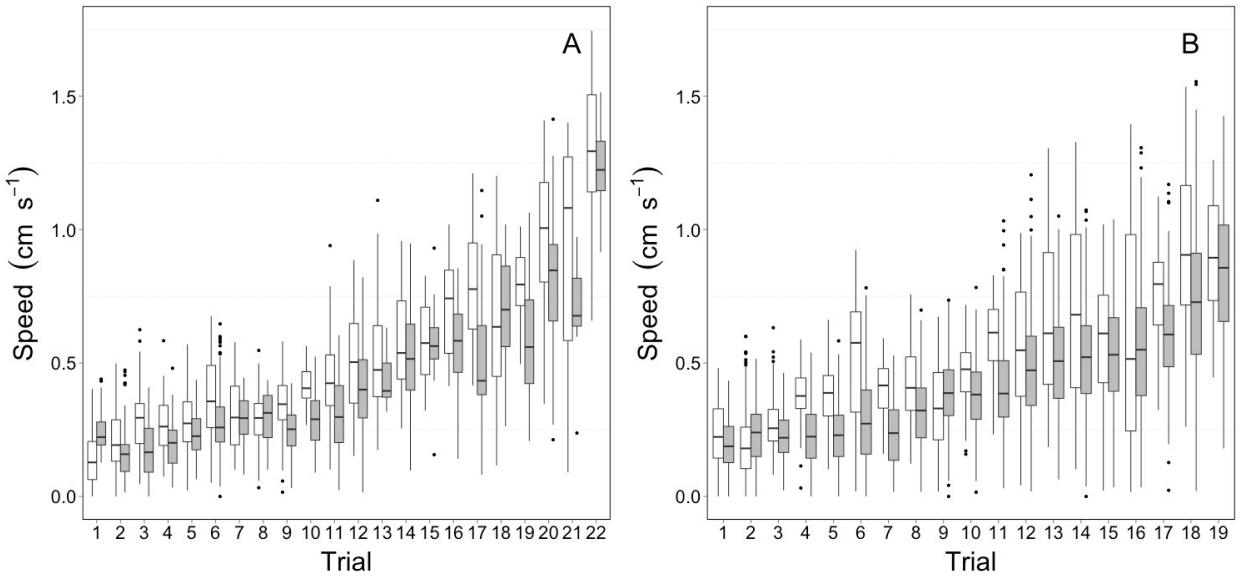


Fig. S6: **Mean speeds for groups navigating an obstacle (gray boxes) and while unobstructed (open boxes) for each trial.** A: trials with the wall; B: trials with the cul-de-sac. Boxes include 50% of the data (going from the 25th to 75th percentiles), and whiskers extend to the lowest and highest values that are within 150% of the interquartile range. Dots are points outside that range. The best general linear model of speeds, determined using AIC, included whether the group was obstructed (β = -0.065) and a random effect of trial nested within colony. While speeds were reduced during obstacle navigation, the reduction in speed was only 10% on average, and amounted to a small change compared with the variation in speeds across trials.

