Supporting Information

The effects of reputational and social knowledge on cooperation

Edoardo Gallo[*†] and Chang Yan[‡]

[*]Faculty of Economics and Queens' College, University of Cambridge, CB3 9ET, UK
[‡]Department of Computer Science, University of Oxford, OX1 3QD, UK
[†]Collegio Carlo Alberto, Università di Torino, 10024 Moncalieri, Italy

1 Experimental Details

We conducted all our experimental sessions using subjects recruited from Amazon Mechanical Turk (AMT), a popular online labor market. Workers (called Turkers) at AMT complete short tasks (called Human Intelligence Tasks or HITs) in return for monetary compensation. AMT hosts a large and diverse population of Turkers, which provides researchers with on-demand access to its labor [1, 2, 3]. AMT enables researchers to conduct research with significantly larger and more diverse subject pools compared to the typical laboratory experiments.

In our experiment, all the subjects are U.S-based and we enforce this requirement by restricting our HITs to U.S. Turkers as well as checking their IP addresses upon participation. All collected data are associated with subjects' Turker IDs only, and not with any personally identifiable information.

There are considerable differences in recruitment and experimental procedures among the few published studies that involve real-time interaction between subjects from AMT. In particu-

1

lar, some previous studies [4, 5, 6] allow subjects to participate in multiple sessions in the same experiment: subjects are allowed to participate in the same treatment multiple times and/or in different treatments. In addition, their main analysis is based on data collected in later sessions only. In contrast, our experiment actively prevents multiple/repeated participation even in cases where the subject only saw the Instructions and then abandoned the experiment. Analogous to other contributions [7, 8], our study requires subjects to read the Instructions and complete the experimental Game in a single uninterrupted session, emulating the workflow of lab experiments.

More specifically, participation in our experiment consists of two parts. First, subjects have to pass a Qualification HIT in which we collect demographic information, and ask basic comprehension questions about the Janken Step game, which is a simple variant of the popular rock, paper and scissors game. The comprehension questions serve the purpose of filtering out a small minority of subjects who are extremely careless in reading and/or have difficulties in understanding the simple Janken Step game and its payoff matrix. We believe that this filtering leads to a negligible bias in our subject pool, because the chosen game is so simple and common that it merely requires rudimentary reading and arithmetic skills (i.e. addition of single-digit numbers) and the failure rate is only 6.6%. Second, we randomly invite qualified subjects by email using AMT's ID-based notification system. Invitations were sent individually so that subjects did not know who else was invited in the same session. In our invitation email, we specify the time and date of the experiment and do not disclose any details of the experimental design. To participate in the actual experiment, subjects need to locate and accept the HIT, and click on a URL to access an external web page hosted on *UbiquityLab*, our purpose-built platform for online experimentation. The experiment consists of the following steps: Waiting Room; Instructions and Interface Tour; Quiz; Game; Final Questionnaire; and Payment Confirmation. At the end of the experiment subjects need to copy a unique confirmation code and

2

submit it on the AMT HIT page for payment.

The graphical game interface requires mouse inputs only, and provides various information to subjects depending on the current stage of the game and the treatment.

In the first stage, subjects see their own previous five actions, their current neighbors' previous five actions, and, in treatments R and RN only, their non-neighbors' previous five actions. In all treatments, there is a figure that shows the subject's current neighbors. In the N and RN treatments, there is also an interactive figure (see Figure S1) that displays the current network in the group: subjects can highlight any node and its neighbor(s) by hovering the mouse pointer onto the node, and they can also rearrange the network layout by dragging the nodes around as the link(s) will automatically adapt to the changes. In the B and R treatments, the network figure is replaced by a figure of all the non-neighbors.
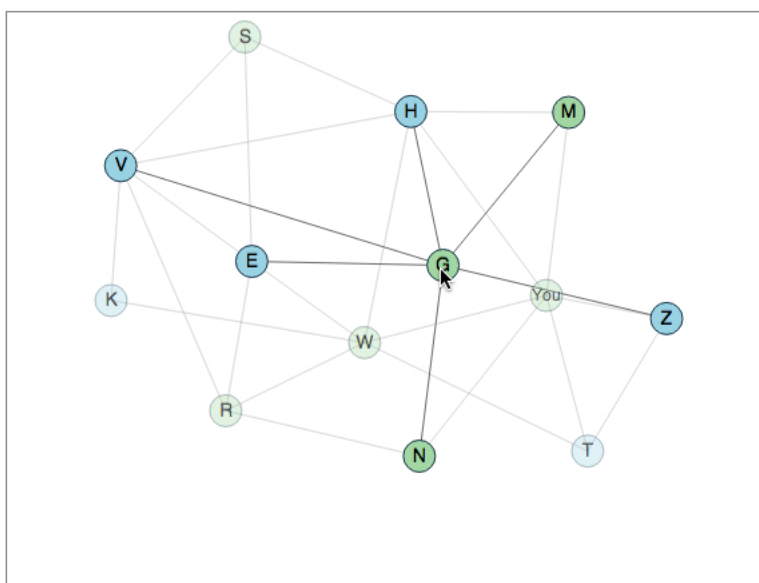

Figure S1: Interactive network figure of the connections among all the subjects in the RN treatment.

In the second stage, subjects see the same reputational and network information as in the first stage. Additionally, they receive notification(s) of link proposals from any non-neighbor

3

who has chosen to propose a connection in the first stage, and have to decide whether to accept or reject each proposal. In treatments with network information, they can continue interacting with the network figure while making their decisions.

In the third stage, both network and reputational information are updated to reflect the outcomes of the link formation/removal choices and the rejection/acceptance of proposal(s) in stages 1 and 2 respectively. Subjects observe the updated information about their neighbors. In treatments B and N, subjects can see the reputational information of their new neighbors, and cannot access any longer the reputational information of removed neighbors. Based on the updated network and reputational information available in each treatment, each subject chooses to cooperate or defect.

The beginning of the experiment starts with the empty network where no subject is connected to any other, and there is no reputational information. In round $x \in \{1, 16\}$ subjects can see the last $\min\{x - 1, 5\}$ actions played by their neighbors (in B and N) or everyone in the network (in R and RN). In other words, before round 5 subjects can see the actions up to that round, and after round 5 they see the actions of the previous 5 rounds.

Visually, the interface is organized into three main panels, as shown in Figure S2.

The top left panel shows the graphical representation of the subject's current neighbors, with the subject herself at the center. The bottom left panel shows the graphical representation of either all other unlinked subjects (in B and N) or all the subjects including the subject herself (in R and RN). In R and RN, the network is laid out using a customized force-based layout algorithm [9] that we fine-tune specifically for networks of 13 individuals. In each stage, the network layout is exactly the same for all subjects in a session except for the labeling of the "You" node that denotes the position of the subject herself. We performed extensive testing to ensure that the algorithm effectively captures and visualizes important structural features such as symmetries and regularities in the network.
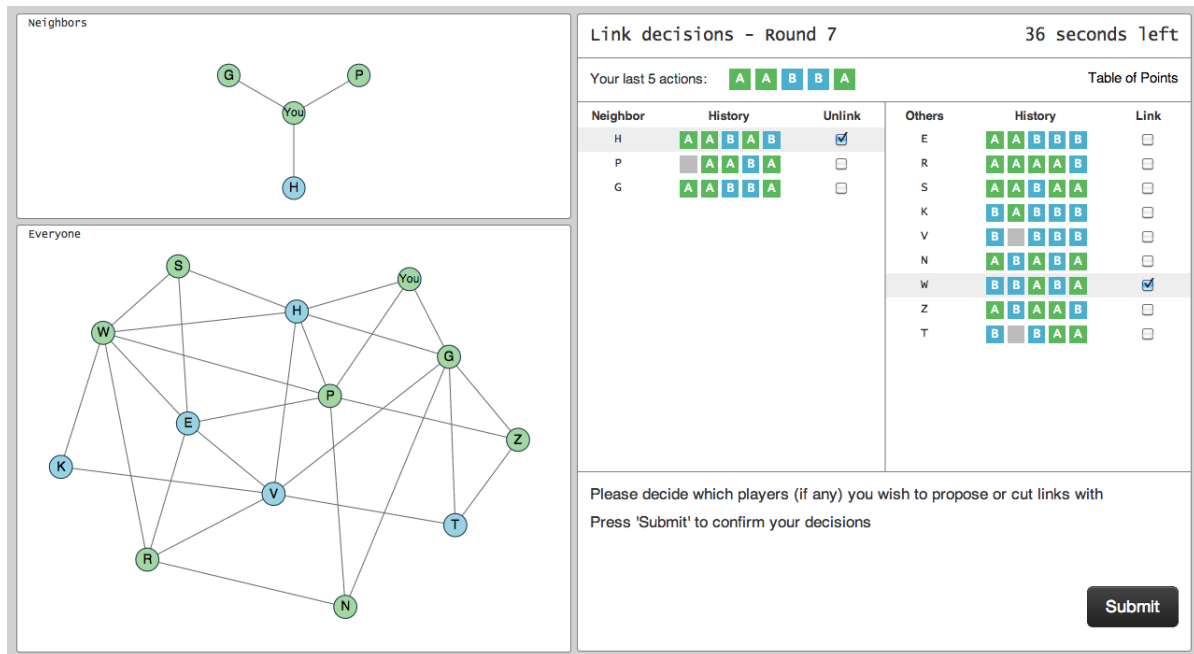
4

