The co-evolution of parochial altrusim and war

Jung-Kyoo Choi (Kyungpook National University)
Samuel Bowles (Santa Fe Institute, University of Siena)

Science 318, 2007

The Problem

- Altruism – conferring benefits on other members of one's group at a cost to oneself -- and parochialism --favoring ethnic, racial or other insiders over outsiders --are commonly observed human behaviors that are well documented in experiments (insider favoritism is far from universal, however).
- Parochial altruism is puzzling from an evolutionary perspective because both reduce the actor's payoffs (whether fitness or material well-being) by comparison to other group members who eschew these behaviors.
- Biologists and economists generally interpret th altruistic behaviors as self interest with a long t (repeated games) or the result of kin selectio one is closely related, genetically)

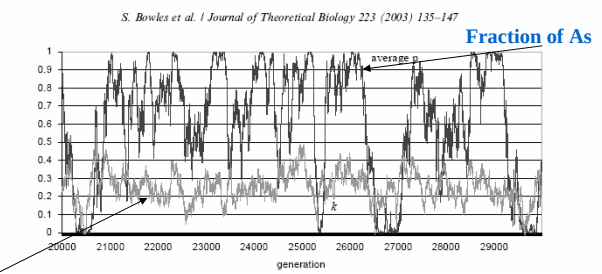
We consider an alternative explanation:
parochial altruistic behavior contributes to success in between-group competition.

- Barring exceptional circumstances, however, between-group selection pressures are unlikely to be decisive.
- We explore the possibility that while within-group altruism and parochialism could not have evolved singly, they could have co-evolved, each providing the exceptional circum-stances allowi for the evolutionary success of the other.
- This may help explain why other-regarding prefere conditional on group membership, and may inv well as positive sentiments toward the well-bein
- A key challenge is to model between group coc competition so that conflict emerges endogeno

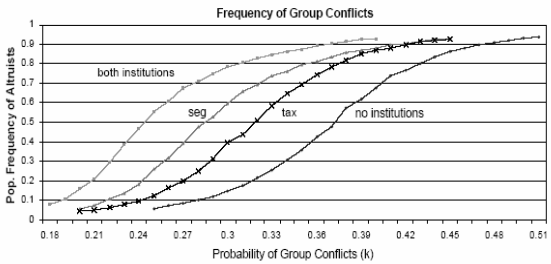
Recent contributions have shown that insider favoritism and other parochial practices could evolve if

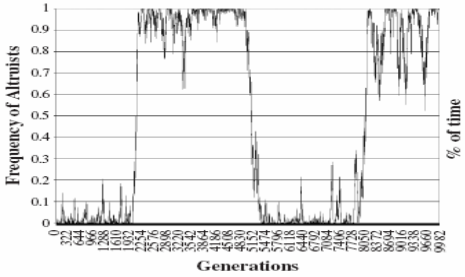
- they facilitate generalized exchange (Yamagishi 2003);
- support the higher payoffs that occur when people with similar norms interact (McElreath, Boyd, and Richerson 2003);
- coordinate the efficient selection of particular contracts (Axtell, Epstein, and Young, 2001); and
- prove communication among group members or reduce group size so as to facilitate informal contract enforcement. (Bowles and Gintis 2004).

Previous papers: war facilitates the evolution of altruism in an inter-demic selection model (Bowles, Choi and Hopfensitz,J.*Theoretical Biology* 2003)



Limited migration, small group size, and within group clustering by type have similar effects.





- Kin altruism does not explain most generosity, even within families (Bowles and Dorrit Posel, "Genetic relatedness predicts South African migrants' remittances to their families" *Nature*, **434** (2005))
- Frequency of war may depend on the population fraction of altruists (Bowles and Choi, Co-evolution of love and hate, 2005)
- War may have been frequent enough during the Pleistocene to support the evolution of altruism (Bowles, "Group competition, reproductive leveling, and the evolution of altruism" *Science*, **314** (2006)
- But why are humans so uniquely warlike?

