On the interplay of hierarchies, conflicts, and cooperation: an experimental approach

Supplementary Information Appendix

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In this document, we present the supplementary information for the main article *On the interplay of hierarchies, conflicts, and cooperation: an experimental approach*. Below, the contents of the document are presented as a table of contents, and the document presents first participant demographics and the experimental instructions, followed by additional experimental results. Finally we report simulation results to be compared with empirical observations.

Contents

1 Participant demographics

Experimental participants were recruited from the subjects registered on the IBSEN recruitment pool. The average participant age was 25,44 ($SD = 7,06$) and the 52,69% of them were female participants. During all sessions we had 18 missing participants (8%) and 24 dropped-out participants (10.7%).

2 Instructions

We present here the instructions that participants read during the experiment. In blue we present text that was only shown to the participants in the egalitarian (EG) treatment, and in red text only shown for participants in the hierarchical treatments (H-small and H-large). If the text is neither blue nor red, it was present in every treatment. Both H-small and H-large treatment have differences between the sizes ($n = 8$ and $n = 16$, respectively), although only the H-small group sizes are shown in the text below.

2.1 Main instructions

Here we present the experimental instructions (translated from Spanish) that were presented to the participants. Additionally, we created several pages with questions to check if the participants understood what they read.

(Here start the instructions)

You are going to participate in an experiment that will consist of an undetermined number of rounds between 50 and 70. You and 7 other people will form a group of 8. This group will not change during the whole experiment, it will always consist of the same people.

In each round you will make some decisions, and depending on them and on those of the members of your group you will accumulate more or less points. The money you earn at the end of the experiment will depend on these points. In each round, the experiment consists of two phases: 1) Collective Action, and 2) Conflicts.

In addition to the accumulated points, each participant will have a score. This score will allow you to win conflicts more easily: the higher the score, the more likely you are to win a conflict. You will start with score 4 and its value can change from round to round: it will go up as you win conflicts and go down as you lose them. minimum score is 1 and the maximum is 8.

Phases:

1) In the first phase, Collective Action, you and the other members of your group can contribute money to a common fund. The amount collected in that fund will be multiplied by 4 (8, for the H-large treatment) and distributed equally among all members of the group. That is, those who do not contribute to the common fund also receive the proportional share.

2) In the second phase, Conflicts, you can try to take from another member of your group what you have earned in the first phase. You will be randomly paired with someone in your group and you can decide to engage into conflict with them or not. It is enough for one of you to choose to engage into a conflict to occur. In such a conflict, the individual with the higher score of the two will be more likely to win, but there is no absolute certainty of winning in any case / the individual who wins the conflict is randomly selected, with a 50% chance for both individuals. The winner of the conflict will score the points that the loser had scored in the previous phase, and the loser will be left with 0 points.

All points will be converted to real money at a rate of 25 points = 1 Euro, plus an additional amount of 2 Euros for participating until the end of the experiment.

Important: In each phase you have a limited, but sufficient, time to make your decision, indicated by a timer. If you do not make your decision, the computer will make it for you by choosing randomly. If you are absent in 3 decisions, you will be expelled from the experiment and you will not receive any money.

(Here end the instructions)

2.2 Collective action text

In the first stage of every round, the collective action, we presented the text below to the participants.

Round X. Collective Action.

In the previous round:

- Action: You did/didn't contribute.
- Outcome conflict: won/lost/no conflict.
- Total points in the previous round: X.
- Current score X (out of 8).

You receive 1 point, which you can spend on contributing; or you can not contribute and accumulate it. What will you do?

2.3 Conflicts text

In the second stage of every round, the conflicts, we presented the text below to the participants.

Round X. Conflicts.

In the previous stage:

- Your contribution: X.
- Your opponent's contribution: X.
- Points spent X.
- Points received from the pool X.
- Round provisional points X.
- Your rank: X. Your opponent's rank: X.

Do you choose to enter a conflict with your opponent?

The screens with the original text the participants saw in their devices can be seen in Fig. S1.

Ronda 2. Acción Colectiva.

Tiempo disponible para completar esta página: 0:04

En la ronda anterior:	
Acción	**Sí** contribuyó
Resultado conflicto	Ganado
Puntos ganados en el conflicto	3,50
Puntos totales en la ronda anterior	7,00
Score actual	5 (sobre 8)

Ahora recibe un punto. Escoja su decisión y pulse Siguiente:

○ Contribuir ○ No contribuir

Siguiente

(a) Contribution stage

Ronda 1. Conflictos.

Tiempo disponible para completar esta página: 0:03

En la fase anterior:	
Acción	Usted contribuyó
Puntos gastados	1
Puntos recibidos del fondo común	3,50
Puntos provisionales de la ronda	3,50

	Usted	**Oponente**
Rango	4	4
Contribución	**Sí**	**Sí**

Ahora elegirá si quiere pelear o no con otro individuo del grupo elegido de forma aleatoria. Si uno de los dos elige pelear, habrá conflicto. Si ambos eligen que no, no habrá conflicto.

Escoja su decisión y pulse Siguiente:

○ Pelear ○ No pelear

Siguiente

(b) Conflicts stage

Figure S1: **Screenshots from the experiment**.

3 Additional results

In this section, we present additional plots to support our results in the main text. The section is divided into five subsections describing the values for the frequencies of cooperation/conflicts/attacks, the evolution of the ranks of the individuals, the values of the Gini indices and the different behavioral types.