Figure S2: Three-panel design of the game interface. The screenshot shown here is stage 1 of a round in the RN treatment.

The right panel contains four blocks from top to bottom:

The first block indicates the current stage and current round of the game, and the time left for making an input. In the first stage, subjects have 70 seconds to propose and cut links. In the second stage, subjects have 45 seconds to accept or reject any link proposal(s) they may have received. In the third stage, subjects have 25 seconds to choose an action. At the end of a round, subjects have 10 seconds to view the results.

The second block reminds the subject of her own past actions. The "Table of Points" link on the right allows the subject to see the payoff information of the game by hovering her mouse pointer on the link.

Figure S3: In stage 1 the third block in the right panel displays other subjects' previous actions and allows subjects to propose and cut links. The example screenshot above is what a subject would see in treatments R and RN with global reputational information. A green box with an "A" indicates that the subject has chosen to cooperate, a blue box with a "B" indicates that the subject has chosen to defect, and a gray box denotes that the subject has not taken an action. For instance, in the screenshot above we have that in the previous round subject H chose to defect and N chose to cooperate. Notice that if a subject does not take an action then the computer selects the defect action by default.

In the first stage, the third block lists the neighbors (on the left) and non-neighbors (on the right) that are carried over from the last round, and their respective actions in the previous five rounds. In the B and N treatments with local reputational information, subjects can only see the history of actions of their neighbors. Subjects are free to propose and cut any link by ticking the box next to the fictitious initial of any other subject (see Figure S3). In the second stage, any unmatched link proposal is shown in the non-neighbors list: a "Y/N" button appears next to the non-neighbor who sent the proposal, and the subject then needs to choose 'Y' (for Yes) or 'N' (for No) for each proposal (see Figure S4). In the third stage, both neighbors and non-neighbors lists are updated based on the results of the earlier stages.

Figure S4: In stage 2 the third block in the right panel displays the reputational information of other subjects and allows subjects to approve or reject other subjects' link proposals

The bottom block indicates what the subject needs to do in each stage and shows the button(s) for making an input. In the first two stages, it displays a "Submit" button the subject can use to confirm her choices. In the third stage, it displays the choices between the "A" (denoting cooperate) and "B" (denoting defect) buttons, and a separate "Submit" button for confirming the choice (see Figure S5).

Figure S5: In stage 3 the bottom block allows subjects to choose between "A" (cooperate) and "B" (defect)

The Game lasts for at least 13 rounds and at most 16 rounds. Starting from the 13th round, the game may randomly terminate with a 50% probability, which subjects are informed about

7

in the Instructions.

2 Sample Description

The main experimental data contains the decisions of 364 subjects, and multiple participations are not allowed. We ran a total of 30 sessions starting at 11am EST between the 12th and the 21st of December, 2013. *UbiquityLab* allows us to run several sessions concurrently in a single "meta-session". We ran 9 meta-sessions consisting of 2 to 5 sessions each. In 2 out of 30 sessions subjects dropped out so we excluded them from the main analysis, but the results are unchanged if we include these sessions (see Section 7 for details). A single experimental session lasted on average 49.6 minutes. Subjects were paid a fixed $2 fee and a bonus based on their performance. The average earnings was $5.13. These earnings are above the average hourly earnings for a Turker on AMT.

There are 13 subjects in each session, and the choice of this sample size stems from a number of considerations. First, the exploration of the impact of social knowledge required networks with a large enough number of subjects to make the task of processing network information non-trivial. Conversely, we did not want the number of subjects to be very large in order to avoid making the network information too complex to be usable by subjects. Second, from the operational side of the experiment, we wanted to minimize the possibility of subjects dropping out of the experiment, and this probability is clearly increasing in the size of the sessions. Finally, we did not want to depart significantly from the session sizes used by previous contributions to the investigation of cooperation in dynamic networks [5, 7, 8, 10]. The choice of 13 subjects per session turned out to be the best option given these considerations.

We match the experimental data with the Questionnaire data. Table S1 summarizes the main socio-demographic characteristics of the participants and their pairwise correlations. All the participants are residents in the U.S.: 43% are female and the average age is 32.6 years

old. We asked subjects the standard interpersonal trust question from the World Values Survey (*WVS*) and found that about 52% believe that others can be trusted, which is higher than the average value from the *WVS* survey of the U.S. population. The level of trust is not correlated with gender, age or education.

Table S1: Summary statistics and pairwise correlations for the main variables.

	n	Mean	s.d.	Gender	Age	Education	Trust	HL
1. Gender[1]	364	0.43	0.50	1.00				
2. Age	364	32.63	10.33	0.06	1.00			
3. Education[2]	364	3.35	1.35	-0.00	0.11*	1.00		
4. Trust[3]	364	0.52	0.50	-0.05	0.09	0.00	1.00	
5. HL[4]	333	7.54	1.74	-0.00	-0.01	0.02	-0.02	1.00

*$P < 0.05$. 1. Female $= 1$. 2. See the caption of Figure S6(b) for codings; 3. Trust question with $0 =$ "Need to be very careful" and $1 =$ "Most people can be trusted"; 4. Holt and Laury's risk attitude test: 21 participants are excluded because they made at least one inconsistent choice (i.e. multiple switching points) and 10 participants are excluded because they had no switching point.

Figure S6 illustrates in more detail the composition of the subject pool, which is more representative of the general population than the student populations that are typical of most laboratory studies. Figure S6(a) shows that subjects belong to different age groups ranging from a minimum of 18 to a maximum of 70 years old. There is also a significant heterogeneity in the education level of participants. Figure S6(b) shows that 6.9% of participants only have a high school diploma, 76.9% have attained some kind of college education, and 15.9% have a master, professional degree or Ph.D. As one would expect, there is a significant positive correlation between age and education level.

During the Questionnaire, subjects also took the Holt and Laury's risk attitude test [11]: there are 10 scenarios and in each scenario a subject has to pick between a safe and a risky
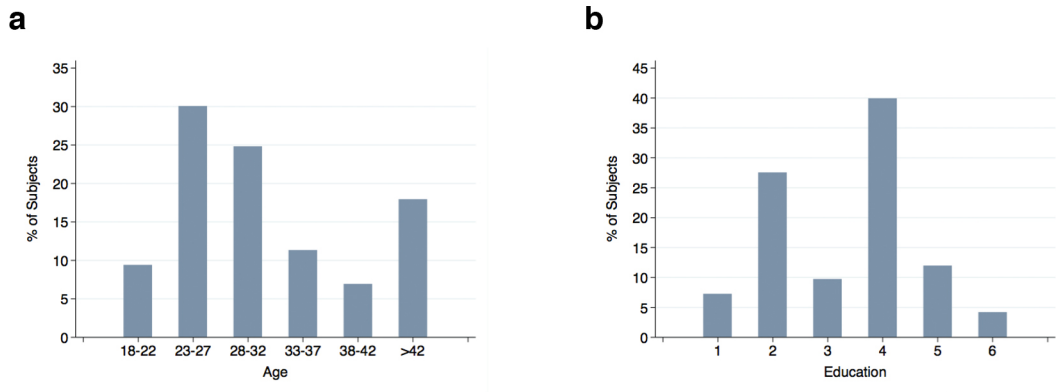
a

b

Figure S6: Percentages of subjects of different age groups (left) and education levels (right) for the 364 participants. Classification of education levels: 1 = high school or less, 2 = some college, 3 = 2-year college, 4 = 4-year college, 5 = master, 6 = professional degree (e.g. MD) or PhD.

lottery. In the early scenarios the safe lottery gives a higher expected payment, while in the late scenarios it is the opposite. A risk-neutral participant would switch from the safe to the risky lottery at scenario 5. The mean switching point is 7.5 so the participants are on average risk-averse. There are 10 (3%) participants who switched at or before scenario 4 and therefore are risk-seeking, and 40 (12%) participants who are risk-neutral. There is no significant correlation of risk aversion with gender, age, education or trust.