Consider a model a population in which individuals may be either Altruistic or Not and either Tolerant or aggressive (Parochial) towards other groups (these are behaviors, not preferences)

	Parochial	Tolerant
Altruist	PA	TA
Not	NP	NT

- A's contribute to the fitness of other group members at a cost to themselves
- Only the PA's fight wars.
- P's induce hostilities and forgo the benefits of peaceful interactions with other groups enjoyed by the T's

Four behavioral types; two selection processes

	P	T
A	PA	TA
N	NP	NT

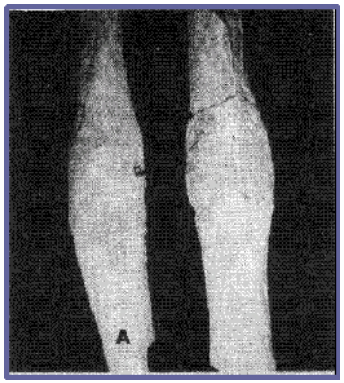
Within group: public goods game with benefits *b* shared equally among n members and costs *c* to the contributor

Between groups: (a) hostile conflict or (b) trade, insurance, exploiting buffer zones

Preview of main results of this study: from game-theoretic analysis and agent-based simulations.

- Under conditions approximating those experienced by our Late Pleistocene (pre12k ybp) ancestors, groups with a large fraction of parochial altruists could emerge, and that such groups would frequently engage in and win hostile conflicts with other groups.
- We recover a stationary distribution and transition matrix of the underlying stochastic Markov process from a very large number of iterations of the model.
- It indicates that independent of initial conditions, neither parochialism nor altruism is viable singly; but that warfare, altruism and parochialism could have evolved jointly.
- We begin with a review of likely late Pleistocene conditions

Deme extinction and survival: climate

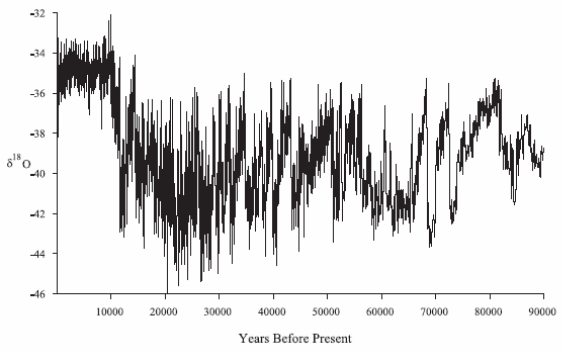


Healed previous arm fractures (Wadi Halfa, 12-14 kybp)

"…towards the end of the Pleistocene as anatomically modern humans began to emerge, group extinction rates could have risen dramatically as needy bands of well armed hunters, strangers lacking established patterns of political interaction frequently collided, either locally or in the course of long distance migration."

Christopher Boehm

Empirical plausibility: Pleistocene and Holocene Temperature Variation



oxygen isotope signatures of a high resolution ice core record from Greenland (17,496 observations, reported in Ditlevsen et al, 1996, and kindly provided by the senior author). Surface temperature scales approximately linearly with the $\delta^{18}O$. Differences in (C) temperature are about 1.2 times the difference in the signal shown the figure.

Table . Warfare in Hunter Gatherer Societies (percent of all N groups with each degree of frequency)

Source	Continuous	Frequent	Rare	N	Comment
Otterbein	20	50	30	10	
Kelly based on Ross	24	48	28	25	external and internal;
Ember	65	25	10	31	including ambush

Note: Continuous means (row 2): both internal or external warfare occurs 'at least every five years,' and one of these occurs 'at least yearly; (row 3)'more than once every two years'

- Early between-group violence was probably closer to the lethal encounters that occur on the boundaries of chimp territories than to modern warfare. (Wrangham, Kelly)
- No correlation with population density, food storage or intergroup mobility (Keeley, Kelly)
- Ave territory lost by losers (per generation, Kelly) 16 %

Archeological evidence: % of deaths due to violence among hunter-gather peoples

A piercing wound in the left innominate (hip) Southern California (Lambert (1997)

Figure S4. Fraction of violent deaths: archeological evidence .

