

Population-specific social dynamics in chimpanzees

Edwin J. C. van Leeuwen, Katherine A. Cronin, Daniel B. M. Haun

Supporting Information Appendix: FIGURES & TABLES

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Figure S1. Proximity (means per group per year). The absence of significant interaction between population and year ($\chi^2 = 0.11$, $df = 6$, $p = 0.86$) corroborates the temporal consistency of variation in social culture across the four neighboring populations of chimpanzees at Chimfunshi. Medians are represented by the bold, horizontal lines within the boxes. The boxes represent the interquartile range (IQR), the vertical lines attached to the boxes represent $Q1-1.5$ IQR (lower) and $Q3+1.5$ IQR (upper).

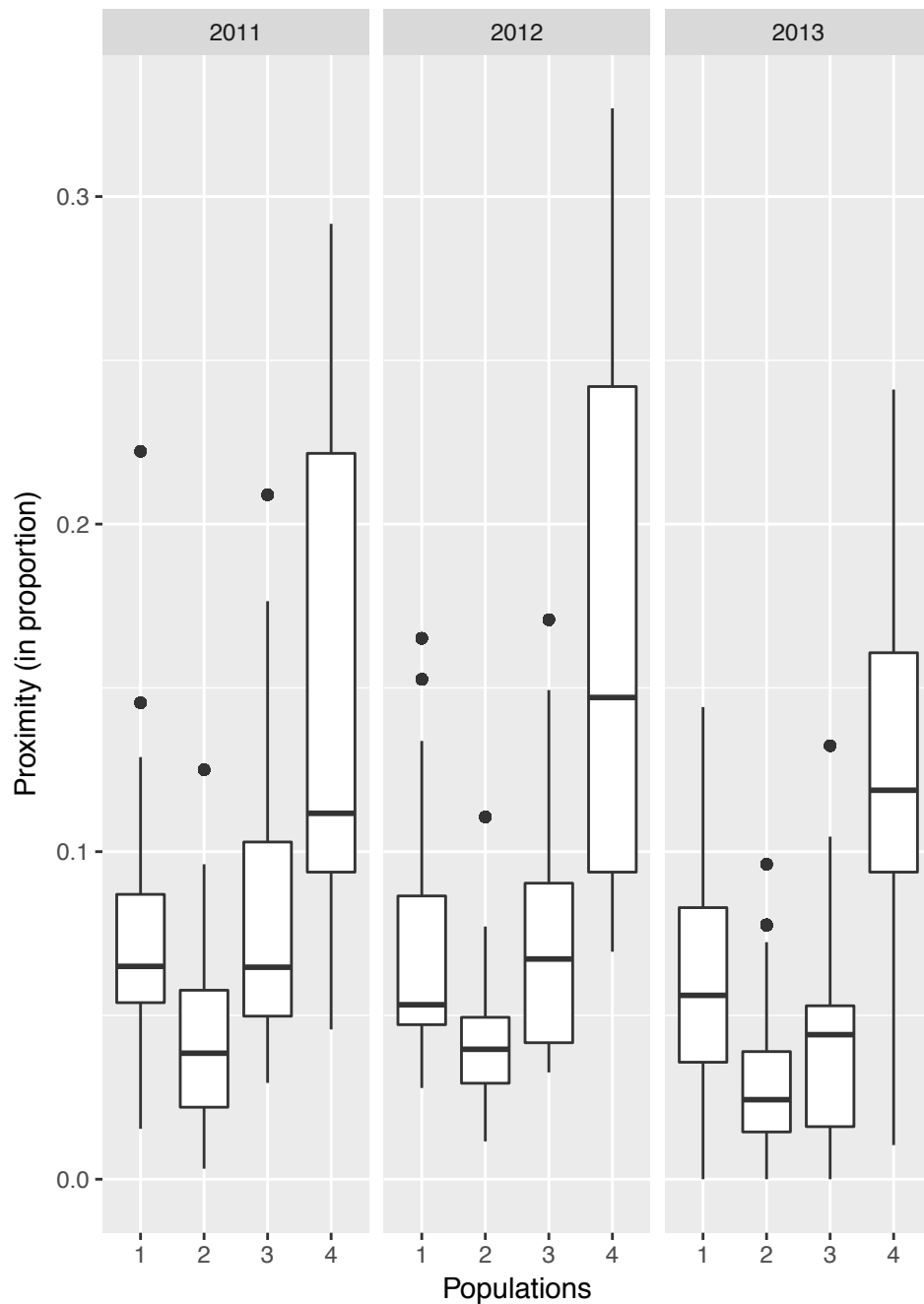


Figure S2. Grooming (means per group per year). The absence of significant interaction between population and year ($\chi^2 = 2.89$, $df = 6$, $p = 0.29$) corroborates the temporal consistency of variation in social culture across the four neighboring populations of chimpanzees at Chimfunshi. Medians are represented by the bold, horizontal lines within the boxes. The boxes represent the interquartile range (IQR), the vertical lines attached to the boxes represent $Q1-1.5$ IQR (lower) and $Q3+1.5$ IQR (upper).