3.1 Cooperation frequency

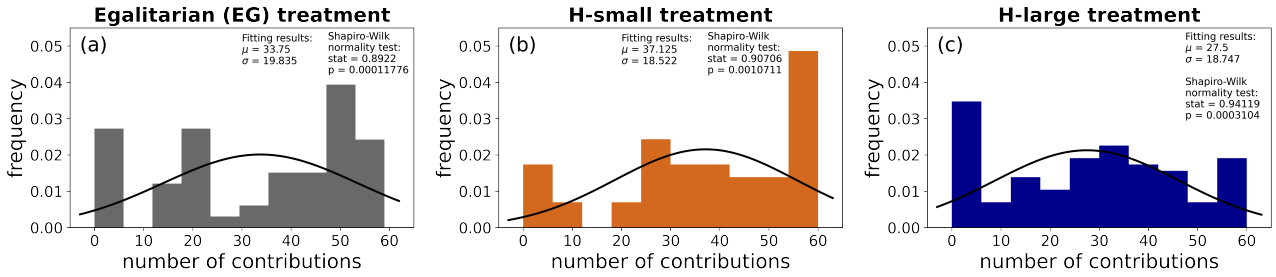


Figure S2: **Participants' cooperation frequency distribution by treatment.**

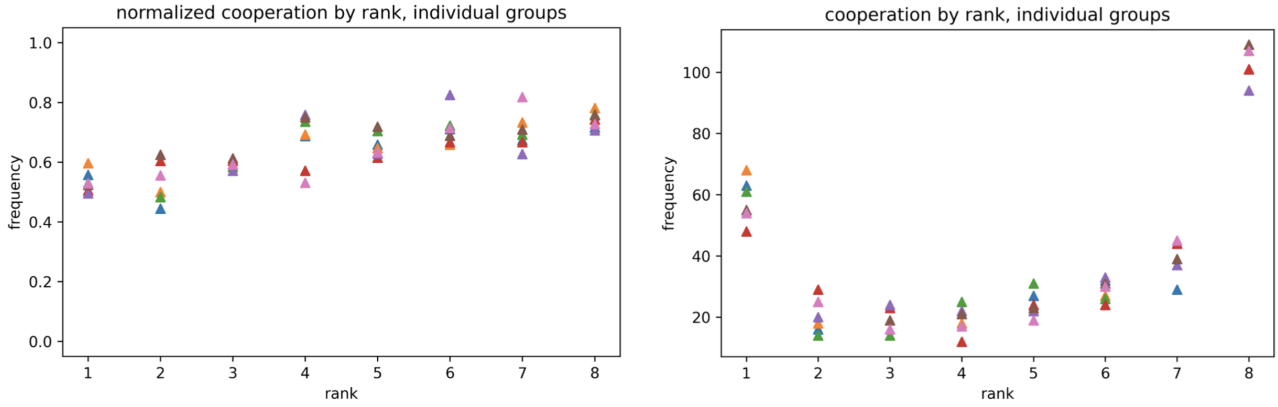


Figure S3: **Groups' cooperation frequency distribution by rank for the H-small treatment.** Each point represents the average cooperation frequency for an independent observation (group).

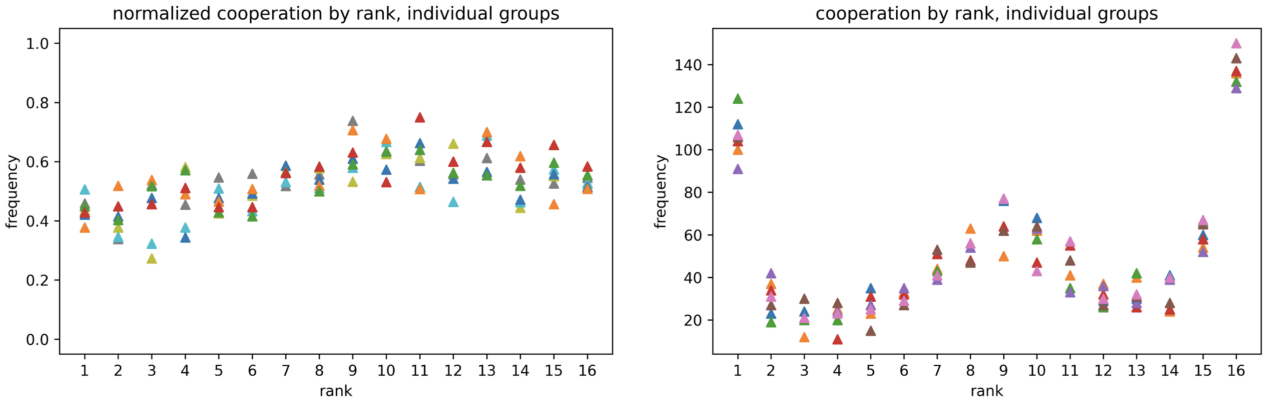


Figure S4: **Groups' cooperation frequency distribution by rank for the H-large treatment.** Each point represents the average cooperation frequency for an independent observation (group).

3.2 Tables for Figures 2 and 5 from the main text

3.2.1 OLS models

Table S1: See also Fig. 2a of the main text (Egalitarian).

Dep. Variable:	y	**R-squared:**	0.585
Model:	OLS	**Adj. R-squared:**	0.575
Method:	Least Squares	**F-statistic:**	55.03
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	5.75e-09
Time:	10:56:03	**Log-Likelihood:**	73.985
No. Observations:	41	**AIC:**	-144.0
Df Residuals:	39	**BIC:**	-140.5
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.8335	0.022	37.083	0.000	0.788	0.879
x	-0.0040	0.001	-7.418	0.000	-0.005	-0.003

Omnibus:	2.537	**Durbin-Watson:**	1.849
Prob(Omnibus):	0.281	**Jarque-Bera (JB):**	1.464
Skew:	0.340	**Prob(JB):**	0.481
Kurtosis:	3.628	**Cond. No.**	147.

Table S2: See also Fig. 2a of the main text (H-small).