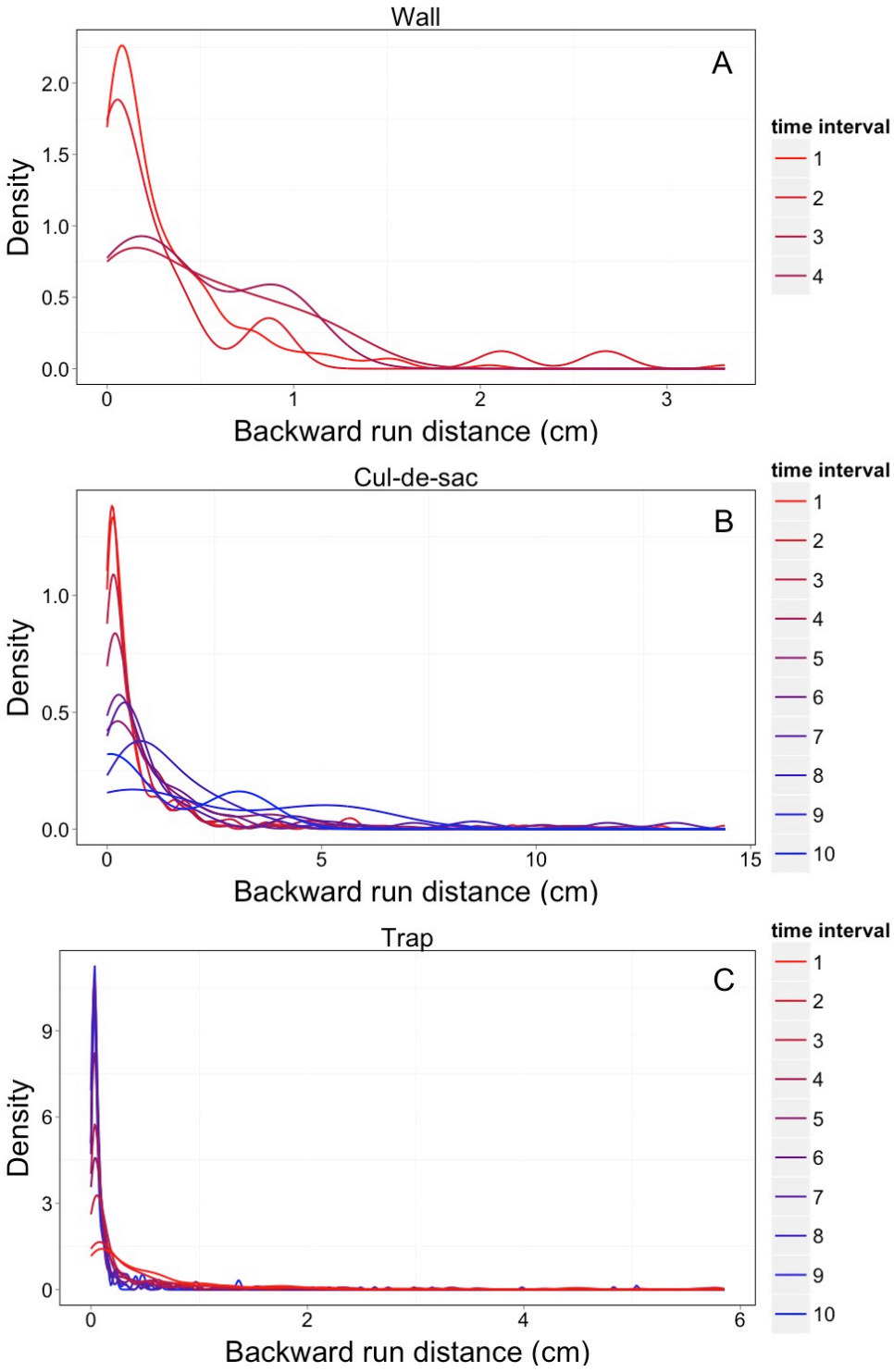


Fig. S7: **Densities of backward run distances of groups navigating obstacles at different time intervals.** A: the wall; B: the cul-de-sac; and C: the trap. Each time interval is 67 seconds long (one-tenth the total time across all trials). Warmer colors indicate earlier time intervals, and cooler colors are later time intervals. Modeled in a Bayesian framework as a gamma distribution

with a changing shape parameter, our estimate of the effect of time, β, in the cul-de-sac (B), is 0.13 (95% CI: 0.07 – 0.20). Thus, in the cul-de-sac, groups move further away from the nest the longer they have been navigating. We did not find strong evidence for this effect in the wall (A; β = 0.0019, 95% CI: -0.15 – 0.15), and found the opposite effect in the trap (C; β = -0.22, 95% CI: -0.26 – -0.19). The distribution of distances of backwards runs becomes more right-skewed over time in the cul-de-sac but not the other obstacles.