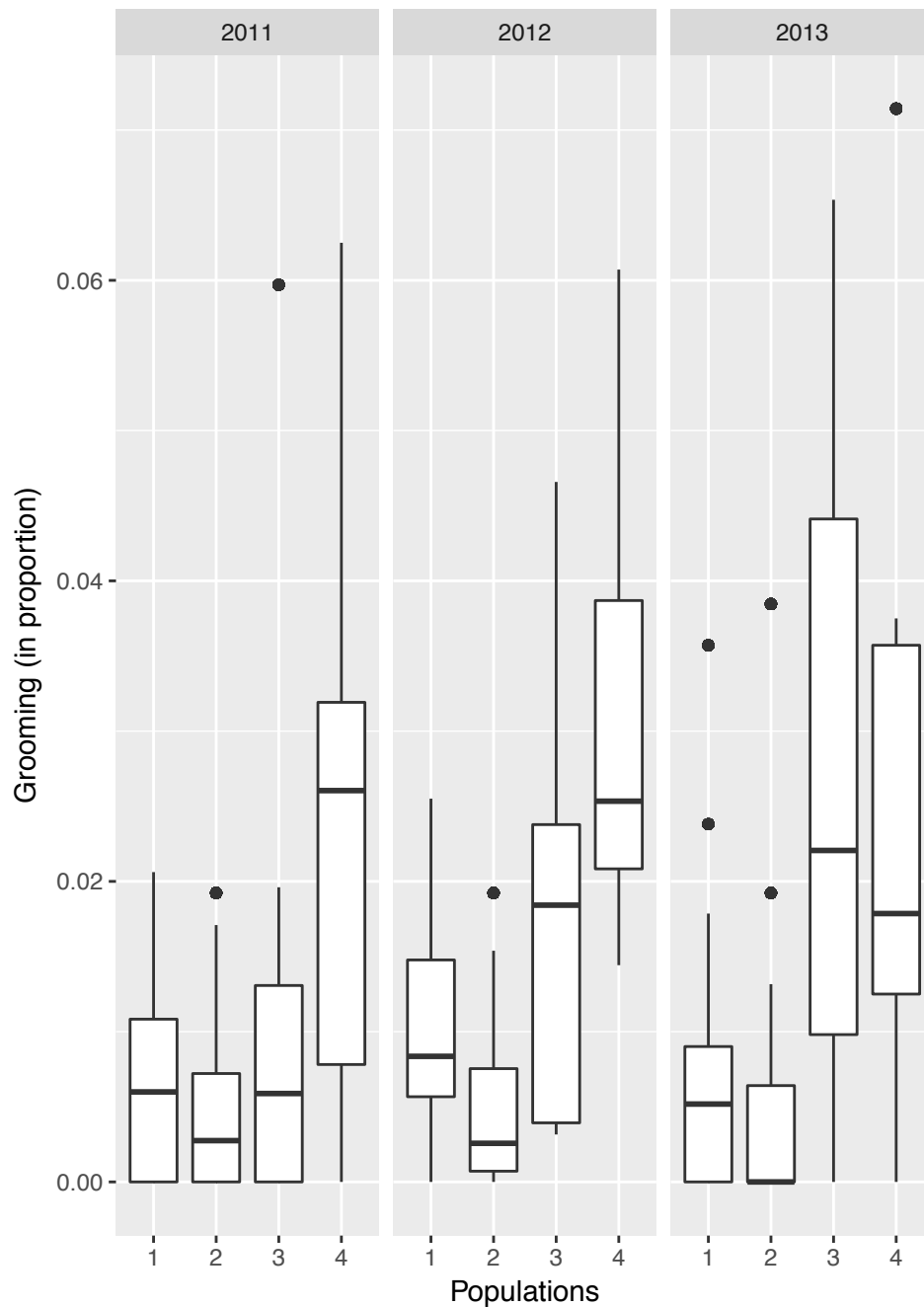


Figure S3. Social networks for the two chimpanzee populations matched in demographics and subspecies ($a =$ population 3; $b =$ population 4), based on twice-weight proximity association indices ($x/(x + 2y_{AB} + y_A + y_B)$). Nodes represent individuals, the lines (edges) between nodes are weighted by the strength of their association. Edge-weights are comparable across populations; edge-weights < 0.1 not shown for either population to improve clarity. Nodes are sized based on their weighted strength (). Nodes representing females are green, nodes representing males are orange, with the exception of the alpha males, which are blue.