Dep. Variable:	y	**R-squared:**	0.237
Model:	OLS	**Adj. R-squared:**	0.217
Method:	Least Squares	**F-statistic:**	12.10
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	0.00125
Time:	10:58:02	**Log-Likelihood:**	64.996
No. Observations:	41	**AIC:**	-126.0
Df Residuals:	39	**BIC:**	-122.6
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.8036	0.028	28.714	0.000	0.747	0.860
x	-0.0023	0.001	-3.479	0.001	-0.004	-0.001

Omnibus:	2.645	**Durbin-Watson:**	1.258
Prob(Omnibus):	0.266	**Jarque-Bera (JB):**	1.948
Skew:	-0.359	**Prob(JB):**	0.378
Kurtosis:	2.209	**Cond. No.**	147.

Table S3: See also Fig. 2a of the main text (H-large).

Dep. Variable:	y	**R-squared:**	0.154
Model:	OLS	**Adj. R-squared:**	0.132
Method:	Least Squares	**F-statistic:**	7.109
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	0.0111
Time:	10:58:02	**Log-Likelihood:**	73.402
No. Observations:	41	**AIC:**	-142.8
Df Residuals:	39	**BIC:**	-139.4
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.6200	0.023	27.196	0.000	0.574	0.666
x	-0.0015	0.001	-2.666	0.011	-0.003	-0.000

Omnibus:	3.573	**Durbin-Watson:**	1.956
Prob(Omnibus):	0.168	**Jarque-Bera (JB):**	1.648
Skew:	0.070	**Prob(JB):**	0.439
Kurtosis:	2.028	**Cond. No.**	147.

Table S4: See also Fig. 2b of the main text (H-small).

Dep. Variable:	y	**R-squared:**	0.068
Model:	OLS	**Adj. R-squared:**	0.044
Method:	Least Squares	**F-statistic:**	2.833
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	0.100
Time:	10:45:49	**Log-Likelihood:**	-28.694
No. Observations:	41	**AIC:**	61.39
Df Residuals:	39	**BIC:**	64.81
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	3.0256	0.275	11.001	0.000	2.469	3.582
x	0.0111	0.007	1.683	0.100	-0.002	0.024

Omnibus:	0.608	**Durbin-Watson:**	1.203
Prob(Omnibus):	0.738	**Jarque-Bera (JB):**	0.301
Skew:	-0.210	**Prob(JB):**	0.860
Kurtosis:	3.014	**Cond. No.**	147.

Table S5: See also Fig. 2b of the main text (H-large).

Dep. Variable:	y	**R-squared:**	0.649
Model:	OLS	**Adj. R-squared:**	0.640
Method:	Least Squares	**F-statistic:**	72.13
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	2.11e-10
Time:	10:45:49	**Log-Likelihood:**	-50.101
No. Observations:	41	**AIC:**	104.2
Df Residuals:	39	**BIC:**	107.6
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	9.5283	0.268	35.568	0.000	8.986	10.070
x	-0.0944	0.011	-8.493	0.000	-0.117	-0.072

Omnibus:	3.720	**Durbin-Watson:**	0.936
Prob(Omnibus):	0.156	**Jarque-Bera (JB):**	2.489
Skew:	0.515	**Prob(JB):**	0.288
Kurtosis:	3.628	**Cond. No.**	49.2

Table S6: See also Fig. 5a of the main text (H-small).

Dep. Variable:	y	**R-squared:**	0.881
Model:	OLS	**Adj. R-squared:**	0.861
Method:	Least Squares	**F-statistic:**	44.29
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	0.000556
Time:	10:23:46	**Log-Likelihood:**	17.959
No. Observations:	8	**AIC:**	-31.92
Df Residuals:	6	**BIC:**	-31.76
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.5261	0.023	22.810	0.000	0.470	0.583
x	0.0304	0.005	6.655	0.001	0.019	0.042

Omnibus:	8.470	**Durbin-Watson:**	2.422
Prob(Omnibus):	0.014	**Jarque-Bera (JB):**	2.985
Skew:	1.459	**Prob(JB):**	0.225
Kurtosis:	3.666	**Cond. No.**	11.5

Table S7: See also Fig. 5a of the main text (H-large).

Dep. Variable:	y	**R-squared:**	0.480
Model:	OLS	**Adj. R-squared:**	0.443
Method:	Least Squares	**F-statistic:**	12.91
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	0.00294
Time:	10:23:46	**Log-Likelihood:**	24.996
No. Observations:	16	**AIC:**	-45.99
Df Residuals:	14	**BIC:**	-44.45
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.4615	0.028	16.227	0.000	0.401	0.523
x	0.0106	0.003	3.593	0.003	0.004	0.017

Omnibus:	0.779	**Durbin-Watson:**	1.043
Prob(Omnibus):	0.677	**Jarque-Bera (JB):**	0.724
Skew:	0.263	**Prob(JB):**	0.696
Kurtosis:	2.101	**Cond. No.**	20.5

Table S8: See also Fig. 5b of the main text (H-small).

Dep. Variable:	y	**R-squared:**	0.939
Model:	OLS	**Adj. R-squared:**	0.929
Method:	Least Squares	**F-statistic:**	92.23
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	7.29e-05
Time:	10:31:08	**Log-Likelihood:**	21.402
No. Observations:	8	**AIC:**	-38.80
Df Residuals:	6	**BIC:**	-38.64
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.4304	0.015	28.697	0.000	0.394	0.467
x	0.0285	0.003	9.604	0.000	0.021	0.036

Omnibus:	1.713	**Durbin-Watson:**	1.724
Prob(Omnibus):	0.425	**Jarque-Bera (JB):**	0.714
Skew:	0.084	**Prob(JB):**	0.700
Kurtosis:	1.546	**Cond. No.**	11.5

Table S9: See also Fig. 5b of the main text (H-large).

