

Supplementary Materials for

Hunter-gatherer multilevel sociality accelerates cumulative cultural evolution

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The PDF file includes:

Table S1. Distribution of intracamp, intercamp, and total dyads by kinship level in forest and coastal multicamp groups.

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Table S4. Fraction of dyads classified by relatedness (close kin, extended kin, non-kin) or location (intra- and intercamp) and estimated at successive innovation level (A1/B1, A2/B2, A3/B3, crossover 1/2).

Legends for data files S1 to S4

Other Supplementary Material for this manuscript includes the following:

(available at advances.sciencemag.org/cgi/content/full/6/9/eaax5913/DC1)

Data file S1 (Microsoft Excel format). Simulation data: Time to crossover.

Data file S2 (Microsoft Excel format). Simulation data: Innovation level.

Data file S3 (.txt format). Edge list, forest group.

Data file S4 (.txt format). Edge list, coastal group.

Table S1. Distribution of intracamp, intercamp, and total dyads by kinship level in forest and coastal multicamp groups. The proportion of unweighted close kin dyads is significantly higher at intra- than inter-camp level both in the forest ($\chi^2=32.3$; $P<10^{-7}$) and coastal ($\chi^2=10$; $P=0.0016$) groups. The same is true for weighted dyads, both in the forest ($\chi^2=4841$; $P<10^{-10}$) and coastal ($\chi^2=1427$; $P<10^{-10}$) groups.

		Close kin	Extended kin	Non-kin
Unweighted dyads				
Forest	intra	39 (21.5%)	28 (15.5%)	114 (63%)
	inter	13 (4.4%)	57 (19.2%)	226 (76.4%)
	total	52 (10.9%)	85 (17.8%)	340 (71.3%)
Coast	intra	30 (11.7%)	61 (23.7%)	166 (64.6%)
	inter	7 (3.5%)	39 (19.4%)	155 (77.1%)
	total	37 (8.1%)	100 (21.8%)	321 (70.1%)
Weighted dyads				
Forest	intra	5851 (62.8%)	1846 (19.8%)	1624 (17.4%)
	inter	947 (11.5%)	1798 (21.8%)	5489 (66.7%)
	total	6798 (38.7%)	3644 (20.8%)	7113 (40.5%)
Coast	intra	3658 (35.1%)	2623 (25.1%)	4157 (39.9%)
	inter	293 (6.1%)	848 (17.7%)	3644 (76.2%)
	total	3951 (26%)	3472 (22.8%)	7801 (51.2%)

Table S2. Distribution of intracamp, intercamp, and total dyads by sex composition in forest and coastal multicamp groups. M-M: male-male; F-F: female-female; M-F: male-female. In the case of unweighted dyads, the predicted inter-, intra-, and total distribution was calculated as the expected proportions under the assumption of random inter- and intra-camp association between all males and females in each group (forest and coastal), and for this reason the total number of predicted dyads is larger than the observed number. The predicted distribution of weighted dyads is an extrapolation of the proportions of the observed sex distribution of unweighted dyads. For this reason, the total number of predicted and observed dyads is the same. Test statistics were derived from chi-square tests comparing observed and predicted distributions.

			M-M	F-F	M-F	Test statistics	
Unweighted dyads							
Forest	Intra	observed	34	55	92	$\chi^2=0.96$; P=0.62	
		predicted	69	86	154		
	Inter	observed	64	87	145	$\chi^2=0.56$; P=0.76	
		predicted	231	292	546		
	Total	observed	98	142	237	$\chi^2=1.03$; P=0.60	
		predicted	300	378	700		
Coast	intra	observed	80	46	131	$\chi^2=0.23$; P=0.89	
		predicted	89	56	159		
	inter	observed	68	38	95	$\chi^2=2.3$; P=0.31	
		predicted	101	80	181		
	total	observed	148	84	226	$\chi^2=2.1$; P=0.36	
		predicted	190	136	340		
	Weighted dyads						
	Forest	intra	observed	1636	2008	5677	$\chi^2=228.9$; P<10 ⁻¹⁰
predicted			1751	2832	4738		
inter		observed	2444	1436	4354	$\chi^2=367.7$; P<10 ⁻¹⁰	
		predicted	1780	2420	4034		
total		observed	4080	3444	10031	$\chi^2=301.5$, P<10 ⁻¹⁰	
		predicted	3822	4815	8917		
Coast	intra	observed	2326	1846	6267	$\chi^2=230.5$; P<10 ⁻¹⁰	
		predicted	3250	1868	5321		
	inter	observed	1689	869	2227	$\chi^2=2.47$; P=0.29	
		predicted	1619	905	2261		
	total	observed	4015	2715	8494	$\chi^2=71.6$, P<10 ⁻¹⁰	
		predicted	4343	3109	7772		