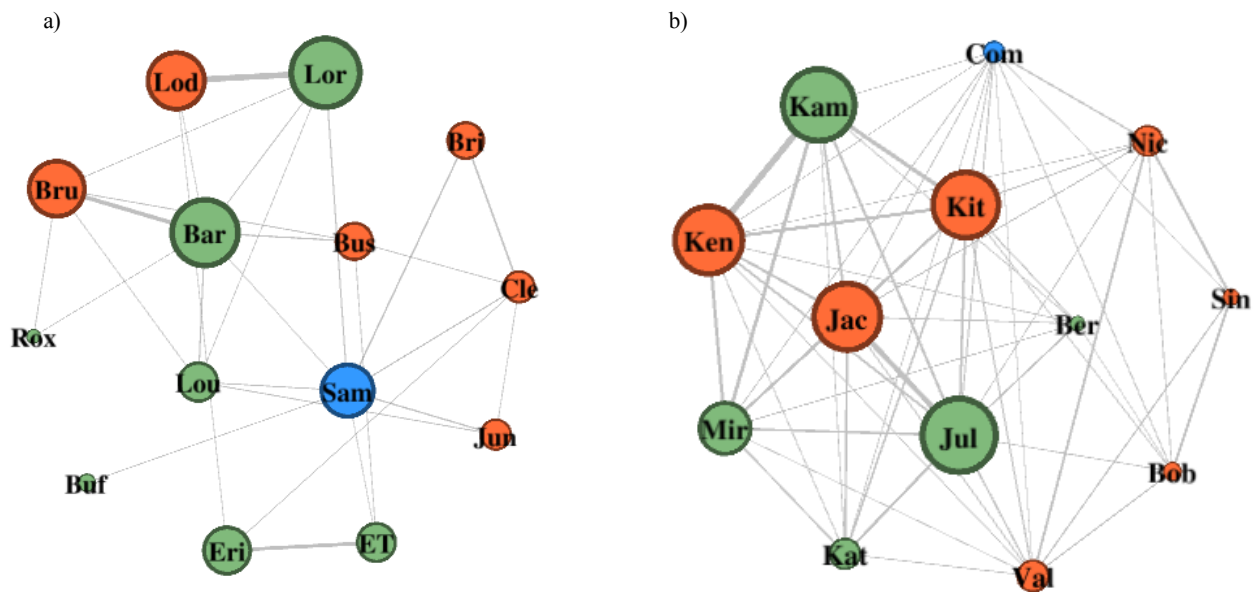


Figure S4. Social networks for the two chimpanzee populations matched in demographics and subspecies (a = population 3; b = population 4), based on twice-weight grooming association indices ($x/(x + 2y_{AB} + y_A + y_B)$). Nodes represent individuals, the lines (edges) between nodes are weighted by the strength of their association. Edge-weights are comparable across populations; edge-weights < 0.1 not shown