Dep. Variable:	y	**R-squared:**	0.783
Model:	OLS	**Adj. R-squared:**	0.768
Method:	Least Squares	**F-statistic:**	50.63
Date:	Fri, 23 Sep 2022	**Prob (F-statistic):**	5.21e-06
Time:	10:31:08	**Log-Likelihood:**	30.657
No. Observations:	16	**AIC:**	-57.31
Df Residuals:	14	**BIC:**	-55.77
Df Model:	1		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	0.4052	0.020	20.294	0.000	0.362	0.448
x	0.0147	0.002	7.115	0.000	0.010	0.019

Omnibus:	1.692	**Durbin-Watson:**	1.262
Prob(Omnibus):	0.429	**Jarque-Bera (JB):**	1.360
Skew:	-0.582	**Prob(JB):**	0.507
Kurtosis:	2.173	**Cond. No.**	20.5

3.3 GLS models

In this subsection we report tables related to the statistical analysis of Figs. 2 and 5 of the main text. All models are Generalized Least Squares (GLS) with random effects clusterizing by each individual participant, i.e. participant ID used in the experimental session. As reported in the main text, results of Fig. 2 only refer to decisions taken after round 20.

Table S10: See also Fig. 2a of the main text.

	Dependent variable:					
	Contribution frequency					
	EG	EG	H-small	H-small	H-large	H-large
Round	-0.030^{***}	-0.031^{***}	-0.022^{***}	-0.025^{***}	-0.009	-0.011^{***}
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Attack		0.455^{***}		0.294^{**}		0.295^{***}
		(0.137)		(0.132)		(0.094)
Rank				0.242^{***}		0.059^{***}
				(0.048)		(0.019)
Constant	1.319^{***}	1.194^{***}	1.552^{***}	0.309^{*}	-0.421	-0.999
	(0.487)	(0.485)	(0.468)	(0.488)	(0.366)	(0.395)
Observations	2,240	2,240	2,240	2,240	4,480	4,480
Note:						*p<0.1; **p<0.05; ***p<0.01

Table S11: See also Fig. 2b of the main text.

	Dependent variable:			
	Rank changes			
	H-small	H-small	H-large	H-large
Round	0.007^{*}	0.007	-0.025^{***}	-0.025^{***}
	(0.004)	(0.004)	(0.003)	(0.003)
Rank		-0.111^{***}		-0.008
		(0.030)		(0.030)
Contribution		-0.193		-0.141^{*}
		(0.126)		(0.083)
Constant	-0.609^{***}	0.051^{***}	0.863^{***}	0.992^{***}
	(0.202)	(0.258)	(0.134)	(0.160)
Observations	2,240	2,240	4,480	4,480
Note:				*p<0.1; **p<0.05; ***p<0.01

Table S12: See also Fig. 5a of the main text.

	Dependent variable:			
	Contribution frequency			
	H-small	H-small	H-large	H-large
Rank	0.161^{***}	0.157^{***}	0.045^{***}	0.042^{***}
	(0.029)	(0.029)	(0.011)	(0.011)
Attack		-0.205^{**}		0.042^{***}
		(0.098)		(0.069)
Constant	-0.188	-0.262	-0.926^{***}	-1.019^{***}
	(0.347)	(0.345)	(0.277)	(0.274)
Observations	3,360	3,360	6,720	6,720
Note:				*p<0.1; **p<0.05; ***p<0.01

Table S13: See also Fig. 5b of the main text.

	Dependent variable:			
	Attack frequency			
	H-small	H-small	H-large	H-large
Rank	0.124^{***}	0.119^{***}	0.035^{***}	0.032^{***}
	(0.024)	(0.024)	(0.010)	(0.010)
Contribution		0.242^{**}		0.329^{***}
		(0.098)		(0.069)
Constant	-0.924^{***}	-1.043^{***}	-1.107^{***}	-1.228^{***}
	(0.228)	(0.227)	(0.190)	(0.187)
Observations	3,360	3,360	6,720	6,720
Note:				*p<0.1; **p<0.05; ***p<0.01

3.4 Attack and conflict frequencies

We report in Fig. S5 the average conflict frequency by round. One can see that the value is the rather stable for all the experimental rounds. The EG treatment shows the lowest level of conflicts demonstrating that introducing a hierarchy increases it, mostly for smaller groups.

Then, looking at Fig. S6 we can notice that, although there were slightly more conflicts in H-small treatments with respect to H-large ones, the average number of attacks is very similar among all treatments. Egalitarian treatments show less conflicts (almost the half) having many participants almost never attacking and more mutual conflicts, i.e., two attacks in the same pairing. Both phenomena were not observed in hierarchical treatments.

Values in Fig. S7 shows instead the attack frequency by coupled ranks. In both H-small and H-large, we observe that individuals with higher ranks engage into conflicts more often against those with lower ranks. These results are also in agreement with our previous modelling work [LGS20].

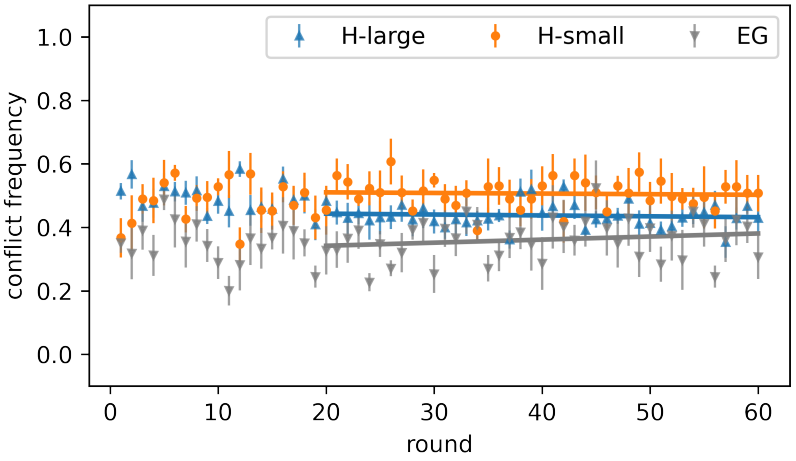


Figure S5: **Conflict frequency by round and by treatment.** We observe in the long run, i.e. after round 20, stable patterns with minor oscillations in all treatments (OLS model after round 20; EG: $\beta = 0.000967, \epsilon = 0.34, p = 0.26$; H-small: $\beta = -0.000194, \epsilon = 0.51, p = 0.74$; H-large: $\beta = -0.000278, \epsilon = 0.44, p = 0.58$).

