Focal coordination and language in human evolution, by Roger Myerson
https://home.uchicago.edu/~rmyerson/research/focalang.pdf

Language has enabled humans to coordinate with each other and trust each other in ways that go far beyond the capabilities of other social mammals.

But if a game has a unique Nash equilibrium, rational coordination must conform to it.

(A *Nash equilibrium* lists a strategy for each player that is optimal against the others'.)

Much literature on game-theoretic models of human evolution has emphasized social-dilemma games, which have a unique equilibrium when played once.

For analytical models of the impact of language in human evolution, we should consider games with multiple equilibria.

Schelling's (1960) *focal-point effect*: Anything that focuses the players' attention on one Nash equilibrium may lead them to expect it, and thus to rationally play it.

Without language, there may be no way to find natural environmental cues for coordinating attention on any but the simplest equilibria.

Focusing attention on a strategy that stipulates different actions in different future conditions is particularly difficult without symbolic representation.

With language, any equilibrium could be made focal by individuals prominently describing it and recommending that everyone should act according to it.

By the definition of a Nash equilibrium, a belief that others will comply with this recommendation would make compliance a best response for each player.

(Requires an ability to recognize and discredit any suggestion that others would act against their own interests, *understanding intentional actions*.)

So let us start from an assumption that members of a species regularly interact in simple rival-claimants games, with given parameters C>0 & V>0, in various contexts.
(*Models of resource conflict in biological game theory since Maynard Smith 1974.*)

	2 defers	2 claims
1 defers	0, 0	**0, V**
1 claims	**V, 0**	–C, –C

1's payoff, 2's payoff

Table 1: **A game among rival claimants** to a valuable resource worth V.
[*payoffs in units of incremental reproductive fitness*] [Ex: C=6, V=4.]

This game has three Nash equilibria:
(1 claims, 2 defers) → E payoffs: **(V, 0)** [*1 owns the claiming rights here*],
(1 defers, 2 claims) → E payoffs: **(0, V)** [*2 owns the claiming rights here*],
each *symmetrically* defers with independent probability p=C/(C+V) → E payoffs: **(0, 0)**
(as Vp–C(1–p) = VC/(C+V)–CV/(C+V) = 0).

Genetic variation can yield a stable distribution of strategies in the population only if each positively-used strategy maximizes expected payoff (reproductive fitness).
If animals have no cues to break their symmetry, they can only implement the inefficient symmetric equilibrium, yielding zero expected benefits for the species.

A shared ability to identify symmetry-breaking cues can increase reproductive fitness

Consider animals that meet in rival-claimants games where each situation identifies one of the players as "owner" and the other as "intruder" (Maynard Smith 1986).

Let Q denote the fraction of this population that recognize these distinctions and use a coordinating strategy of claiming when identified as owner but deferring as intruder.

The other 1–Q ignore situational identities and just claim or defer unconditionally.

Given any Q>0, **when the 1–Q all maximize their individual Epayoffs, the Q get higher average payoffs** (higher reproductive fitness). So Q grows to **Q=1 in eq'm**.

Let δ denote the fraction of the ignorant players that are expected to defer.

Any player who defers gets payoff 0.

A coordinating player's expected payoff from claiming would be

$W(Q,\delta) = -C + (V+C)(Q+(1-Q)\delta)$.

but with probability 1/2 of getting cued to claim, their expected payoff is $W(Q,\delta)/2$.

An ignorant player's expected payoff from claiming would be

$U(Q,\delta) = -C + (V+C)(Q/2+(1-Q)\delta) < W(Q,\delta)$.

An equilibrium can have $\delta=1$ if $U(Q,\delta)\le 0$, $\delta=0$ if $U(Q,\delta)\ge 0$, $0<\delta<1$ only if $U(Q,\delta)=0$.

(*Equilibria|Q have $\delta=1$ if $Q>2(1-p)$, $\delta=0$ if $Q>2p$, $0<\delta<1$ if $Q < 2\min\{p,1-p\}$.*)

In an equilibrium with **$\delta=1$**, the ignorant get $(1-\delta)U(Q,\delta)+\delta 0 =$ **$0 < W(Q,\delta)/2$** $= V/2$.