for either population to improve clarity. Nodes are sized based on their weighted strength (\cdot). Nodes representing females are green, nodes representing males are orange, with the exception of the alpha males, which are blue.

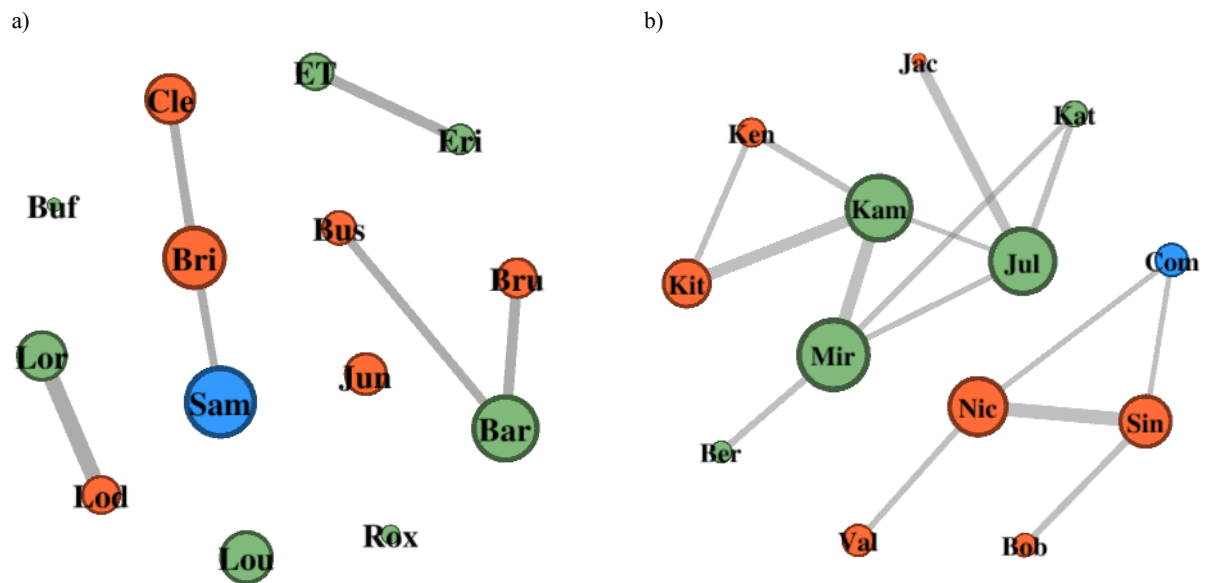


Figure S5. Aerial view of the habitats of the four chimpanzee populations under study (at the Chimfunshi Wildlife Orphanage). Numbers in circles represent population identity.