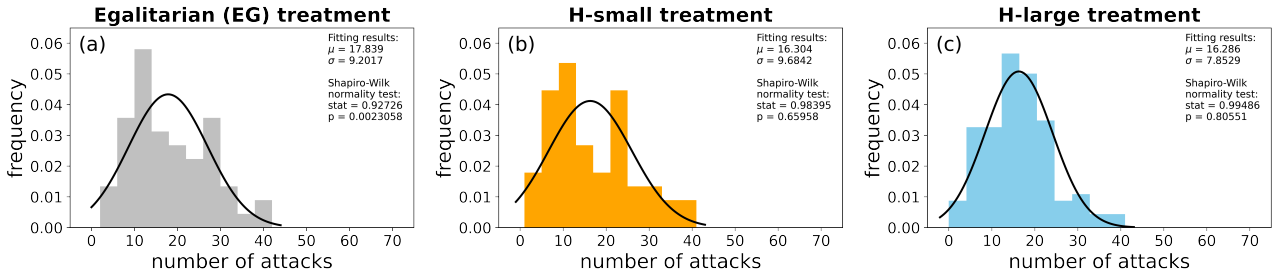
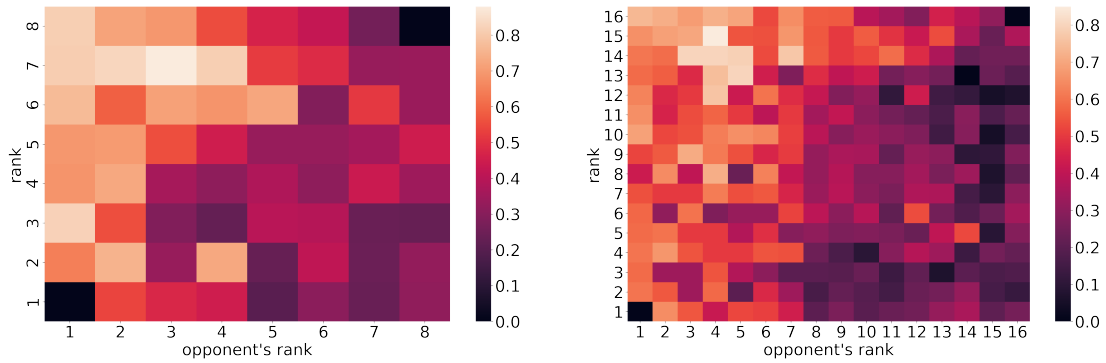


Figure S6: **Participants' attack frequency distribution by treatment.**



(a) H-small (b) H-large

Figure S7: **Attack frequencies by couple ranks and by hierarchical treatment.** The plot reports the frequency of time the row participant (rank) decided to engage into a conflict against the column participant (opponent's rank). As expected, we can notice that lighter areas, meaning that there are more attacks, are present in the top-left half of the plot when the row participant is the highly-ranked one.

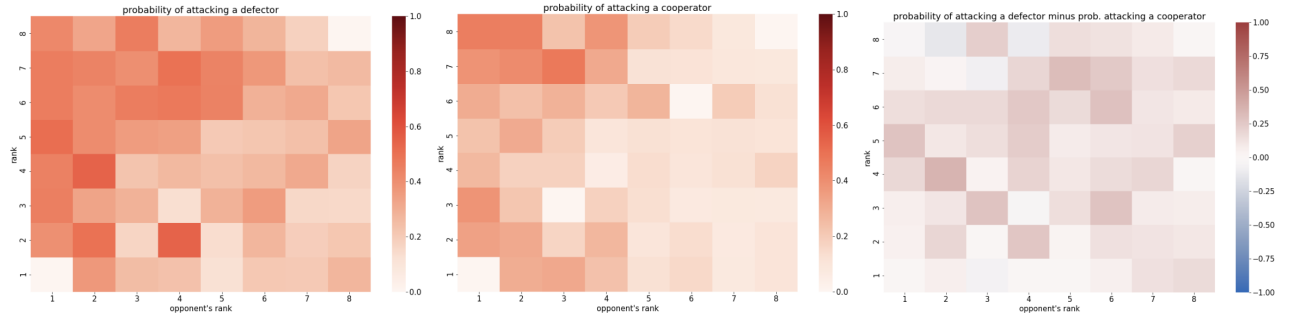


Figure S8: **Attack frequencies by couple ranks and by opponent's decision for the H-small treatments.** The plot reports the frequency of time the row participant (rank) decided to engage into a conflict against the column participant (opponent's rank). In the first plot we report the probability of attacking a defector, while in the second a cooperator. The third heatmap represents the difference between the first and the second heatmap. In this last plot, positive values (red) mean that participants attack more often defector.