3   Further Experimental Data

In this section we report additional data on subjects' decisions during the experiment.

On average, subjects take 18.9 minutes ($SD = 3.4$) to complete the Instructions and the Quiz. There are slight variations in the Instructions and the Quiz across treatments, so the average time spent on them are 18.1, 20.4, 17.1 and 20.0 minutes for treatments B, N, R and RN respectively.

In the Quiz there are 5 questions in the B and the R treatments, and 6 questions in the N and the RN treatments. The extra question in the N and RN treatments tests subjects' under-

10

standing of the interactive features of the network figure in the interface, which are available only in those two treatments. Subjects have a maximum of 3 tries to pass the Quiz, and in case they fail the third try they are not allowed to continue to the experiment. Moreover, after each unsuccessful attempt, we randomly re-generate the numbers in the failed question(s) for the subsequent try to ensure it is very unlikely that subjects pass the Quiz by randomly guessing the answer through trial and error. Overall, subjects take on average 1.5 ($SD = 0.7$) tries to answer correctly all the questions. The mean numbers of tries for treatments B, N, R and RN are 1.5, 1.6, 1.4 and 1.5 respectively, and there is no significant difference across treatments. 64.0% of subjects pass the Quiz in their first try, 24.7% pass with two tries, and 11.3% need three tries. For those subjects who do not pass the Quiz in their first try, they make on average 1.4 ($SD = 0.6$) mistakes in their first try and 1.3 ($SD = 0.5$) mistakes in their subsequent try (if required).

On average, subjects spend 20.9 ($SD = 3.6$) minutes to play the experimental game. The mean time for subjects to submit their choices in the first stage is 16.3 ($SD = 8.2$) seconds, the mean time in the second stage is 11.3 ($SD = 6.8$) seconds, and the mean time in the third stage is 9.1 ($SD = 4.0$) seconds. During the N and RN treatments, we implement real-time tracking of subjects' mouse movements on the network figure of the interface, in terms of both the number of times a subject hovers over a node with the mouse pointer to highlight that node and its neighbors, and the number of times a subject clicks and drags the nodes to re-arrange the network layout. Figure S7 below shows the evolution of both measurements over the course of the game for both the N and RN treatments. On average, subjects hover over 4.3 ($SD = 1.5$) and 4.9 ($SD = 1.3$) nodes in each round of the RN and N treatments respectively. Every instance of node dragging is also recorded as an instance of hovering over a node, so we measure the usage of node dragging per round in terms of the percentage of times that hovering over a node involved node dragging as well, as shown by the red line in Figure S7. Subjects

drag a node to re-arrange the network 10.5% of times they hover over it in the N treatment, and 11.8% of times in the RN treatment. The relatively lower usage of the node dragging feature may indicate that our customized force layout algorithm is effective at displaying the network and subjects do not need to re-arrange its layout manually.
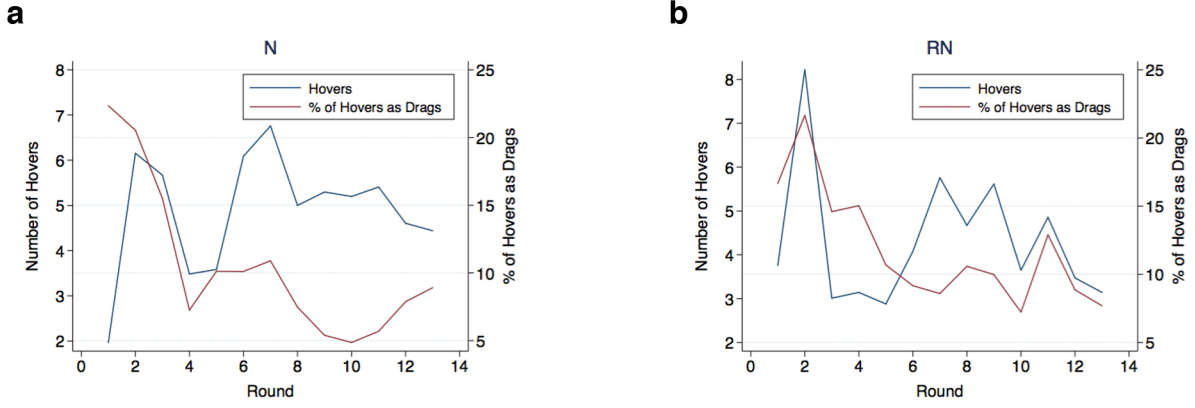
a

b

Figure S7: Usage of the interactive features of the network figure in treatments (a) N and (b) RN. The blue line shows the evolution of the usage of hovering over a node during the game, while the red line shows the evolution of the usage of node dragging (as a percentage of instances of hovering over a node).

4   Louvain community detection algorithm

We use the Louvain community detection algorithm [12] to detect communities in the network structure that emerges in each round. The Louvain method adopts a hierarchical design to greedily partition the network into communities that obtain the highest value of modularity. Modularity is defined as:

$$Q = \frac{1}{2L} \sum_C \left(2l_C - \frac{d_C^2}{2L} \right)$$

where L is the total number of links in the network, C denotes a community, l_C is the number of links in community C, $d_C = \sum_{i \in C} d_i$ is the sum of the number of connections, or degree, d_i for each subject $i \in C$. The algorithm starts by placing each node in its own community and

seeks to merge it with neighboring communities such that the modularity gain is maximized by iterating through every node. A node that is previously merged to a community can be detached to join a new community in subsequent iterations, which allows the algorithm to correct initial sub-optimal choices. This phase is repeated until it is not possible to move a node to achieve an increase in modularity. The second phase builds a new network by collapsing all the nodes of the same community into a "super node", and then it runs the first phase with this new network consisting of super nodes. This alternating two-phase procedure is repeated several times until there is no more improvement in modularity. The pseudo-code in Algorithm S1 summarizes the algorithm.

Algorithm S1 Louvain Community Detection Method

Require: G the original network
1: **loop**
2:     Initialize each node of G as a cluster
3:     **while** some node(s) can be moved **do**
4:         **for** every node i in G **do**
5:             Move i to a neighboring community to maximize the modularity gain if possible, otherwise retain i in its own community
6:         **end for**
7:     **end while**
8:     **if** resulting modularity is higher than before **then**
9:         Collapse each cluster into a super node
10:         $G \leftarrow$ the network of super nodes
11:     **else**
12:         **return** resulting clusters and terminate
13:     **end if**
14: **end loop**

Using the Louvain method, we detect communities that emerge in each round of the experimental game and order them by size in descending order. Figure S8(a) shows the distribution of the number of detected communities in each treatment. There is no difference across treatments in terms of the fragmentation of the networks. The most frequent outcome of the algorithm is the decomposition of the network into two communities, followed by the decomposition into three communities. There is no significant difference across treatments in terms of the number of communities that emerge in the networks. Figure S8(b) shows the distribution of the mean sizes of communities for each treatment. We find that communities 1 and 2 together make up