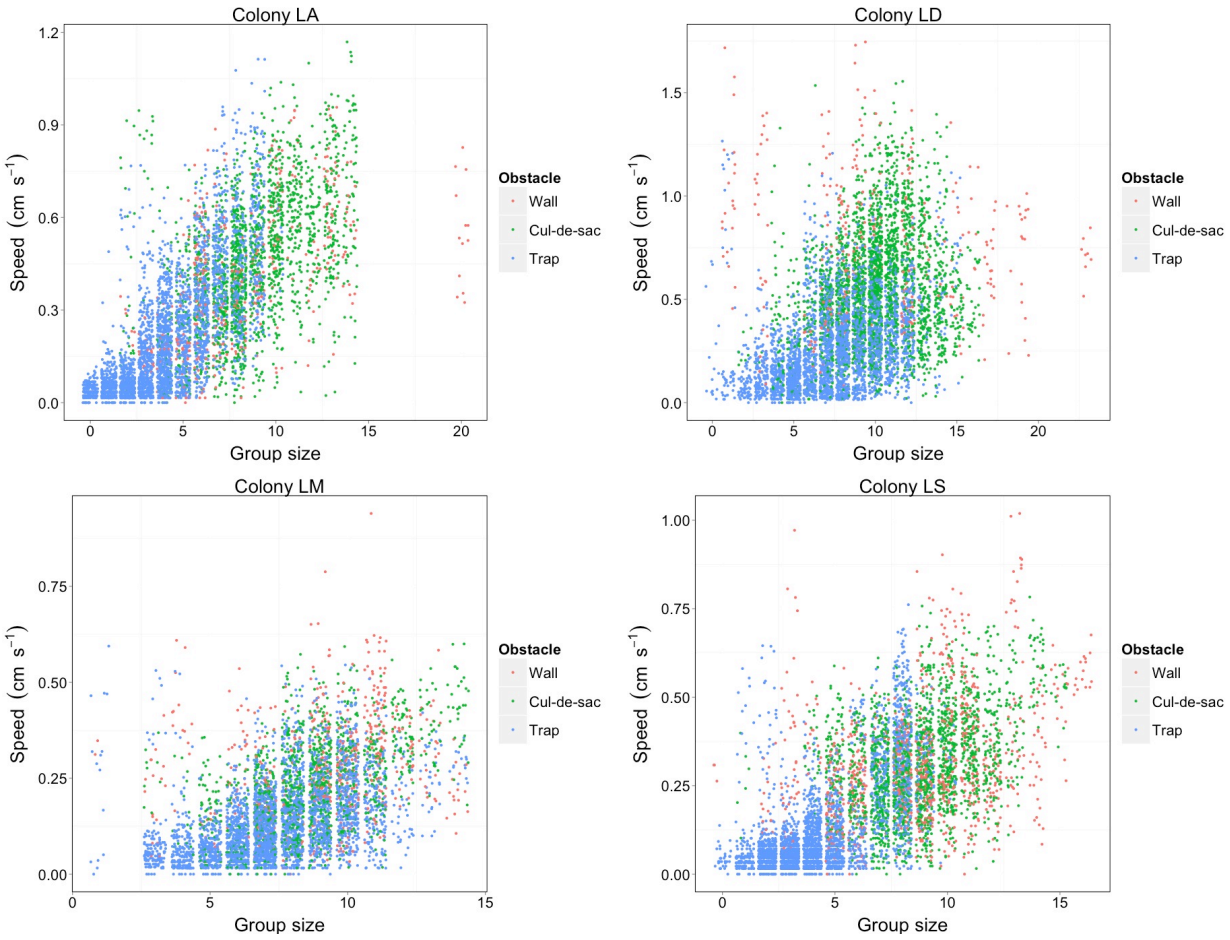


Fig. S8: **Speeds of groups at different group sizes.** Group sizes are jittered. Speed is positively correlated with group size, and this effect is consistent across colonies (Kendall's τ = 0.44, P < 0.0001).