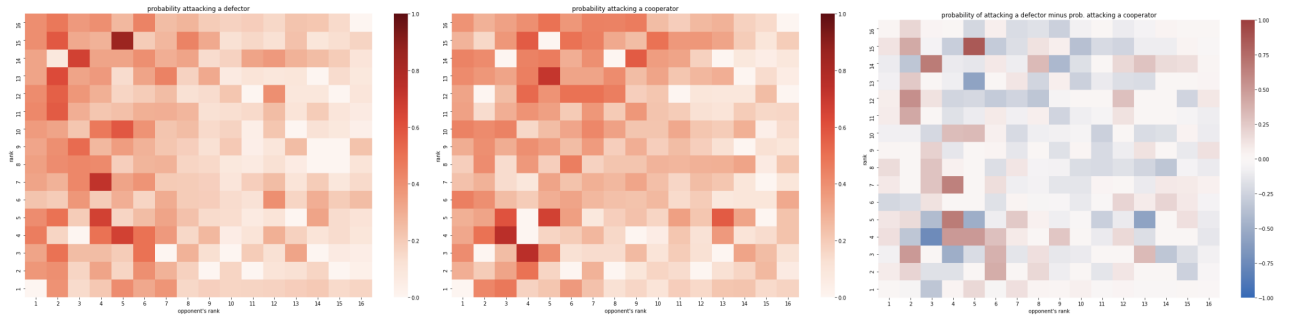
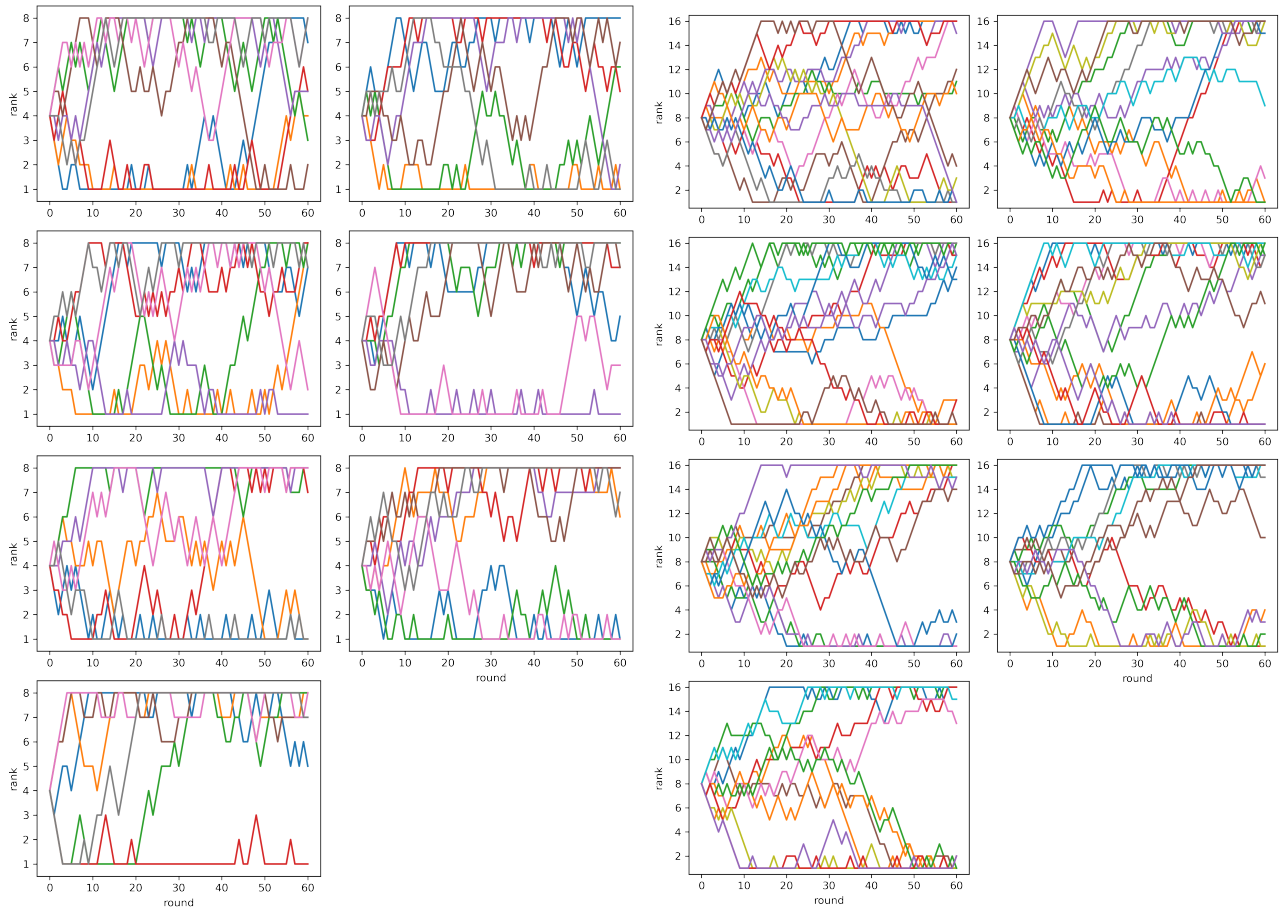


Figure S9: **Attack frequencies by couple ranks and by opponent's decision for the H-large treatments.** The plot reports the frequency of time the row participant (rank) decided to engage into a conflict against the column participant (opponent's rank). In the first plot we report the probability of attacking a defector, while in the second a cooperator. The third heatmap represents the difference between the first and the second heatmap. In this last plot, positive values (red) mean that participants attack more often defector.

3.5 Rank evolution

To ensure that the rank distributions' in the experiments are similar to those in [LGS20], as well as to see how the individual ranks evolve over time, we plot participants' rank evolution for each separated group of the experiment in Fig. S10. We observe that the final rank distribution is, mostly, bimodal: participants start with the same rank and end up distributed into two groups with the highest and the lowest ranks. Very few individuals remain in the middle level of the hierarchy and when they do they converge to the bottom or to the top of it after few rounds.



(a) H-small (b) H-large

Figure S10: **Rank evolution by group and hierarchical treatment during the 60 rounds.** After a transient state, which is longer for the H-large treatment, ranks converge into two classes of hierarchies, i.e. high and low ranks, which they result to be stable for subsequent rounds.