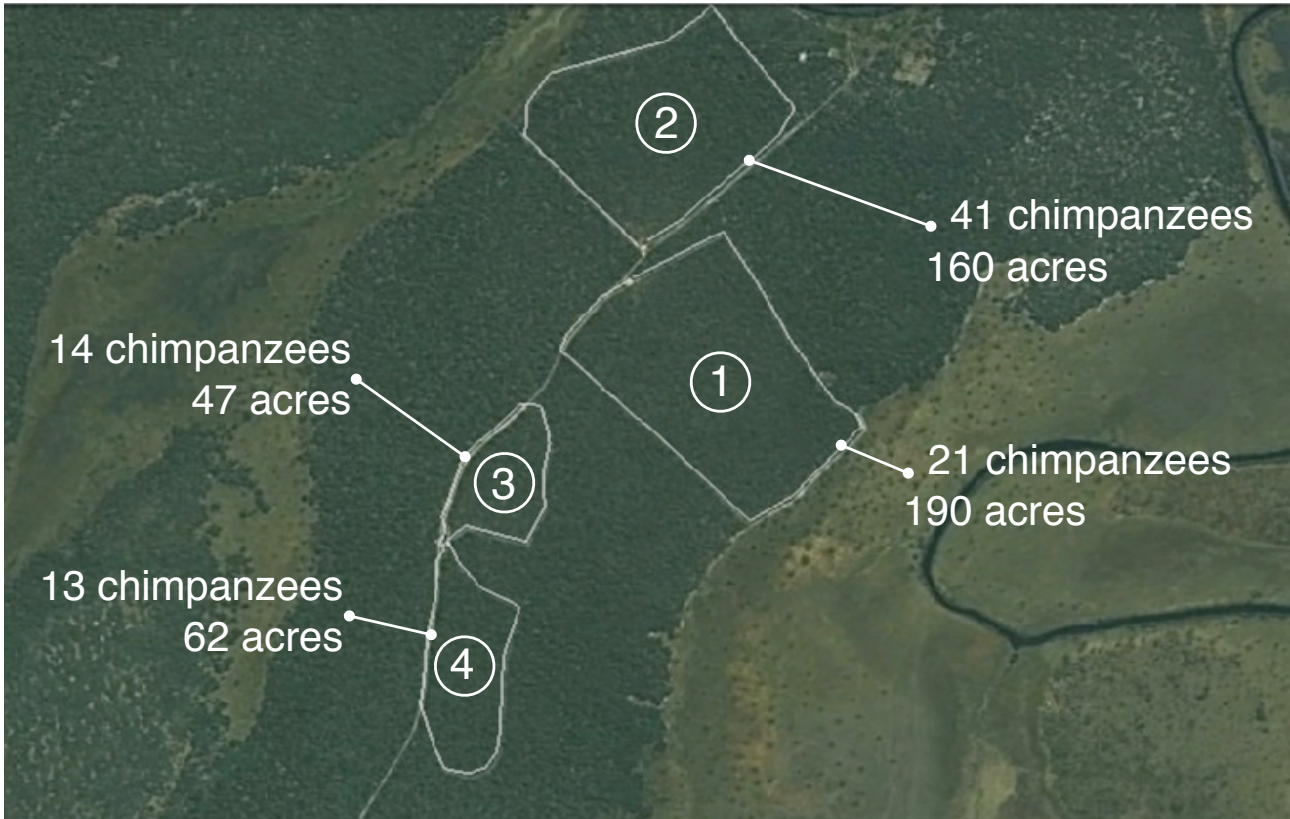


Table S1. Sociality expressed in the mean number of individuals congregating during focal follow sessions of our random sampling procedure, as conducted at four neighboring populations of semi-wild chimpanzees at the Chimfunshi Wildlife Orphanage Trust, Zambia.

Population	Population size	Party size (mean±sd)
1	24	6.20±1.65
2	45	8.96±2.57
3	14	6.03±1.49
4	13	8.15±1.74

Table S2. Demographic details of the chimpanzees under study.