13

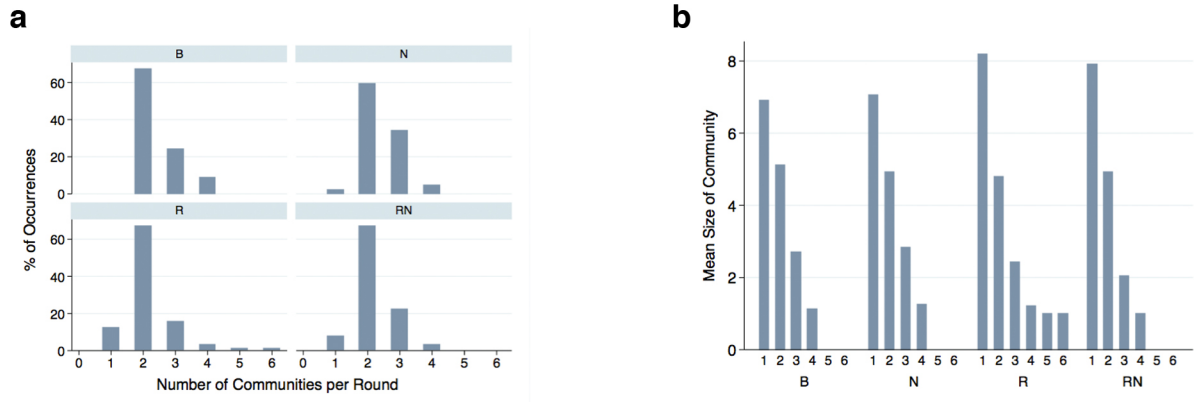on average over 85% of the group for all the treatments.

Figure S8: (a) Distribution of the number of detected communities in each treatment: the percentages are calculated using $\frac{\text{number of occurrences}}{13 \times 7}$, where 13 is the total number of rounds in each of the 7 sessions in a treatment. (b) Distribution of the mean sizes of communities in each treatment: the labels (e.g. 1, 2, 3, etc) on the x-axis within each treatment denote communities (e.g. $C1$, $C2$, $C3$, etc).

5 Detailed analysis

In this section we describe the technical details and provide further analysis of our data. We have organized it in three separate parts: section 5.1 presents the aggregate analysis at the session level, section 5.2 presents the analysis at the community level, section 5.3 presents the regression analysis at the individual level, and section 5.4 presents a visual summary of our results.

5.1 Aggregate level

After aggregating the data at the session level, we use the Kruskal-Wallis test [13] to detect the presence of a treatment effect by comparing across treatments, and use the Dunn's test [14] as the post-hoc test to conduct multiple pairwise comparisons between treatments. We choose the Dunn's test because: (a) it uses the same ranks as those in the Kruskal-Wallis test; and (b) it uses

the pooled variance implied by the null hypothesis in the Kruskal-Wallis test. Other pairwise comparison tests (e.g. the Mann-Whitney test) are not appropriate as the post-hoc test following the Kruskal-Wallis test because they violate (a) and (b). Furthermore, we apply the Benjamini-Hochberg adjustment [15] method with a 5% false discovery rate to the Dunn's test to control for the false discovery rate during the multiple comparisons. The choice of a non-parametric test and the application of a correction for multiple comparisons with a small $n = 7$ sample per treatment after aggregation is very conservative, and therefore any statistically significant finding denotes a sizable treatment effect.

Table S2 lists the full results of the Kruskal-Wallis tests and the Dunn's tests with P-values adjusted using the Benjamini-Hochberg correction (with a 5% false discovery rate) for different variables at the aggregate level from round 6 to 13. We report the results for the same range of rounds as in the main text.

Table S3 replicates the analysis in Table S2 for rounds 1 to 13. Note that prior to round 5 subjects have access to all the past actions of their neighbors (in B and N) or everyone in the group (in R and RN), while after round 5 they have access to the previous 5 actions. The inclusion of these initial rounds in our analysis has no substantial impact on our results.

Table S4 replicates the analysis in Table S2 for round 1 only. The results show that there is no significant difference in subjects' play in the very first round of the experiments between different treatments.

Table S2: Results of the Kruskal-Wallis tests and the Dunn's tests with P-values adjusted using the Benjamini-Hochberg correction for different variables at the aggregate level from round 6 to 13. $n = 7$ sample size per treatment after aggregation at the session level.

Variable	Kruskal-Wallis Test $\left(\begin{smallmatrix} \chi^2(3) \\ P\text{-value} \end{smallmatrix}\right)$	Dunn's Test $\left(\begin{smallmatrix} z\text{-statistic} \\ P\text{-value} \end{smallmatrix}\right)$		
			RN	B	N
Coop. Level	9.538 0.023	B	2.096 0.036		
		N	2.323 0.060	0.227 0.492	
		R	0.065 0.474	-2.031 0.032	-2.259 0.036
Avg. Payoff	9.545 0.023	B	2.047 0.041		
		N	2.307 0.032	0.260 0.477	
		R	0.000 0.500	-2.047 0.031	-2.307 0.063
Density	9.538 0.006	B	2.535 0.017		
		N	2.600 0.028	0.065 0.474	
		R	0.130 0.538	-2.405 0.012	-2.470 0.014
Clustering	11.090 0.011	B	2.762 0.017		
		N	2.437 0.022	-0.325 0.373	
		R	0.585 0.335	-2.177 0.030	-1.852 0.048

Table S3: Results of the Kruskal-Wallis tests and the Dunn's tests with P-values adjusted using the Benjamini-Hochberg correction for different variables at the aggregate level from round 1 to 13. $n = 7$ sample size per treatment after aggregation at the session level.

Variable	**Kruskal-Wallis Test** $\left(\begin{smallmatrix}\chi^2(3)\\P\text{-value}\end{smallmatrix}\right)$	**Dunn's Test** $\left(\begin{smallmatrix}z\text{-statistic}\\P\text{-value}\end{smallmatrix}\right)$		
			RN	B	N
Coop. Level	9.583 0.023	B	1.949 0.038		
		N	2.144 0.032	0.195 0.423	
		R	-0.260 0.477	-2.209 0.041	-2.404 0.049
Avg. Payoff	9.350 0.025	B	1.884 0.045		
		N	2.047 0.041	0.162 0.436	
		R	-0.357 0.433	-2.242 0.038	-2.404 0.049
Density	10.060 0.018	B	2.307 0.063		
		N	2.242 0.038	-0.065 0.474	
		R	0.065 0.569	-2.242 0.025	-2.177 0.022
Clustering	10.997 0.012	B	2.502 0.037		
		N	2.339 0.029	-0.162 0.436	
		R	0.162 0.523	-2.339 0.019	-2.177 0.022

Table S4: Results of the Kruskal-Wallis tests and the Dunn's tests with P-values adjusted using the Benjamini-Hochberg correction for different variables at the aggregate level for round 1. $n = 7$ sample size per treatment after aggregation at the session level.

Variable	Kruskal-Wallis Test $\left(\begin{smallmatrix}\chi^2(3)\\P\text{-value}\end{smallmatrix}\right)$	Dunn's Test $\left(\begin{smallmatrix}z\text{-statistic}\\P\text{-value}\end{smallmatrix}\right)$		
Coop. Level	6.455 0.092		RN	B	N
		B	1.123 0.261		
		N	1.058 0.174	-0.065 0.474	
		R	-1.074 0.212	-2.197 0.084	-2.132 0.050
Avg. Payoff	6.187 0.103		RN	B	N
		B	0.977 0.197		
		N	1.091 0.207	0.114 0.455	
		R	-1.091 0.276	-2.067 0.058	-2.181 0.088
Density	2.387 0.496		RN	B	N
		B	0.000 0.500		
		N	0.016 0.592	0.016 0.740	
		R	-1.256 0.209	-1.256 0.314	-1.272 0.610
Clustering	3.547 0.315		RN	B	N
		B	1.219 0.223		
		N	1.137 0.192	-0.081 0.468	
		R	-0.276 0.469	-1.495 0.405	-1.414 0.236

We also run Ordered Logistic Regression (with the proportional odds model) for the same variables at the aggregate level, which allows us to test for interaction effects between the (indicator) treatment variables rep and net using effect coding (B: $rep = -1, net = -1$; N: $rep = -1, net = 1$; R: $rep = 1, net = -1$; RN: $rep = 1, net = 1$). This regression model can be seen as a generalization of the Kruskal-Wallis test, and caters for more than two outcomes in the dependent variable. We apply a rank-transformation before running the OLR, and such transformation induces a natural ordering from the data. Table S5 lists the results of these regressions for the rounds between 6 and 13, and shows that the presence of global reputational knowledge (i.e. indicator variable $rep = 1$) has a significant effect on the level of cooperation, average payoff per round, density and clustering of the networks, while the presence of global social knowledge (i.e. indicator variable $net = 1$) and the interaction between global reputational and global social knowledge are not significant at the aggregate level.