3.6 Gini index

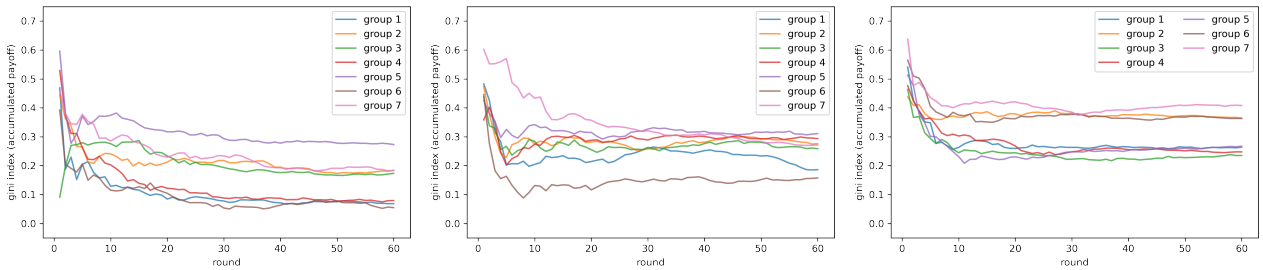
The Gini coefficient is a classic measure of inequality [SO04] over a given distribution. The coefficient is a number between 0 (perfect equality) and 1 (perfect inequality). The standard definition for the Gini coefficient over a set of values $\{x\}$ is

$$G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j|}{2n^2 \langle x \rangle};$$

but for computational reasons we used the rewritten version:

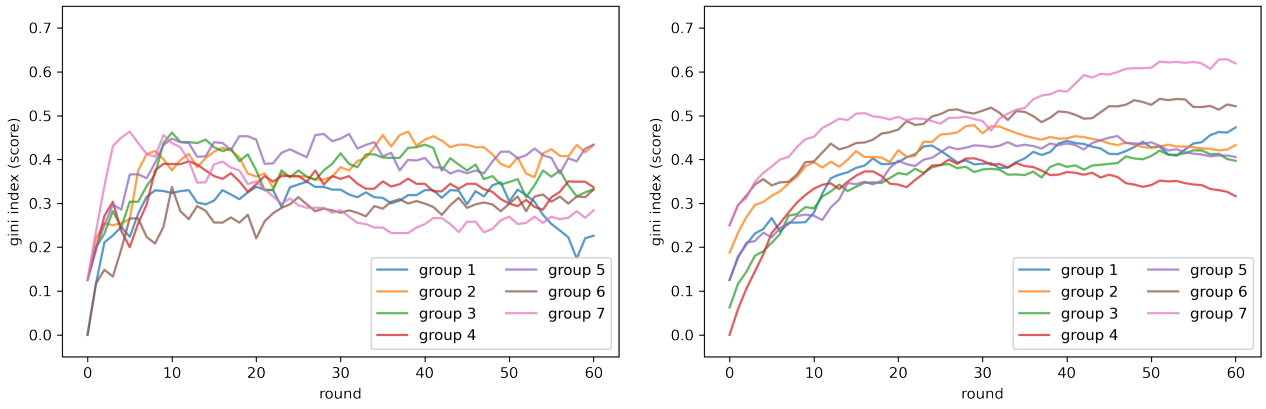
$$G = \frac{\sum_{i=1}^{n} (2i - n - 1) x_i}{n \sum_{i=1}^{n}}.$$

As we can observe in Fig. S11, the Gini index of the cumulated payoffs is larger at the beginning of the experiment since the differences are greater: some contribute and lose the conflict, whereas others do not contribute and won the conflict. Later, the value decreases because all individuals end up earning points, so the difference decreases. There are some groups where the difference between the low and high *earners* is more pronounced. On the other hand, by looking at Fig. S12, the Gini index of the ranks starts at zero because all individuals begin as an egalitarian group. Subsequently, due to the conflicts, individuals are able to increase or decrease their ranks in the hierarchy through conflicts and the Gini index consequently increases for both hierarchical treatments. However, higher levels of inequality are only possible to be reached in larger groups.



(a) Egalitarian (EG) (b) Hierarchical small (c) Hierarchical large

Figure S11: **Gini index for the accumulated payoff.** The payoff is computed as the number of points earned at each round, including saved round endowment (if any) and earnings from the public goods game and from the engaged conflict (if any).



(a) Hierarchical small (b) Hierarchical large

Figure S12: **Gini index for the ranks.** All participants begin with the same value as rank (4 for H-small and 8 for H-large). Then, ranks can reach up to the size of the group (8 for H-small and 16 for H-large).

3.7 Behavioral types

To study if there is any relationship between the total number of attacks and the total number of contributions for each individual, we plot each value for all the groups in Fig. S13 and individuals in Fig. S14. We can only observe that in the H-small treatment there is a small evidence that individuals who contribute few times do not engage into conflicts although not significant. Correlations are even weaker in the H-large treatment. Further investigation could be done to better unveil these relationships, if any.