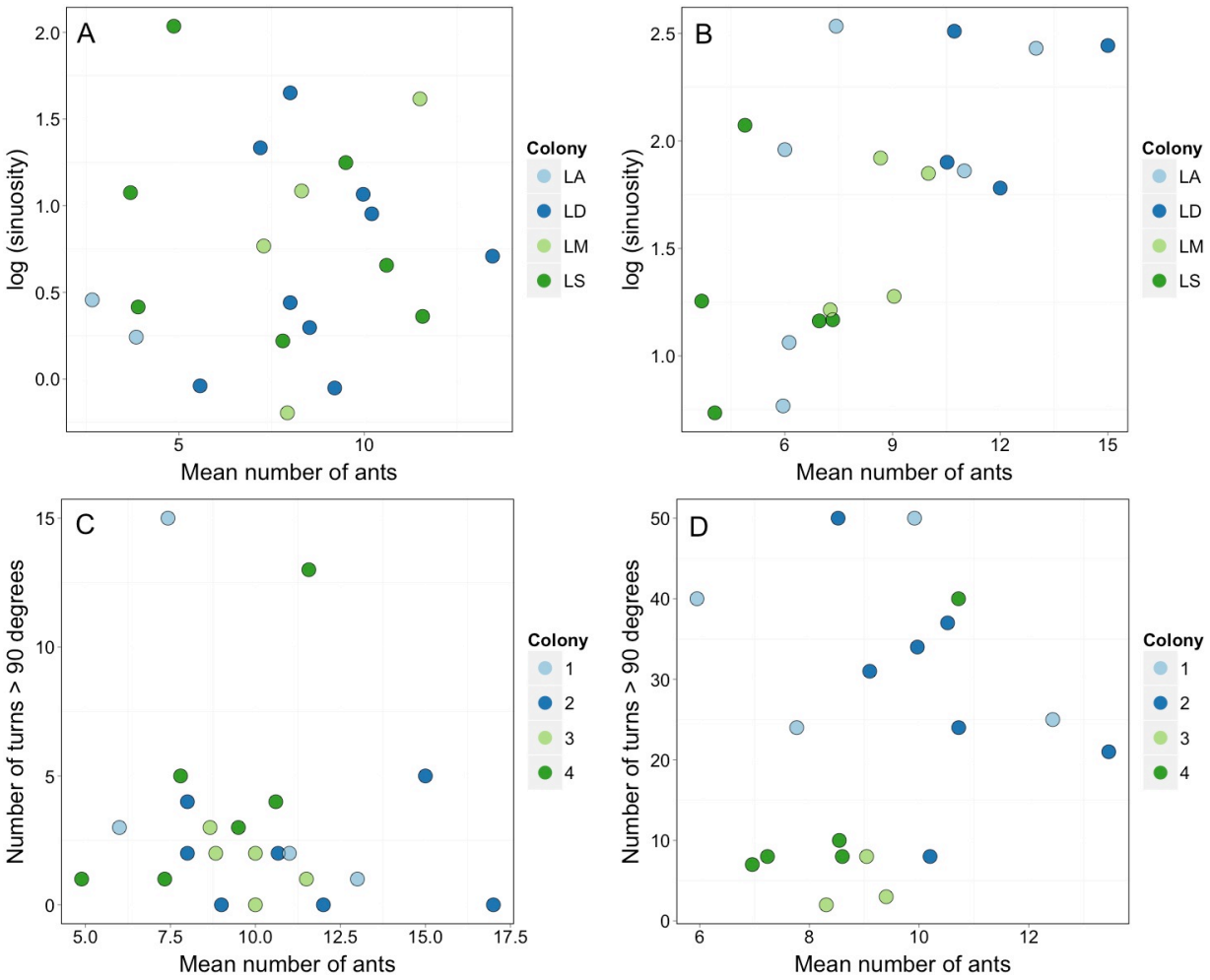


Fig. S9: **Neither sinuosity nor number of direction changes are not correlated with the mean number of ants (group size).** A and B: Sinuosity in the wall (Pearson's r = -0.18, P = 0.43) and cul-de-sac (Pearson's r = 0.25, P = 0.30), respectively. C and D: Number of direction changes in the wall (Kendall's τ = -0.19, P = 0.25) and the cul-de-sac (Kendall's τ = 0.17, P = 0.36), respectively. Blue dots are points for colonies at Arizona State University (light blue: colony LA; dark blue: colony LD) and green dots indicate colonies at Biosphere 2 (light green: colony LM; dark green: colony LS).