As a robustness check for these results, we also run the same analysis using the Robust Regression model. In these regressions we use the original outcome variables, and therefore we do not apply a rank-transformation before running the analysis. Table S6 lists the results of these regressions for the rounds between 6 and 13, and the conclusions are unchanged: global reputational knowledge has a significant effect on the level of cooperation, average payoff per round, density and clustering of the networks, while the presence of global social knowledge and the interaction between global reputational and global social knowledge are not significant at the aggregate level.

Table S5: Treatment effects at aggregate level using ordered logistic regression. n = 7 sample size per treatment after aggregation at the session level.

	Coop. Level	Avg. Payoff	Density	Clustering
rep	1.296**	1.285**	1.745***	1.514***
	(0.408)	(0.406)	(0.483)	(0.459)
net	-0.201	-0.220	-0.189	0.200
	(0.334)	(0.336)	(0.334)	(0.329)
rep $\times$ net	0.074	0.078	-0.011	-0.010
	(0.334)	(0.336)	(0.335)	(0.329)
Observations	28	28	28	28
χ^2	11.863	11.808	17.393	14.472
$P > \chi^2$	0.008	0.008	0.001	0.002

Standard errors in parentheses. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table S6: Treatment effects at aggregate level using robust regression. n = 7 sample size per treatment after aggregation at the session level.

	Coop. Level	Avg. Payoff	Density	Clustering
rep	0.155**	6.471**	0.120***	0.082***
	(0.039)	(1.622)	(0.027)	(0.020)
net	-0.021	-0.927	-0.015	0.003
	(0.039)	(1.622)	(0.027)	(0.020)
rep × net	0.004	0.427	-0.005	-0.008
	(0.039)	(1.622)	(0.027)	(0.020)
Observations	28	28	28	28
F	5.341	5.437	6.566	5.852
$P > F$	0.006	0.005	0.002	0.004

Standard errors in parentheses. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

5.2 Community level

After aggregating the data at the session level, we use the Mann-Whitney test for pairwise comparisons to detect the presence of within treatment differences between $C1$ and $C2$ for each treatment.

Table S7 lists the full results for the Mann-Whitney tests that compare $C1$ and $C2$ within treatments for the variables in Figure 2 and Figure 3 of the main text. For each comparison we report the z-statistic and the P-value.

Table S7: Results of the Mann-Whitney tests for comparing $C1$ and $C2$ for different variables at the community level from round 6 to 13. $n = 7$ sample size for each community in each treatment after aggregation at the session level.

| **Variable**	**B** $\left(\begin{smallmatrix} z\text{-statistic} \\ P\text{-value} \end{smallmatrix}\right)$	**N** $\left(\begin{smallmatrix} z\text{-statistic} \\ P\text{-value} \end{smallmatrix}\right)$	**R** $\left(\begin{smallmatrix} z\text{-statistic} \\ P\text{-value} \end{smallmatrix}\right)$	**RN** $\left(\begin{smallmatrix} z\text{-statistic} \\ P\text{-value} \end{smallmatrix}\right)$
Coop. Level	0.192 0.848	-0.319 0.749	0.703 0.482	2.236 0.025
Comm. Neighbor Payoff	0.640 0.522	-0.192 0.848	0.704 0.482	2.364 0.018
Links Removed	0.703 0.482	0.447 0.655	0.128 0.898	2.364 0.018
Removals Received	-0.703 0.482	0.447 0.655	-1.663 0.096	-3.130 0.002
Proposals Rejected	0.064 0.949	0.064 0.949	-1.597 0.110	-2.364 0.018
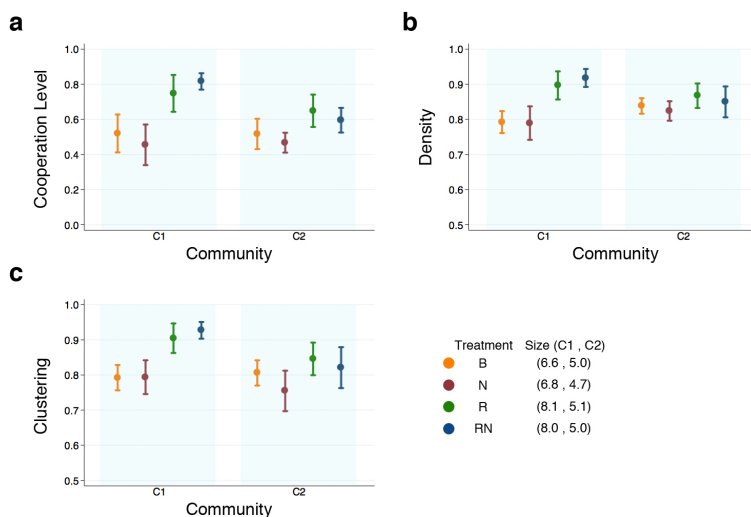
Figure S9: Cooperation level (**a**), density (**b**), and clustering (**c**) of the *largest* and the *second largest* communities for treatments B, N, R and RN. Error bars indicate $\pm$ one SEM. For each treatment data is aggregated for each community at the session level.

Figure S9 shows the aggregated absolute levels of cooperation, density and clustering for $C1$ and $C2$ in each treatment. As Table S7 above shows, there is a significant difference in cooperation level between $C1$ and $C2$ in RN, but not in any of the other treatments. As the

figures suggest, there is a qualitative difference in density and clustering between $C1$ and $C2$ in the RN treatment, but this difference is not significant for RN or any of the other treatments.

5.3   Individual level

Table S8 lists the full output of the logit panel estimation with random effects per subject and standard errors clustered at the session level. The dependent variable is the action taken by subjects (1 = cooperate), and we exclude observations (35 out of 5,018 or 0.7% of the total) in which subjects take no action.

We include the following network metrics as independent variables to investigate the association between network structure and cooperation: *Degree* is the number of connections; *Clustering* is the local clustering coefficient [16]; *Betweenness* is the betweenness centrality index [17]; *Eigenvector* is the eigenvector centrality index [18]; and *Community* equals to 1 if the individual is part of the largest community $C1$ and equals to 0 if the individual is part of the second largest community $C2$.

Payoff captures the number of points the individual wins in a round. The *L1.action*, *L2.action*, *L3.action*, *L4.action*, and *L5.action* variables are controls for lagged actions, so *Lx.action* denotes the action the individual took x rounds before. We also include a number of socio-economic characteristics (*Gender, Age, Education*), a measure of *Trust* from the standard question from the World Values Survey, and the results of a Holt-Laury risk elicitation test from the Questionnaire, see the caption of Table S1 for details on the coding of the variables.

We have a number of controls for the linking behavior of subjects in a given round. *Links added* is the number of new links the subject adds in a given round; *Total links removed* is the number of links the subjects loses (either by removing others or by being removed by others); *Proposals received* is the number of link proposals received by the subject; *Removals received* is the number of link removals received by the subject; *Proposals approved* is the number of a

subject's link proposals approved by others; and *Proposals rejected* is the number of a subject's link proposals rejected by others.

Time 1, Time 2 and *Time 3* denote the time in seconds that subjects take to complete stage 1, 2 and 3 respectively in each round. *Mouse hover 1*, *Mouse hover 2* and *Mouse hover 3* capture the number of times a subject hovers over a node in the network figure in stages 1, 2 and 3 respectively. *Mouse drag 1*, *Mouse drag 2* and *Mouse drag 3* capture the number of times a subject clicks and drags nodes in the network figure in stages 1, 2 and 3 respectively. *Quiz tries* denotes the number of times a subjects has to take the Quiz before getting all the questions correct. *Quiz errors 1* and *Quiz errors 2* denotes the number of errors a subject makes when she takes the Quiz the first and second time respectively. *Session* denotes session fixed effects, which are included in all regressions.