Site (source):page	Date	%	
N. British Columbia(*37*)	3500BC-1774AD	21.8	Incl North and South, all dates
Nubia (*35*)	12,000 ybp	24.1	Adults (site 117 and 'Qadan')
Ukraine (Vasylivka) (*38*)	Mesolithic	15.9	Based on (*39*)
S. California(*36*)	3500BC-1380AD	7.5	Excluding later 'chiefdom'
Central California (*40*):183	1500BC-500AD	≥5.0	Points embedded in skeletons only
Denmark (Vedbaek) (*41*)	4100BC	13.6	"affluent foragers"
Sweden (Sketeholm I) (*41*)	4300BC	≥3.8	Points embedded in skeletons only

19 stone points were embedded in or associated with the individual on the left (Wadi Halfa burial, 12-14k ybp)

War in hunter gatherer society: rare archeological evidence

- Near Wadi Halfa in the Sudan 58 skeletons dating from 12-14k ybp were found along with 189 flaked stone points and barbs of spears or projectiles, many of which were lodged in the vertebral column, chest cavity and skull.
- The deceased had been large savannah mammal hunters and occasional fishers.
- Forty five percent of the adult females, 48 percent of the adult males and 36 percent of the children appear to have died violent deaths, the children apparently by execution. Many of the adults had healed fractures that most likely were the result of earlier non-lethal violence.
- Small groups of individuals were buried at the same time; the site appears to have been used over many generations.
- The archeologist who excavated the site (Wendorf) remarked: *Violence must have been a very common event in Nubia at this time, if we are to consider this graveyard as typical. There appears to be no significant distinction between males, females and children in their exposure to violent death; evidently all members of the group were involved in conflict, not just the adult males.*

Intergroup conflict among ancestral humans

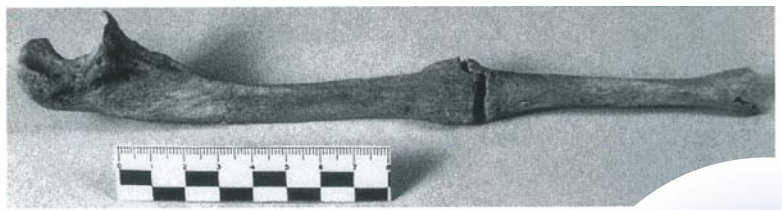


Fig. 2. Ununited fracture, midshaft, left ulna. Female, aged 30–50 years

Archeological and ethnographic evidence suggests that among late Pleistocene and early Holocene foragers one-seventh of the deaths may have been due to between group conflict, an order of magnitude greater than among Europeans during the 20th century (Sources detailed in the *Supporting Online Materials* of Bowles, *Science*, 8 Dec 2006)

The benefits of peaceful relations with others; costs of outsider hostility

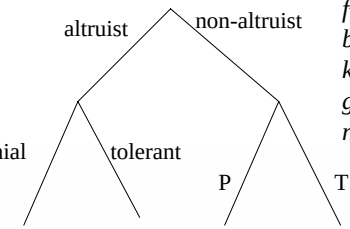
Long distance trade, division of labor

More effective co-insurance and consumption smoothing (Wiessner, Kelly, Nettle, may have been enhanced by local climate variability)

More effective use of resources larger carrying capacity due to smaller buffer zones (LeBlanc)

Group size benefits favor tolerance of immigrants

Within-group interactions: selection against A's and Ps



f^A, f^P fraction A, P
b, c benefits costs of altruism
k probability of interaction
g benefit of non-hostile interation
n group size