Population	Subject	Age*	Sex	Dam	Origin	Subspecies
1	Pal	32,0	male	unknown	wild	schweinfurthii
1	Booboo	31,0	male	unknown	wild	schweinfurthii
1	Girly	31,0	female	unknown	wild	schweinfurthii
1	Tobar	31,0	male	unknown	wild	verus
1	Rita	30,0	female	unknown	wild	schweinfurthii
1	Tara	30,0	male	unknown	wild	schweinfurthii
1	Ingrid	22,0	female	Liza	captive	schweinfurthii
1	Brenda	17,7	female	Bella	captive	schweinfurthii
1	Genny	16,0	female	Girly	captive	schweinfurthii
1	Renate	16,0	female	Rita	captive	schweinfurthii
1	Bob	11,9	male	Big Jane	captive	schweinfurthii
1	Gerard	10,9	male	Girly	captive	not determined
1	Ilse	10,8	female	Ingrid	captive	not determined
1	Regina	7,3	female	Renate	captive	not determined
1	Rusty	6,4	male	Rita	captive	not determined
1	Chrissie	6,3	female	Cleo	captive	not determined
1	Innocentia	6,2	female	Ingrid	captive	not determined
1	BJ	5,8	female	Big Jane	captive	not determined
1	Gonzaga	5,2	male	Genny	captive	not determined
1	Irene	1,1	female	Ingrid	captive	not determined
1	Rachel	0,7	female	Renate	captive	not determined
2	Noel	36,0	female	unknown	wild	schweinfurthii
2	Donna	29,0	female	unknown	wild	schweinfurthii
2	Coco	28,0	female	unknown	wild	schweinfurthii
2	Little Jane	28,0	female	unknown	wild	schweinfurthii
2	Maggie	27,0	female	unknown	wild	schweinfurthii
2	Misha	25,0	female	unknown	wild	schweinfurthii
2	Dora	24,0	female	unknown	wild	schweinfurthii
2	Pan	24,0	male	unknown	wild	schweinfurthii
2	Pippa	24,0	female	unknown	wild	schweinfurthii
2	Trixie	23,0	female	unknown	wild	schweinfurthii
2	Zsabu	23,0	male	unknown	wild	schweinfurthii
2	Diana	22,0	female	unknown	wild	schweinfurthii
2	Masya	22,0	female	unknown	wild	schweinfurthii
2	Violet	22,0	female	unknown	wild	schweinfurthii
2	Little Judy	18,0	female	Little Jane	captive	not determined
2	Dolly	16,6	female	Dora	captive	schweinfurthii

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2	Carol	16,4	female	Coco	captive	not determined
2	Nikkie	15,7	female	Noel	captive	schweinfurthii
2	Mikey	15,0	male	unknown	wild	schweinfurthii
2	Tess	15,0	female	Tina	captive	not determined
2	Tilly	12,2	female	Trixie	captive	not determined
2	Maxine	11,8	female	Misha	captive	not determined
2	David	11,5	male	Diana	captive	not determined
2	Debbie	11,3	female	Donna	captive	not determined
2	Claire	10,8	female	Coco	captive	not determined
2	Doug	10,2	male	Dora	captive	not determined
2	Nina	10,0	female	Noel	captive	not determined
2	Vis	8,9	male	Violet	captive	not determined
2	Daisey	8,4	female	Diana	captive	not determined
2	Mary	7,4	female	Masya	captive	not determined
2	Long John	7,3	male	Little Judy	captive	not determined
2	Max	6,6	male	Misha	captive	not determined
2	Little Jenkins	6,2	female	Little Jane	captive	not determined
2	Moyo	5,6	male	Maggie	captive	not determined
2	Dizzy	5,4	female	Diana	captive	not determined
2	Charity	5,2	female	Carol	captive	not determined
2	Little Jones	2,7	male	Little Jane	captive	not determined
2	Little Jacky	1,0	male	Little Judy	captive	not determined
2	Martin	0,9	male	Misha	captive	not determined
2	Danny	0,9	male	Dora	captive	not determined
2	May	0,4	female	Maggie	captive	not determined
3	Buffy	28	female	unknown	wild	schweinfurthii
3	Sampie	21	male	unknown	wild	schweinfurthii
3	Clement	20	male	unknown	wild	schweinfurthii
3	Brian	19	male	unknown	wild	schweinfurthii
3	Barbie	18	female	unknown	wild	schweinfurthii
3	E.T.	18	female	unknown	wild	schweinfurthii
3	Roxy	18	female	unknown	wild	schweinfurthii
3	Junior	18	male	unknown	wild	schweinfurthii
3	Lori	18	female	Liza	captive	not determined
3	Louise	16	female	unknown	wild	schweinfurthii [#]
3	Bussie	9	male	Barbie	captive	not determined
3	Erika	7	female	E.T.	captive	not determined
3	Bruce	3,3	male	Barbie	captive	not determined
3	Lods	2,8	female	Lori	captive	not determined
4	Nicky	22	male	unknown	wild	schweinfurthii