Table S8: Determinants of subjects' actions with SEs clustered at the session level

Treatments	B		N		R		RN	
Dep. Var.: Action								
Degree	1.226	(2.504)	2.832	(1.614)	13.38***	(2.485)	36.80***	(8.774)
Clustering	-0.202	(0.747)	1.205*	(0.514)	-2.080*	(0.907)	-0.171	(1.478)
Betweenness	4.672	(2.605)	1.550	(1.531)	-10.85***	(3.144)	-19.61**	(7.433)
Eigenvector	7.147	(4.451)	1.459	(1.787)	-3.636	(4.043)	-2.528	(11.48)
Community	0.550	(0.393)	0.464	(0.286)	0.658	(0.439)	2.018*	(0.797)
Payoff	-0.234***	(0.0300)	-0.126***	(0.0177)	-0.303***	(0.0352)	-0.950***	(0.177)
L1.action	0.609	(0.495)	0.134	(0.345)	1.509**	(0.575)	0.834	(0.945)
L2.action	0.922*	(0.428)	0.778**	(0.300)	0.371	(0.573)	2.327	(1.251)

24

L3.action	0.876*	(0.413)	0.607*	(0.299)	0.459	(0.505)	2.318*	(1.090)
L4.action	1.357***	(0.387)	0.847**	(0.299)	-0.263	(0.486)	-0.310	(0.767)
L5.action	0.642	(0.390)	0.324	(0.304)	-0.398	(0.513)	-1.726	(0.970)
Gender	-0.169	(0.376)	0.0345	(0.288)	-0.0692	(0.445)	-0.713	(0.831)
Age	-0.0130	(0.0185)	0.00189	(0.0166)	-0.0305	(0.0220)	0.0211	(0.0426)
Trust	0.155	(0.365)	-0.0176	(0.298)	0.0216	(0.505)	-0.721	(0.795)
Education	-0.0722	(0.142)	-0.0707	(0.106)	0.0559	(0.174)	-0.781*	(0.320)
Risk	-0.0246	(0.464)	0.0957	(0.268)	0.134	(0.435)	0.690	(0.844)
Links added	-1.645***	(0.290)	-1.166***	(0.210)	-0.512	(0.317)	-0.843	(0.704)
Total links removed	0.768***	(0.222)	0.132	(0.158)	0.912**	(0.333)	-0.242	(0.398)
Proposals received	1.416***	(0.241)	0.801***	(0.170)	0.909***	(0.225)	0.674	(0.636)
Removals received	-0.445	(0.287)	0.0348	(0.182)	-0.584	(0.354)	0.110	(0.426)
Proposals approved	1.264***	(0.348)	1.156***	(0.286)	0.138	(0.417)	-0.0206	(0.826)
Proposals rejected	0.000763	(0.103)	0.0207	(0.0755)	0.00624	(0.129)	-0.255	(0.242)
Time 1	-0.0389	(0.0240)	0.0135	(0.0167)	-0.0587	(0.0360)	-0.0705	(0.0789)
Time 2	-0.0305	(0.0283)	-0.00429	(0.0217)	-0.00961	(0.0455)	0.118	(0.101)
Time 3	-0.0600	(0.0377)	-0.0658*	(0.0270)	-0.0750	(0.0577)	-0.255*	(0.129)
Mouse hover 1	-		0.00990	(0.0221)	-		0.155	(0.244)
Mouse drag 1	-		0.191	(0.284)	-		0.809	(1.391)
Mouse hover 2	-		0.0808	(0.0727)	-		0.0233	(0.166)
Mouse drag 2	-		1.781	(1.661)	-		-0.995	(0.608)

Mouse hover 3	-		-0.0134	(0.0690)	-		-0.0272	(0.223)
Mouse drag 3	-		0.149	(0.256)	-		-0.607	(1.121)
Quiz tries	0.134	(0.672)	-0.548	(0.511)	0.763	(0.829)	-1.044	(1.521)
Quiz errors 1	-0.0795	(0.446)	0.207	(0.340)	-0.113	(0.628)	1.443	(0.894)
Quiz errors 2	-0.313	(0.580)	0.487	(0.617)	-2.256*	(1.140)	-2.136	(2.152)
Session	Y		Y		Y		Y	
Constant	1.788	(1.852)	-2.378*	(1.068)	-3.381	(2.029)	8.992*	(4.171)
Observations	658		722		802		756	
χ^2	132.7		188.9		114.0		39.66	

Standard errors in parentheses. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table S9 shows the results of a logistic regression to investigate how a subject's decision to propose a link to another subject depend on the recipient's network position and previous action. We run a logistic regression with session and round fixed effects and standard errors clustered at the session level. The dependent variable is a dummy, proposal$_{ij}$, indicating whether subject i makes a proposal to another subject j in round $t + 1$ (1 = proposal made). We only include i-j pairs that are not linked at round t, which explains the different number of observations for each treatment.

We include three independent variables for all four treatments: d_i is the number of neighbors of i in round t; d_j is the number of neighbors of j in round t; d_{ij} is the number of common neighbors between i and j in round t. Furthermore, we control for the action taken by j in round t for the R and RN treatments because in these treatments reputational knowledge is available about everyone in the network. In treatments B and N, the information about j's

action at time t is not available to j so we do not include the control in the main regressions, but, as a robustness check, we also run the same regressions including the control and the results are unchanged.

The results in Table S9 below show that the variable d_{ij} is highly significant only in the N treatment, which shows that the probability that a subject proposes a link to another subject in the N treatment is increasing in the number of common neighbors.

Table S9: Determinants of subjects' link proposals with SEs clustered at the session level

	B	B	N	N	R	RN
Dep. Var.: proposal$_{ij}$						
d$_i$	-0.240*	-0.247*	-0.192*	-0.210**	-0.204**	-0.155**
	(0.105)	(0.105)	(0.090)	(0.081)	(0.079)	(0.051)
d$_j$	0.094*	0.006	-0.007	-0.076	0.089*	0.182***
	(0.046)	(0.048)	(0.065)	(0.059)	(0.038)	(0.035)
d$_{ij}$	0.049	0.081	0.178***	0.217***	0.092	0.016
	(0.031)	(0.052)	(0.047)	(0.063)	(0.059)	(0.019)
action$_j$		1.269***		1.050***	2.001***	1.762***
		(0.190)		(0.091)	(0.122)	(0.389)
Observations	6102	6102	6040	6040	3986	4138

Standard errors in parentheses. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

5.4 Visual summary

Here we present snapshots of representative sessions to give a visual summary of our findings.
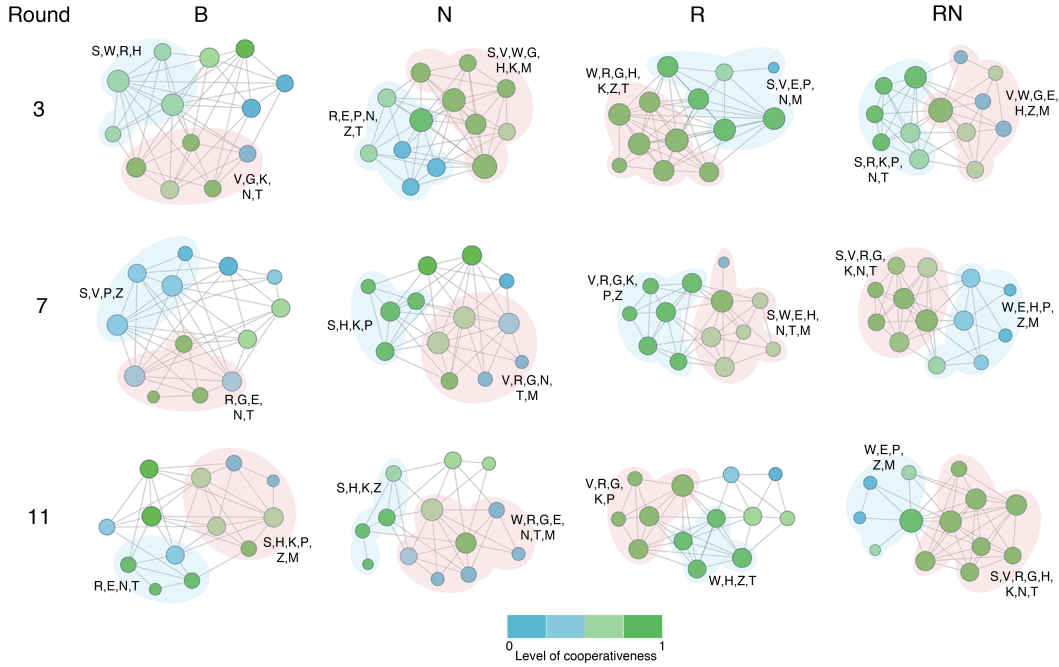
Figure S10: Snapshots showing the evolution of the network and cooperative behavior for representative sessions. Each column is a representative session for each treatment, from left to right: B, N, R and RN. Each row is a round: 3, 7 and 11 from top to bottom. The size of a node is proportional to its degree. The colour of a node corresponds to the number of cooperative actions in the previous 5 rounds: blue (0 or 1 cooperative actions), light blue (2), light green (3), and green (4 or 5). Red and blue bubbles distinguish the $C1$ and $C2$ communities respectively. The labels next to the bubbles list the fictitious IDs of the members of the corresponding communities. Both the bubbles and the labels are displayed for the two largest communities only.