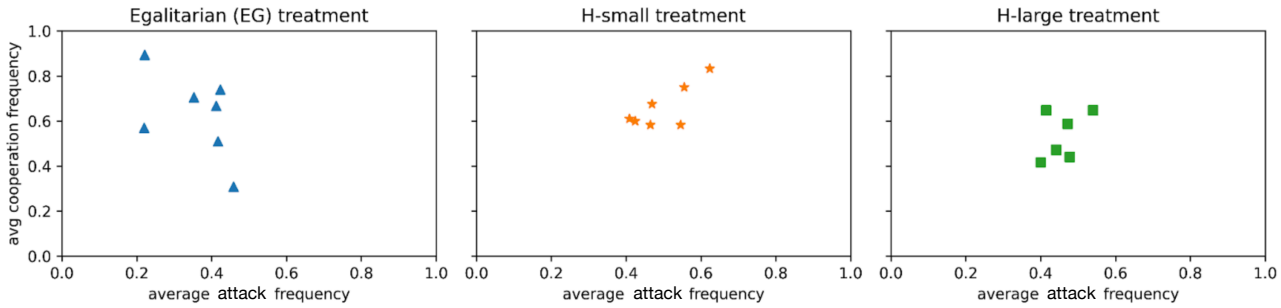


Figure S13: **Scatterplot of contributions and attack frequency by group.**

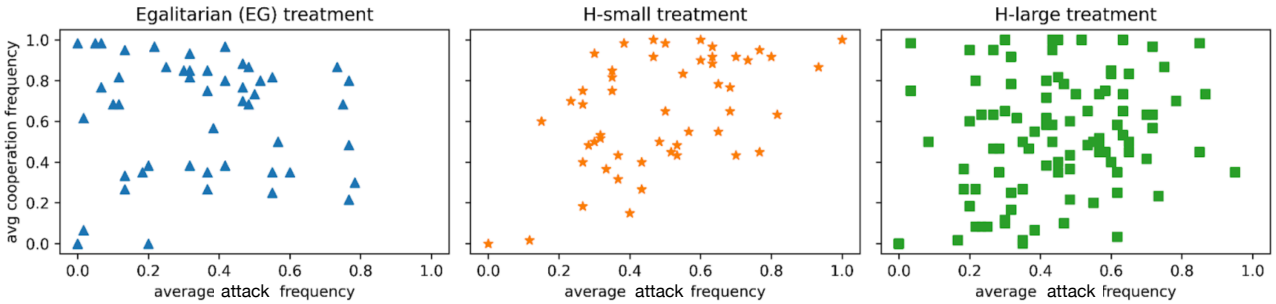
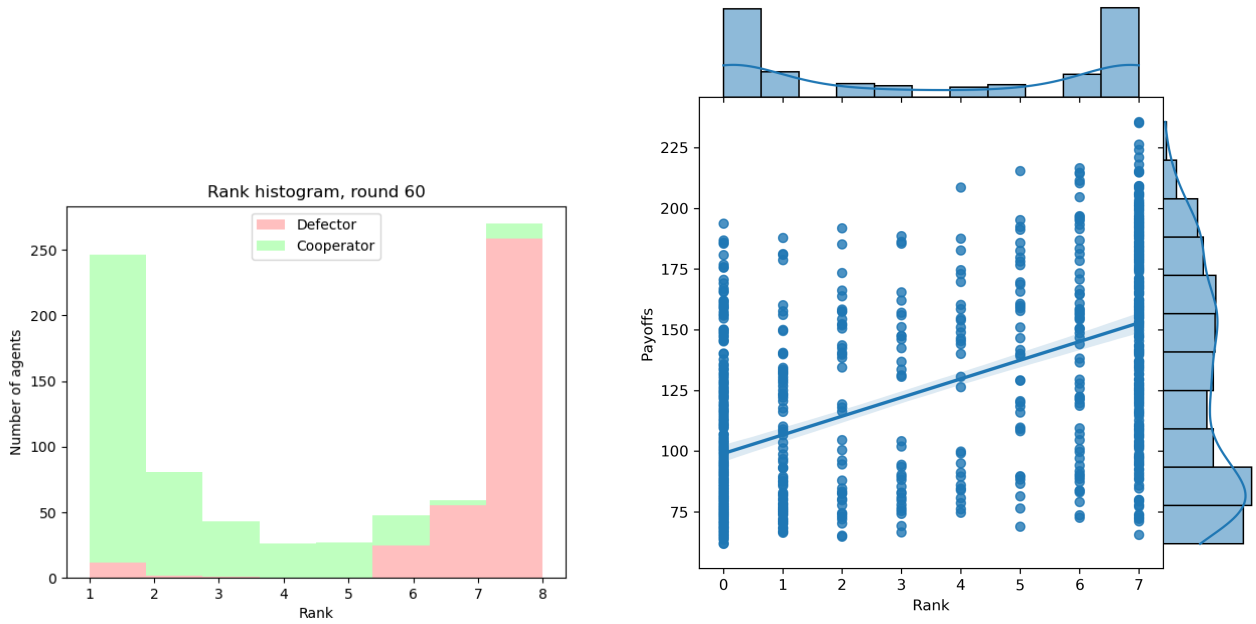


Figure S14: **Scatterplot of contributions and attack frequency k by individual.**

4 Simulation results

Simulation results from the model in [LGS20] are presented in Fig. S15 to show the similarities with the data from the experiments. In Fig. S15a the red color in the histogram represents the individuals who do not cooperate, whereas the green one represents the individuals who cooperate in the collective action (in the model defined as *following the social norm)*. In this case the results are the opposite of what we observe in the experiments. In fact, cooperative participants are also those having higher ranks (but also those engaging into conflict more often). On the other hand, in Fig. S15b, we observe a clear relationship in which highly-ranked individuals earned more than those in the lower part of the hierarchy. This result is also observed in our experimental setup.



(a) Rank distribution

(b) Relationship rank-payoffs

Figure S15: **Simulation model results.** Parameters: $b = 2$, $c = 1$, $\eta = 0.25$, size $= 8$, number of groups $= 100$.

References

[SO04] Alan Stuart and John Keith Ord. *Distribution theory*. eng. Ed. by Maurice G. Kendall. sixth edition. Kendall's advanced theory of statistics Volume 1. Chichester: Wiley & Sons, 2004. ISBN: 978-0-470-66530-5.

[LGS20] Pablo Lozano, Sergey Gavrilets, and Angel Sánchez. "Cooperation, social norm internalization, and hierarchical societies". en. In: *Scientific Reports* 10.1 (Sept. 2020). Number: 1 Publisher: Nature Publishing Group, p. 15359. ISSN: 2045-2322. DOI: 10.1038/s41598-020-71664-w. URL: https://www.nature.com/articles/s41598-020-71664-w (visited on 02/11/2021).