Table S3. Time to crossover as a function of camp size, network type, and transmission mode. Each time to crossover (t) is the mean value of 1000 simulations. Fully connected networks, all neighbours: innovations transmitted to all neighbours (i.e. all nodes). Real network, all neighbours: innovations transmitted only to nodes directly linked to innovating dyad, with network topology as in the real Agta camps or multi-camp groups. Real network, close kin only: innovations transmitted only to close kin individuals directly linked to innovating dyad, with network topologies also as in real Agta groups. The two columns with tests statistics represent the results of Wilcoxon rank tests between the adjacent columns. Significant tests ($P < 0.05$) shown in bold. Also shown are the 95% confidence interval of the difference between group means.

Camp size	Time to crossover (t)				
	Fully connected, all neighbours		Real network, all neighbours		Real network, close kin only
18	1545.4	95% CI: [-7, 151]; $P=0.07$	1460.1	95% CI: [600, 727]; $P < 10^{-15}$	680.8
26	1035.2	95% CI: [-43, 63]; $P=0.71$	1026.2	95% CI: [428, 518]; $P < 10^{-15}$	475.7
33	835.4	95% CI: [129, 211]; $P < 10^{-10}$	640.4	95% CI: [273, 336]; $P < 10^{-15}$	233.5
36	746.6	95% CI: [-28, 49]; $P=0.61$	727.5	95% CI: [420, 488]; $P < 10^{-15}$	169
39	650.5	95% CI: [-46, 23]; $P=0.53$	659.4	95% CI: [388, 446]; $P < 10^{-15}$	142.5
48	558	95% CI: [33, 89]; $P < 10^{-4}$	503.3	95% CI: [246, 295]; $P < 10^{-15}$	128.8
Multi-camp group					
53 (forest)	509.5	95% CI: [250, 295]; $P < 10^{-15}$	177.3	95% CI: [27, 40]; $P < 10^{-15}$	60.7
37 (coast)	698.7	95% CI: [124, 189]; $P < 10^{-15}$	516.7	95% CI: [367, 424]; $P < 10^{-15}$	99

Table S4. Fraction of dyads classified by relatedness (close kin, extended kin, non-kin) or location (intra- and intercamp) and estimated at successive innovation level (A1/B1, A2/B2, A3/B3, crossover 1/2). Data are from simulations (N=1000) based on real hunter-gatherer network, and transmission of innovations to close kin only.

Camp	Innovation Level	Close kin	Extended kin	Non-kin	Intra-camp	Inter-camp
Forest	A1/B1	0.536	0.172	0.292	0.695	0.305
	A2/B2	0.502	0.187	0.311	0.656	0.344
	A3/B3	0.461	0.197	0.342	0.658	0.342
	Crossover 1/2	0.364	0.228	0.408	0.522	0.478
Coast	A1/B1	0.311	0.198	0.491	0.636	0.364
	A2/B2	0.281	0.186	0.532	0.570	0.420
	A3/B3	0.277	0.213	0.510	0.637	0.363
	Crossover 1/2	0.228	0.173	0.600	0.612	0.389

Data file S1. Simulation data: Time to crossover.

Data file S2. Simulation data: Innovation level.

Data file S3. Edge list, forest group.

Data file S4. Edge list, coastal group.