In the baseline B, the level of cooperation is low leading to sparse networks and no association between cooperation and position in the social structure. The addition of global social knowledge in N leads to a positive association between clustering and cooperativeness, but it has no impact on the aggregate level of cooperation and the structure of the network. The introduction of global reputational knowledge in the R treatment leads to a sharp increase in cooperation level, payoffs, the emergence of cooperative hubs, and a very dense and clustered network. The presence of both global reputation and global social knowledge in RN has no impact on the aggregate level of cooperation compared to R, but it has a distributional effect: it

allows cooperators to fully exploit the ability to form and remove connections by creating a separate community which effectively excludes defectors. RN is the only treatment where there is a significant gap in outcomes depending on community membership: individuals in community $C1$ tend to be more cooperative than individuals in $C2$ so $C1$ achieves a significantly higher cooperation level than $C2$, and within-community interactions produce a larger payoff for the community members of $C1$ compared to $C2$.

6 Stability

In this section we motivate our choice to focus our main analysis to rounds 6 to 13 by showing that subjects' play becomes more stable from round 6 onwards.

Given the ordered communities (by size) in each round, we compare membership of corresponding communities in consecutive rounds to see if the communities stabilize over time. We first define two stability metrics, and then use them to investigate when community membership becomes stable.

The first stability metric we define is *C1 Stable*: it captures the stability of the largest community ($C1$) in any given round by comparing the membership of $C1$ in round t to that of the $C1$ community in the $t - 1$ and $t - 2$ rounds respectively. If the $C1$ community in at least one round between $t - 1$ and $t - 2$ has at most two changes in membership compared to the $C1$ community at t, then we set the value of *C1 Stable* to 1 for round t, otherwise we set it to 0.

The second stability metric we define is *Any Stable*, which expands the definition of *C1 Stable* by extending the comparison to more communities. The *Any Stable* metric compares the membership of a given community ($C1$, $C2$, or $C3$) in round t to that of *any* other community in the $t - 1$ and $t - 2$ rounds. If the difference is less than 2 for any comparison, then we set the value of *Any Stable* to 1 for round t, otherwise we set it to 0. If any community in at least one round between $t - 1$ and $t - 2$ has at most two changes in membership compared to the given

community at t, then we set the value of *Any Stable* to 1 for round t, otherwise we set it to 0.

We compute the values of both metrics for every community in every round of the game, and aggregate it by computing the mean value over the $[13 - x, 13]$ range of rounds for each treatment. We select the largest integer x such that the means of both the *C1 Stable* and the *Any Stable* metrics are above 0.5 with the additional constraint that $x < 9$ so that the history of the previous 5 actions is already available to subjects. Moreover, we require that if the metrics are above 0.5 in the $[13 - x, 13]$ range of rounds, then they must be above 0.5 in the $[13 - y, 13]$ range, where $y < x$. The largest x that satisfies these criteria is $x = 7$, and Table S10 shows the values of the *C1 Stable* and the *Any Stable* metrics for each community in all 4 treatments.

Table S10: Stability metrics for communities $C1$ and $C2$ in each treatment

Treatment	Community	Size	$C1$ Stable	Any Stable
B	1	6.6	0.55	0.73
B	2	5.0		0.79
N	1	6.8	0.59	0.71
N	2	4.7		0.73
R	1	8.1	0.52	0.63
R	2	4.9		0.68
RN	1	8.0	0.5	0.57
RN	2	4.9		0.57

Mean values of the *C1 Stable* and *Any Stable* metrics in rounds $[6, 13]$. Size is the mean size of the communities in each treatment. By definition the *C1 Stable* metric is only available for the $C1$ community.

7 Robustness Checks

In this section we check that our results are robust to the inclusion of the sessions with dropped out subjects.

There are a total of 2 sessions (out of 30) in which subject(s) drop out during the game. In treatment R, four subjects subsequently dropped out during the game in rounds 1, 2, 5 and 9. In treatment RN, one subject dropped out in round 3. UbiquityLab actively prevents drop-outs caused by temporary network problems, and any temporarily disrupted connection is automatically restored upon detection. However, we cannot circumvent issues such as the permanent loss of power or Internet connection, the crash of a subject's browser or operating system, and voluntary termination. In the event of a drop-out, UbiquityLab automatically pauses the game at the end of the affected stage, notifies remaining subjects about the drop-out(s), and resumes the game after removing the subject who dropped out.

In this section, we re-run the analyses in the main text after including the data collected in these two sessions with drop-outs, and show that our results are robust to the inclusion of this additional incomplete data.

At the aggregate level, Figure S11 shows that the evolution of the cooperation level, average payoffs, density and clustering of the network in the different treatments is essentially unchanged compared to Figure 1 in the main text. As it is the case without the sessions with drop-outs, treatments R and RN with global reputational knowledge have a higher level of cooperation, payoff, density and clustering than treatments B and N with only local reputational knowledge. There is no significant difference for any of the metrics between RN and R, and no significant difference for any of the metrics between B and N.
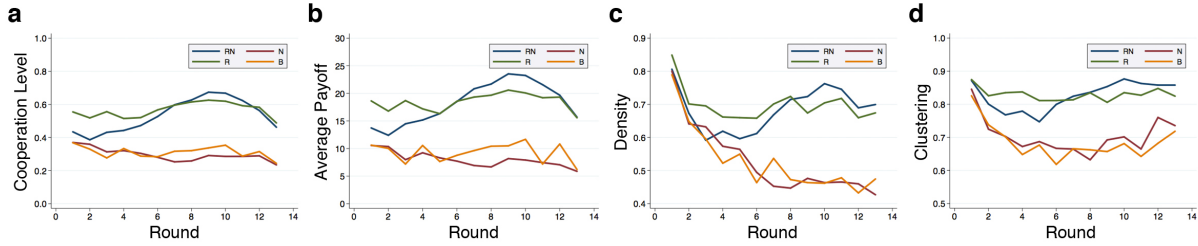
Figure S11: (a) Cooperation level, (b) average payoff, (c) density, and (d) clustering over 13 rounds of play for treatments B (yellow), N (red), R (green) and RN (blue) after including the "drop-out" sessions. Analyses are based on aggregated data at the session level after round 5. Here we only present the P-values for significant comparisons of the Kruskal-Wallis test and/or the Dunn's test (with the Benjamini-Hochberg adjustment with a 5% false discovery rate): (a) Cooperation level: K-W: $P = 0.010$; Dunn's: RN vs. B, $P = 0.021$; RN vs. N, $P = 0.034$; R vs. B, $P = 0.019$; R vs. N, $P = 0.021$. (b) Average payoff: K-W: $P = 0.017$; Dunn's: RN vs. B, $P = 0.033$; RN vs. N, $P = 0.036$; R vs. B, $P = 0.038$; R vs. N, $P = 0.029$. (c) Density: K-W: $P = 0.003$; Dunn's: RN vs. B, $P = 0.009$; RN vs. N, $P = 0.015$; R vs. B, $P = 0.008$; R vs. N, $P = 0.009$. (d) Global clustering: K-W: $P = 0.005$; Dunn's: RN vs. B, $P = 0.013$; RN vs. N, $P = 0.016$; R vs. B, $P = 0.014$; R vs. N, $P = 0.025$.