In eq'm with **$\delta=0$**, ignorant get $U(Q,\delta)=$ **$-C+(V+C)Q/2 < W(Q,\delta)/2$** $= -C/2+(V+C)Q/2$.

In an eq'm with **$0<\delta<1$**, ignorant get $0 = U(Q,\delta) < W(Q,\delta)$, but then also **$0 < W(Q,\delta)/2$**.

Consider a population that mixes individuals of two types that apply two different criteria for identifying which player has claiming rights (or ownership), where the two criteria have probability $\beta>0$ of designating different "owners" in any match.

Conflicts occurs only in matched pairs that have one individual from each group; so individuals in the larger group have a smaller probability of conflict.

With random matching, an individual whose criterion is used by a Q fraction of the population would get expected payoff $[V-(1-Q)\beta(V+C)]/2$, *increasing in Q.*

So the more common type has the greater expected payoff, and its population share should then grow until it comprises the whole population.

Thus, any coordination strategy that these individuals can understand could become a stable self-enforcing equilibrium.

We may distinguish ***two broad classes of simple claiming-rights criteria*** that are commonly used to break symmetry among animals without language:

Political criteria assign claiming rights based on the players' individual identities, independently of the prize (as in deference to others by size or by pecking order).

Economic criteria assign claiming rights based on an individual's prior relationship with the prize (as in claims to territory that can be observably patrolled).

If our distinction between economics and politics in the social sciences is fundamental, it should have some broad extension to the biology of social animals.

Political dominance systems create pervasive inequalities in the community. [→*strong*]

Establishing economic ownership rights may require more social cognition. [→*invest*]

A criterion for claiming rights can be effective only if it is jointly recognized by the players, and communication (language) can help to ensure common recognition.

Consider a community where condition X indicates that 1 should claim, 2 should defer.
If X is evident in the environment, 1 would want to point this out to 2. [*"See it has my mark!"*]

Incentives to invest may depend on development of economic claiming rights

Consider a game where individual 1 first chooses whether to invest in making a useful object at some cost K.

If 1 does not invest then both players get payoff 0.

But if 1 invests then 1 and 2 play a rival-claimants game for this object, with payoffs as before except that we subtract the investment cost K from 1's payoff.

Suppose that V>K>0, and both would know that 1 made the object.

	2 defers	2 claims
1 not-invest	0, 0	**0, 0**
1 defers	–K, 0	–K, V
1 claims	**V–K, 0**	–(C+K), –C

Then this game has a strict equilibrium where 1 invests and then claims while 2 defers.

But no equilibrium has 1 invest & defer, because 1 could do better by not investing.

This suggests that the **development of capabilities for sophisticated manufacturing** would require some complementary development of social norms that support a **manufacturer's rights to economic ownership** of valuable manufactured objects.

After diverging from other great apes, ***our austalopithecine ancestors became bipedal, thus freeing hands for making and manipulating useful objects***.
So bipedalism could lead to increased reliance on skilled manual craftsmanship.

When an object is useful and requires effort to make, others could be tempted to take it for their own use without investing in its manufacture.
Craftsmen must be rewarded for their costly development of specialized skills, but achieving maximal value from manufactured objects may involve others using them.
Thus, **bipedalism could increase the need for social structures to support economic ownership and exchange of valuable manufactured objects**.
With language, manufacturer can transfer ownership to purchaser. (*Parent's gift of toy.*)

For a community of social animals to develop a culture of complex rules for claiming rights, the **young should be innately ready to learn claiming-norms** from elders.
When such norms prevail, they induce adaptive advantages for young who have innate interest in learning their society's rules for how to claim when elders would approve.
Then principles for socially accepted claiming rights become something to talk about.

Neurological systems that humans use for language are closely related to those used for complex motor skills, which also have a recursive structure (Lieberman 2002).
Language helps clarify terms for complex transactions to avoid conflict: "if you give me that egg then I'll let you use my handaxe today, but I'll reclaim it tomorrow."
*So the **origin of human language** (in both supply and demand) may be rooted in the manual dexterity that followed from bipedalism.*

When ownership in rival-claimants games is allocated by learned cultural principles, communities can get competitive advantages from better-adapted principles.

