



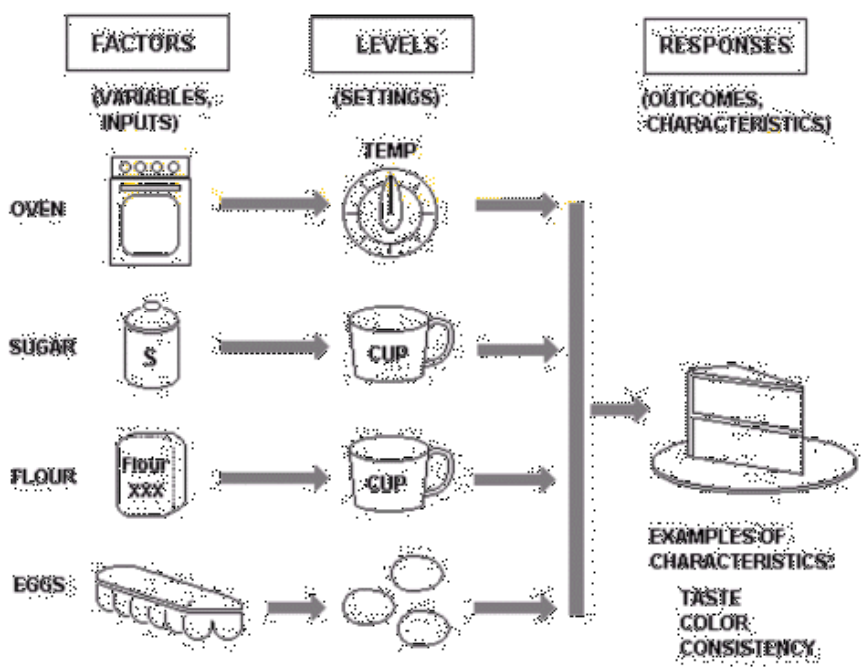
Stephen Heap and Mikael Puurtinen

How to bake a cooperative social system


How do you bake a cake?



Pre-made cakes can only tell so much



Chemistry in the Kitchen



$$\text{NaHCO}_3 + \text{KHC}_4\text{H}_4\text{O}_6 \rightarrow \text{KNaC}_4\text{H}_4\text{O}_6 + \text{H}_2\text{O} + \text{CO}_2$$

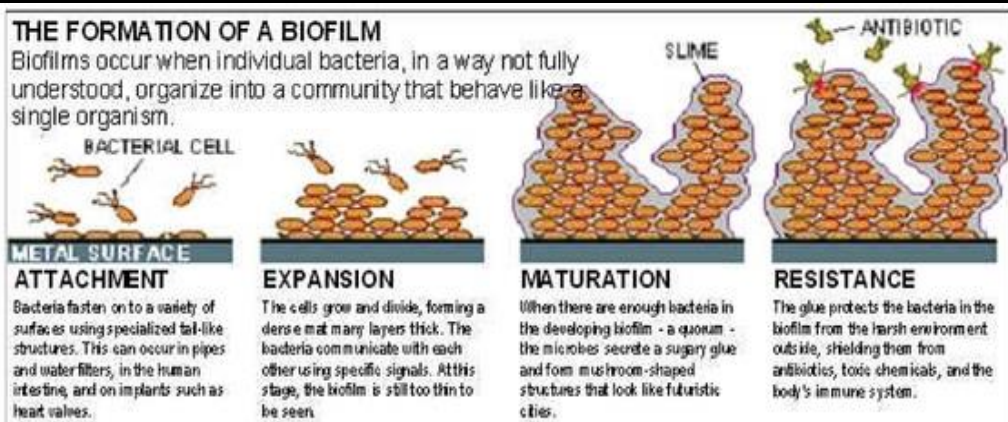
Baking Soda + Cream of tartar → Carbon Dioxide

To understand the cake, we must make the cake



How do cooperative social systems build themselves?

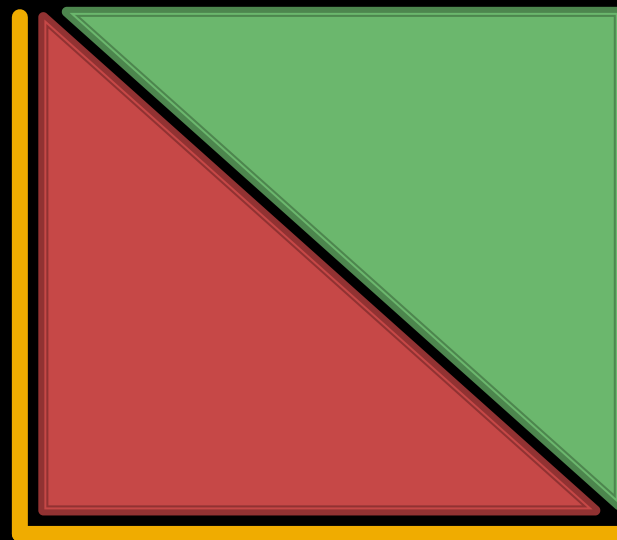
The same problem exists for the evolution of cooperative social systems





'Pre-cooked' social environments describe the range of conditions that can support cooperation

Environmental Variable



Environmental Variable

But we don't know how cooperative social systems can structure themselves



Loneliness




Complex population structures can be determined by individual level decisions



Stasis

A cell with exactly 2 adjoining cells remains the same.