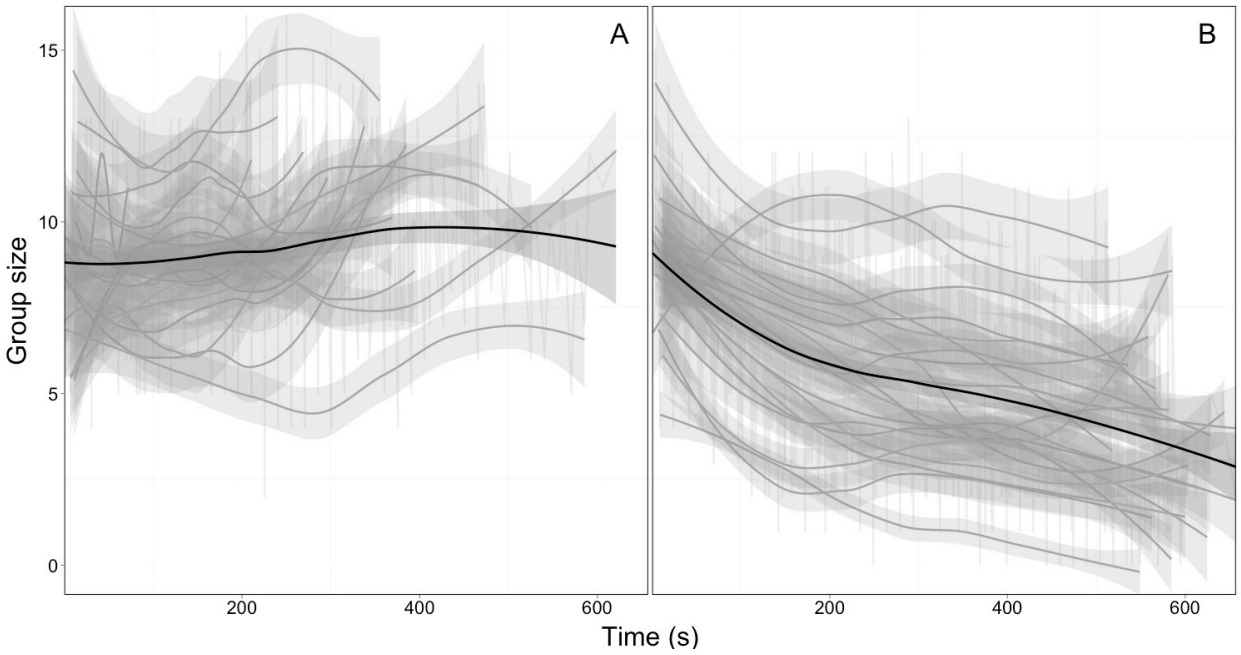


Fig. S10: **Group sizes over time of groups navigating the cul-de-sac (A) and in the trap (B).** Group size reduced in the trap dramatically, as individuals spent less time grasping the object. Groups in the cul-de-sac maintain relatively constant group sizes. Light grey, unsmoothed lines (background) show raw speed data. Grey, smooth lines show the smoothed speed for each trial and black lines show smoothed speed across trials, all computed with LOESS.