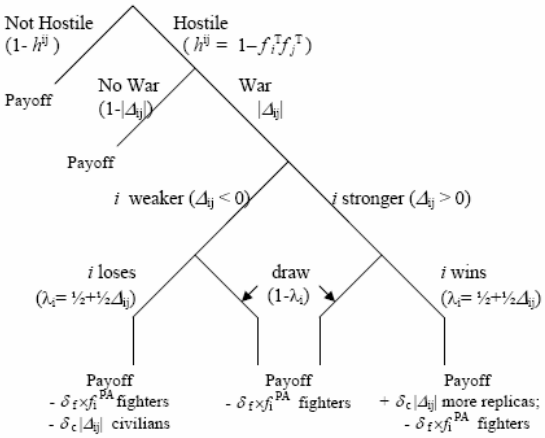
Payoffs to the Four Types

	Parochials	Tolerant
Altruist	$bf_i^A - c$	$bf_i^A - c + g\, n_j f_j^T$
Not Altruist	bf_i^A	$bf_i^A + g\, n_j f_j^T$

Dominant strategy

Expected Payoffs to Four Behavioral Types in the Absence of Hostile Between-Group Interactions. Note: All players receive the benefit of the public good, bf^A; tolerant players of both types receive the benefits of non-hostile group interaction, $kg/n(1-f^P)$. Altruists of both types pay the cost of the public good, c. As a result, for altruists of either type, switching to non-altruist is a dominant strategy, and for parochials of either type switching to tolerant is dominant. Thus the parochial altruists payoff is thus less than each of the other three types.

Between-group interaction game tree: frequent interactions may favor APs



f^{AP}, f^P
Δ =
of

Review so far: Four behavioral types; two selection processes (multi-level selection)

	P	T
A	PA	TA
N	NP	NT

Within group selection:
a) N's payoffs exceed A's
b) in absence of war, T's payoffs exceed P's

Inter-groups interactions: (a) hostile conflict or (b) trade, insurance, exploiting buffer zones

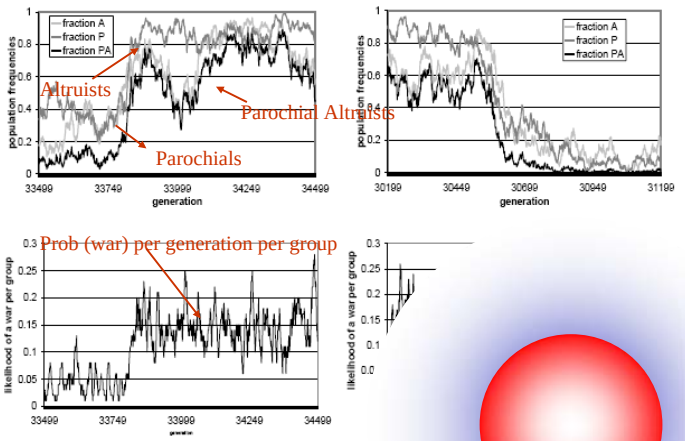
Between group selection: Group with fewer PA

- Within group selection favors N over A and ir
inter-group conflict favors T over N; between g
PA over other behaviors.
- Analytical solutions of the underlying Markov pı
possible (or informative) so we use agent based simu

The model parameter values
(per generation, where relevant)

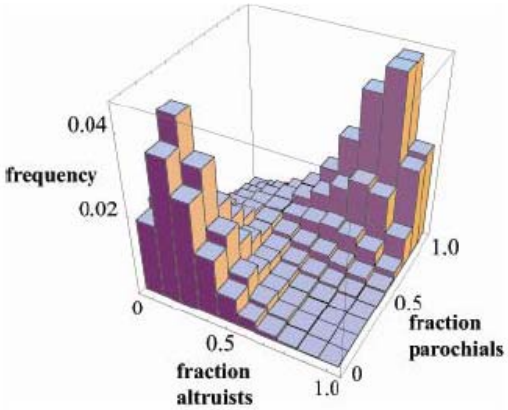
# of groups = 20
Group effective size =26
Mutation =0.005
Between group island (random) migration =0.2
Benefits and costs: b=0.02, c=0.01, baselir
Benefit from peaceful interaction: g=0.0
Between group interactions per generati
Fitness loss of losing group from war δ
Fighters' mortality in warfare = 0.14