... individual behaviours
that structure the population...

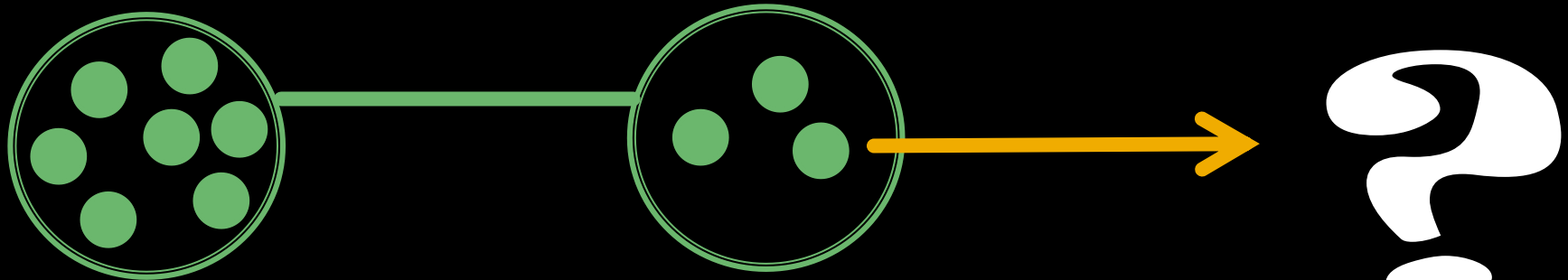
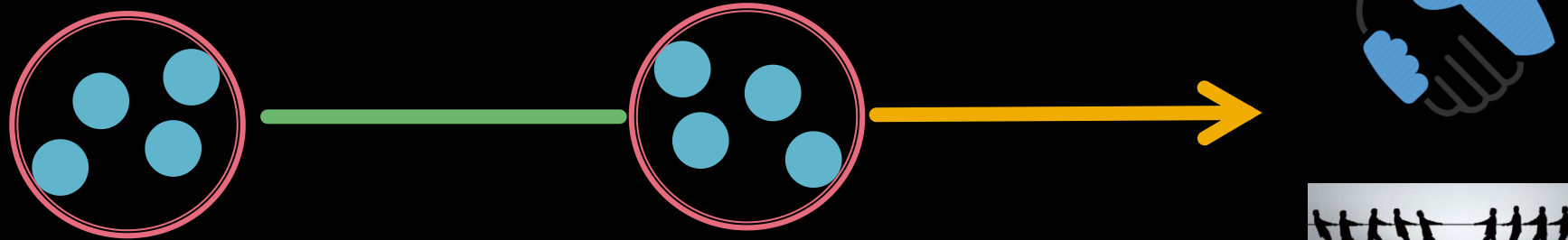
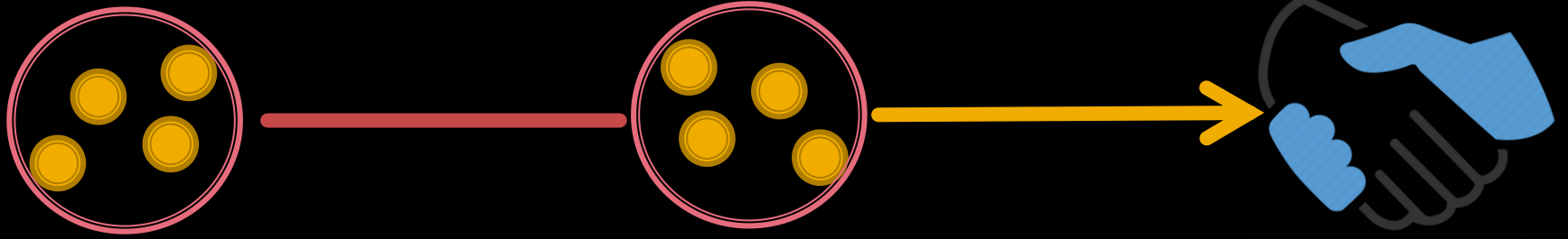
... which affects...

... determine...

... the payoffs of cooperating...

What is the role of **between-group**
competition?







Returns for cooperation **decrease**
with group size



Costly to cooperate and vote for
competition



Ryhmien välinen vuorovaikutustapa on KILPAILU.