With self-enforcing norms adopted by immigrants, get **cultural group selection**.

In successful societies, some forms of economic ownership could require a social status which is politically earned by cooperative contributions to public goods.

Consider a community where individuals play frequent rival-claimants games but also occasional social-dilemma games for a high-value public good (big-game hunting).

Dependence of socially recognized claiming rights on past actions can be used to support equilibria with positive cooperative contributions to public goods.

Example: $k \in \{0,1,...,m\}$ individuals cooperating in hunt at private cost D yields probability k/m of benefit B to each of n in the community, $nB/m > D > B/m$.

Cooperation is promoted by an expectation that refusing to cooperate could cause an individual to lose claiming rights in at least $(D–B/m)/V$ rival-claimants games.

Success in warfare may also depend on group members acting as a cooperative team.

Rewards of social status for valor motivates martial risk-taking in human societies, but not in chimpanzee societies (Zefferman & Mathew 2015).

A bully consistently claims in situations where he has no socially recognized rights, which generates costly conflicts that he could have avoided by deferring ($-c < 0$).

Bullying could be advantageous only if a reputation for bullying would cause others to revise their social expectations and start deferring to the recognized bully.

Those who have high social status that a bully is trying to take could see him as a rival & lead punitive responses, such as ostracism (loss of all socially recognized rights).

Chimpanzees do not need language to understand that competition to be alpha male may require contenders to accept some risks of costly conflict with each other.

But even this risk may be minimized in a well-adapted system of chimpanzee politics, where a contender may induce others to accept his leadership by a long series of limited challenges to the incumbent's authority (De Waal 1982).

Chimpanzee communities normally have promiscuous mating and uncertain paternity.

But the top-ranked alpha male chimpanzee can generally claim the largest share of mating opportunities and expect lower-ranked males to defer to him, even when females have different preferences.

From this perspective, the development of **human pair-bonding** looks like another example of **claiming rights that depend on socially-recognized relationships**, not just on an individual's general rank in society.

Social animals avoid inbreeding by having at least one gender (chimpanzee females) regularly leave their birth community to find mates in another community.

Then **language and pair-bonding enable individuals to recognize kinship links across communities** (*e.g.: cooperation between a female's husband & her brother*).

So our ancestors could form **multi-band societies or tribes** including many local communities that share a **common culture** (Richerson & Boyd 1999, Chapais 2008).

Then boundaries of tribal identity matter, as **interactions with outsiders involve more risks of conflict** from different expectations about rights in rival-claimants games.

So within-tribe relationships become better for avoiding conflict, as the tribal culture provides a shared understanding of ownership in rival-claimants games.

With a system of naming individuals (personal name & home-community name) **reputational incentives for cooperation could extend across tribal communities**.

Thus, although the partition of the world into nation-states is a recent development, the existence of social structures that facilitate constructive relationships between individuals from widely separated communities may be ancient.

Conclusions: ***Humanity as a species uniquely adapted to use Schelling's focal effect.***

Our story has conjectured a sequence of developments in human evolution:

bipedalism → manual skills and manufacture of valuable objects

→ greater returns to social support for complex forms of economic ownership

→ innate readiness to learn social norms for ownership rights, with language

→ dependence of ownership rights on prosocial behavior (cultural adaptation)

→ pair bonding & kinship → multi-band tribal societies with shared culture.

Game-theoretic models of human evolution offer simple perspectives on human nature, offering insights about which aspects might be fundamental to our evolution.

Models of repeated social dilemmas have suggested a nature of **parochial altruism**, where parochial means identifying with a group and favoring its members.

Models of rival-claimants games, which have multiple equilibria, enable us to analyze the role of human language in promoting complex strategic coordination.

These rival-claimants models suggest a natural tendency to **contentious compliance** (accepting norms for claiming rights, but arguing for favorable interpretation).

Then tendencies to cooperative altruism & parochial aversion to risks of interacting with outsiders could develop later.

These notes:

https://home.uchicago.edu/~rmyerson/research/focalang_notes.pdf

The published paper:

https://link.springer.com/article/10.1007/s12110-024-09476-4