The co-evolution of altruism, parochialism, and war



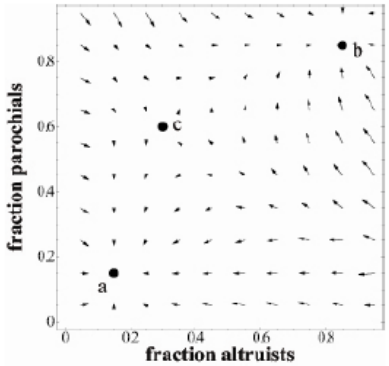
Shown: Transitions from selfish peace to Altruistic war (and back)

Limit Distribution from Long-term dynamics



The height of the bars gives the fraction of a very long period in which we observe the indicated pair of population level frequencies of altruists and parochials in the population. These frequencies give the stationary distri
underlying
Markov
our mo
recove
numbe
of the
seeds a
state spac

Explicit dynamics recovered from the underlying Markov process



Each vector represents the expected change at each state The relative length of each arrow reflec
relative magni
probability f
so the long
the higher
probability

Are the simulation results plausible?

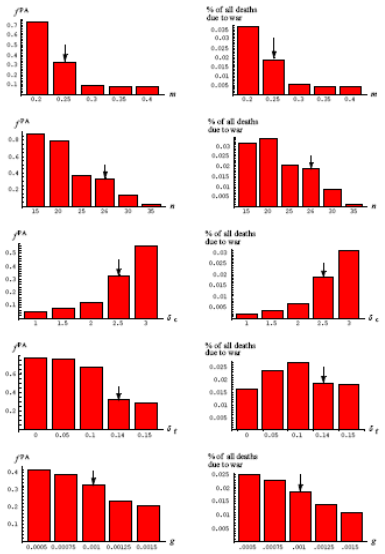
Table S.1 Inter-group interactions. Entries refer to averages per generation over 50,000 generations using the benchmark parameters.

	Fraction of total pop killed in war (all periods)	Fraction of groups engaged in war (ave. all periods)	Fraction of weaker group killed (if war)	Fraction of stronger group killed (if war)	Ts' inter-gro
All states	0.015	0.071	0.339	0.0	
States near **b** $f^A > 0.5$ $f^P > 0.7$	0.036	0.141	0.409	0	
States near **a** $f^A \leq 0.4$ $f^P \leq 0.4$	0.002	0.016	0.168	0.	

Table S.2 Direct individual fitness effect of switching to parochial altruism.

States	Switch to PA	Net Effect
All states, all periods	From TA	-0.010
	From PN	-0.012
	From TN	-0.020
Near **b** ($f^A>0.5, f^P>0.7$), all periods	From TA	-0.005
	From PN	-0.015
	From TN	-0.015
Near **a** ($f^A\leq0.4, f^P\leq 0.4$), all periods	From TA	-0.015
	From PN	-0.010
	From TN	-0.025

Figure S1. Sensitivity analysis. The data shown are from 50,000 generations, starting with $f^A=0, f^P=0$. Notation is given in Figure 1 and Table 1 of the text.



Conclusion:

- Under conditions approximating those experienced by our Late Pleistocene ancestors, groups of parochial altruists could emerge, and such groups would frequently engage in and win hostile conflicts with other groups.
- Other processes could also explain parochialism (exposure).
- The stationary distribution and transition matrix of the underlying stochastic Markov process indicates that independent of initial conditions, neither parochialism nor altruism is viable singly but that warfare, altruism and parochialism could have evolved jointly
- Parochial altruism thus may be our (genetic and cultural) legacy, but it need not be our fate.