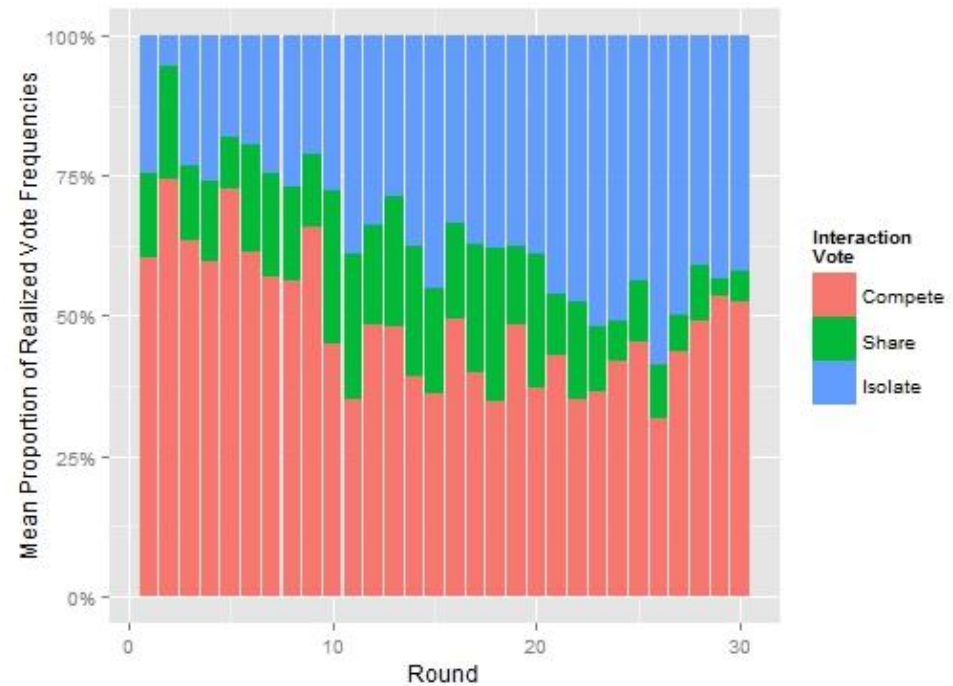
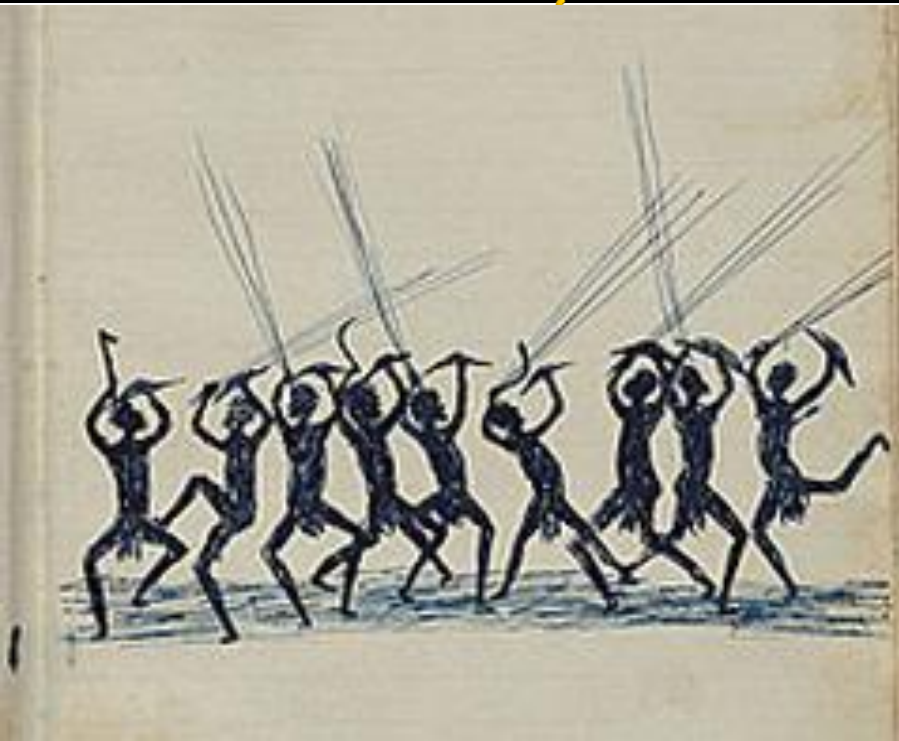
Sinun ryhmäsi oli valinnut KILPAILU.
Vertailtava ryhmä oli valinnut TASAJAKO.