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4	Bobby	20	male	unknown	wild	schweinfurthii
4	Sinkie	19	male	unknown	wild	schweinfurthii
4	Julie	19	female	unknown	wild	schweinfurthii
4	Kambo	17	female	unknown	wild	schweinfurthii
4	Kathy	14	female	unknown	wild	schweinfurthii
4	Val	13	male	unknown	wild	schweinfurthii
4	Berta	13	female	unknown	wild	schweinfurthii [#]
4	Miracle	12,7	female	Maggie	captive	schweinfurthii
4	Commander	12	male	unknown	wild	schweinfurthii
4	Kit	8	male	Kambo	captive	not determined
4	Jack	4,9	male	Julie	captive	not determined
4	Ken	1,8	male	Kambo	captive	not determined

* At the end of the study (March 2013)

Conflicting results, possibly “verus”

Table S3. Results of permutation tests comparing social network attributes across the four study populations. P-values correspond to probability that populations are distinct with regard to attribute. P-values in bold represent statistically significant results after Bonferroni-Holm corrections.

Social network attribute	Proximity (p-values)	Grooming (p-values)
Strength	0.518	0.052
Eigenvalue centrality	0.015	<0.0001
Reach	0.767	<0.0001
Clustering coefficient	<0.0001	0.061
Affinity	<0.0001	<0.0001

Table S4. Social network attribute comparisons across the two closely matched (in terms of sex, age, origin, subspecies, and population size) study populations. P-values correspond to probability that populations are distinct with regard to attribute.

Social network attribute	Proximity (<i>p</i>-values)	Grooming (<i>p</i>-values)
Strength	0.353	0.999
Eigenvalue centrality	0.889	0.957
Reach	0.998	0.001
Clustering coefficient	0.006	0.005
Affinity	<0.0001	0.131

Table S5. Clustering, modularity (based on eigenvector method from Newman (1), calculated from gregariousness), and social differentiation based on proximity data for each population.

Population	Clustering Coefficient	Modularity	Social differentiation
1	0.1444	0.354	1.369
2	0.0954	0.307	1.549
3	0.1079	0.281	0.793
4	0.2877	0.180	0.544

Table S6. Clustering, modularity (based on eigenvector method from Newman (1), calculated from gregariousness), and social differentiation based on grooming data for each population.

Population	Clustering Coefficient	Modularity	Social differentiation
1	0.05	0.576	2.716
2	0.03	0.668	4.193
3	0.12	0.446	1.545
4	0.25	0.395	1.169

Table S7. Individual social network attributes for weighted networks, used for assessing individuals' social integration as measured by closeness (1-meter proximity) and grooming.

Measure	What it means	Formula
Strength	How connected individuals are to other individuals	$s_i = \sum_j a_{ij}$
Eigenvalue centrality	Embeddedness in the group, in terms of number and strength of connections	$e_i = (\text{first eigenvector of } a)_i$
Reach	Overall strength of neighbors	$r_i = \sum_j a_{ij} \cdot s_j$
Clustering coefficient	How well connected neighbors are to each other	$c_{ij} = \frac{\sum_j \sum_k a_{ij} \cdot a_{ik} \cdot a_{jk}}{\max(a_{jk}) \cdot \sum_j \sum_k a_{ij} \cdot a_{jk}}$
Affinity	Weighted mean of strength of neighbors	$f_i = r_i / s_i$

References

1. Newman MEJ (2006) Modularity and community structure in networks. *Proc Natl Acad Sci U S A* 103(23):8577–82.