9



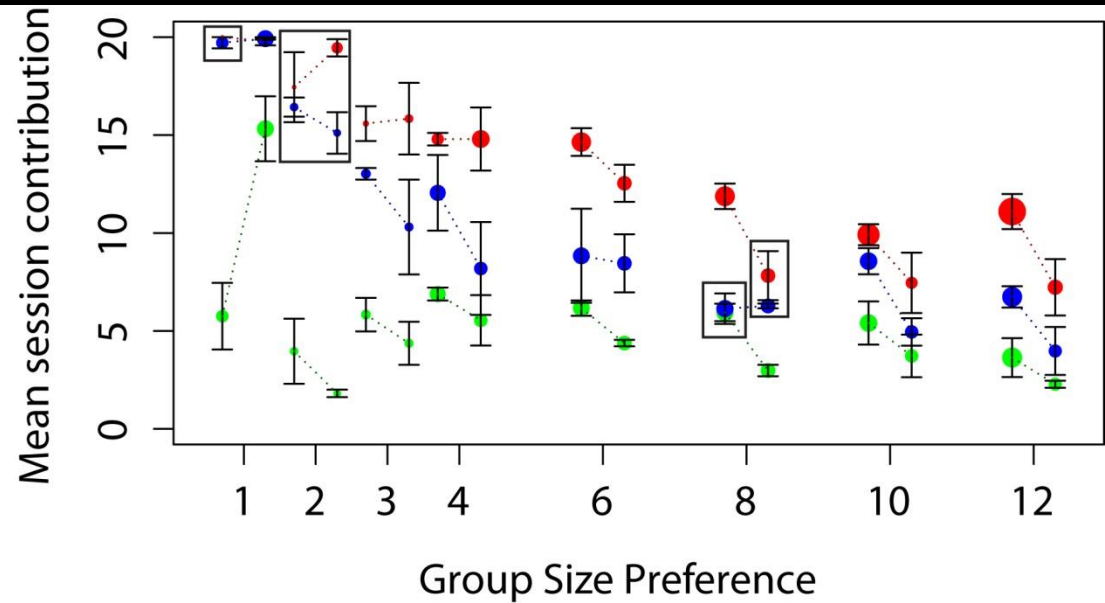
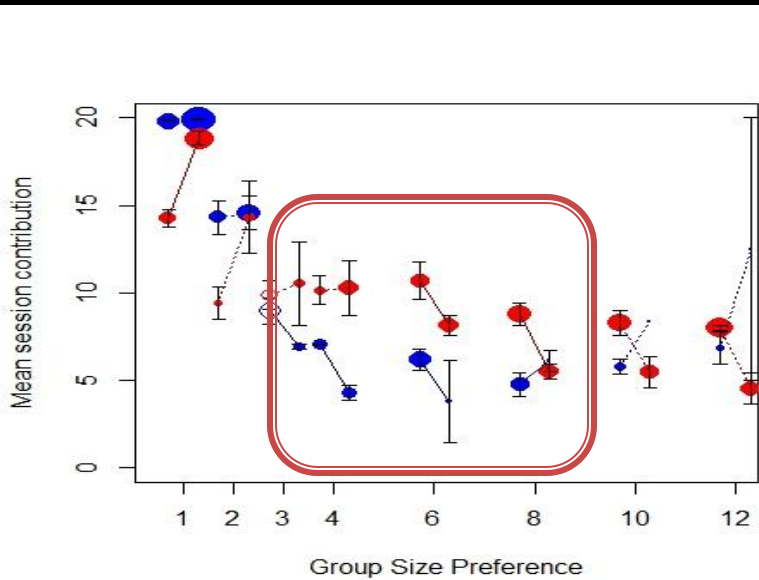
Spontaneous Emergence of Group-Based Competition



Individual decisions that promote between-group competition generate a competitive social environment

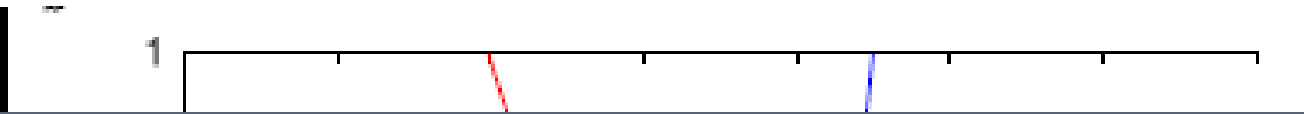
Competition Promotes Group Formation

Within-Group Cooperation Supported by Between-Group Conflict



Cooperation can be sustained in mid-sized groups and is greatest for competitive groups

Group Competition in Coevolutionary Scenarios



Group competition
may alter
Co-evolutionary dynamics
in important ways

Group size faced by the average individual

No Group Interactions



Group Interactions Allowed



Take-Home Message

A special ingredient for baking a cooperative social system is a pinch of conflict





Mikael Puurtinen

Matti Kinnunen



Aleksi Pekkala

Oleksii Kyslytsyn