At the community level, all the results in the main text are substantially unchanged. As in the main analysis, we use the Mann-Whitney test to compare the largest community $C1$ and the second largest community $C2$ within each treatment. RN remains the only treatment in which $C1$ is more cooperative than $C2$ ($P = 0.009$). Moreover, RN is the only treatment where a member of $C1$ achieves a higher average payoff from an interaction with a neighbor within community $C1$ than a member of $C2$ achieves from an interaction with a neighbor in $C2$ ($P = 0.009$). Moreover, only in the RN treatment, members of $C1$ remove significantly more links than those of $C2$ ($P = 0.046$), members of $C2$ receive significantly more removals than those of $C1$ ($P = 0.001$), and members of $C2$ receive significantly more proposal rejections than those of $C1$ ($P = 0.006$). Additionally, members of $C2$ receive significantly more proposal rejections than those of $C1$ ($P = 0.046$) in the R treatment once we include the problematic session with 4 dropped out subjects.

8 Experimental Instructions (for treatment B)[1]

General rules[2]   1/7

There are 3 parts to the Experiment:

- Instructions

- Experiment

- Final Questionnaire

You will earn \$2 for sure only if you complete the Experiment and the Final Questionnaire. In addition, you can earn Experimental Points (EP) that will be converted into real earning in dollars. We expect the average total earning to be within the \$4 - 7 range, but your actual earnings may vary considerably depending on your performance.

The expected duration of the Experiment is about 45 minutes, and you need to fully dedicate your time to this Experiment for the next 45 minutes. If you exit at any point before completion, you will not receive any earnings.

The aim of this Experiment is to study how individuals make decisions in certain contexts. You will make decisions that will affect the amount of points you earn and the amount of points other Turkers earn.

All your decisions will remain completely confidential. We will not disclose your Turker ID or any other information that may allow others to identify you. Each Turker will be assigned a one-letter ID that is kept the same throughout the Experiment. ID assignments are random and carry no meaning.

You will be asked to take a Quiz later to ensure that you understand the Instructions. If you cannot pass the Quiz within 3 tries, you will not be able to participate in the Experiment.

---

[1]Instructions for the other three treatments are available upon request from the authors.

[2]Each section heading corresponds to a web page of the Instructions.

The expected average time before you reach the Quiz is 15 minutes, and it is important that you read through the Instructions carefully. Note that each participant is shown exactly the same Instructions.

Please click the 'Next' link below to continue.

The game   2/7

You and 12 other Turkers will play several rounds of a "game". Each round is the same and consists of 3 stages.

In Stages 1 and 2, you can form and cut links with any of the other Turkers, which we will explain shortly. If you are linked with another Turker then that Turker is a "neighbor".

In Stage 3, you choose either action A or action B, and the choice of action A or B applies to all your neighbors. Action **A** is color-coded in **green** and action **B** is color-coded in **blue**. The colors are only a visual aid to distinguish the actions and have no meaning. You get points for the action you choose and the action each of the other Turkers chooses, in the following way:

You get 0 points if you are not linked with another Turker regardless of your choice of action.

The number of points you get depends on the actions you and your neighbor choose, according to the table below:

		Neighbor	
		A	**B**
You	**A**	3	−5
	B	5	−3

This is what the table says:

- If you choose **A** and the neighbor chooses **A**, you get 3 points

- If you choose **A** and the neighbor chooses **B**, you get -5 points

34

- If you choose **B** and the neighbor chooses **A**, you get 5 points

- If you choose **B** and the neighbor chooses **B**, you get -3 points

At the end of each round you will see a summary of the number of points you get with each of the other Turkers.

You will play 13 rounds of this game for sure. After round 13, there is a 50% chance that the game will terminate in the following round. In other words, in every round after round 13 the computer will "flip a coin" and if the outcome is "Heads" then the game will terminate.

Please click the 'Next' link below to continue to a detailed description of Stage 1.

Stage 1 - Link decisions   3/7

In Stage 1, you decide which Turkers you want to link with.

We will explain each part of the interface separately and you will see the whole interface in the Tour later.

Top-right of the screen   The first row shows the current stage and the current round you are in. You also see a countdown timer that indicates the time you have left to make your decisions. In every round, you have 70 seconds to complete Stage 1.

Link decisions - Round 7	36 seconds left

The second row reminds you of the actions you have chosen in last 5 rounds. For example, the sequence below means that you chose action A in last round (the rightmost green square), action B two rounds ago (blue square in the 2nd slot counting from the right), action B three rounds ago (blue square in the 3rd slot counting from the right), etc.

Your last 5 actions:	A	A	B	B	A		Table of Points

Note that if you do not have any neighbor in a round, then you cannot choose an action in that round, and your round action is denoted by a gray box ▇.

There is also a "Table of Points" link: you can move your mouse pointer over it to show the table of points you saw previously. Try it now!

Top-left of the screen   This figure visualizes your current neighbors.
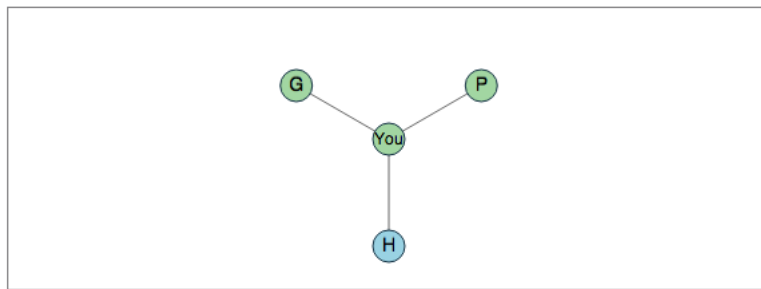
The neighbors you have at the start of each round are the same as the neighbors you had at the end of the previous round. The links are reciprocal so if you are linked to Turker G then Turker G is linked to you.

Each circle denotes a Turker with an ID. The "You" circle is always positioned at the center. For example, above you are linked with H, P, and G.

The colors of the circles denote the action chosen by each Turker in the previous round. For example, in the above figure Turker P chose action A and Turker H chose action B in the previous round.

Note that no links exist between Turkers in Stage 1 of Round 1, so only the "You" circle will be displayed.

Middle-left of the screen   This table allows you to make your decisions in Stage 1.

36

Neighbor	History	Unlink		Others	Link
H	A A B A B	☐		E	☐
P	▨ A A B A	☐		R	☐
G	A A B B A	☐		S	☐
				K	☐
				V	☐
				N	☐
				W	☐
				Z	☐
				T	☐

You can cut a link to any neighbor by ticking the corresponding box under the "Unlink" column. You can also propose a link to any other Turker by ticking the corresponding box under the "Link" column. There is no limit to how many boxes you can tick, and you can also choose not to cut or propose any link by leaving all the boxes unticked.

The table has 5 columns, from left to right:

Neighbor: lists the IDs of Turkers who are currently linked with you.

History: lists last 5 actions chosen by each of your neighbors.

Unlink: allows you to cut your link to any of your neighbors. For example, ticking the box in the first row will cut your link to Turker H.

Others: lists the IDs of Turkers who are not currently linked with you.

Link: allows you to propose a link to any of the Turkers you are not linked with. For example, ticking the box in the first row will propose a link to Turker E.

The color-codings of the other Turkers' actions are the same as before. The green box A denotes the choice of action A. The blue box B denotes the choice of action B. The gray box ▨ denotes

37

that the Turker did not have any neighbor in that round, and therefore the Turker did not choose an action. For example, no action was chosen by Turker P five rounds ago.

Note that in Round 1 all the Turkers will be listed under "Others" because no links exist between Turkers.

Bottom-left of the screen   This figure shows you the Turkers you are not currently linked with. Each circle denotes a Turker with an ID.
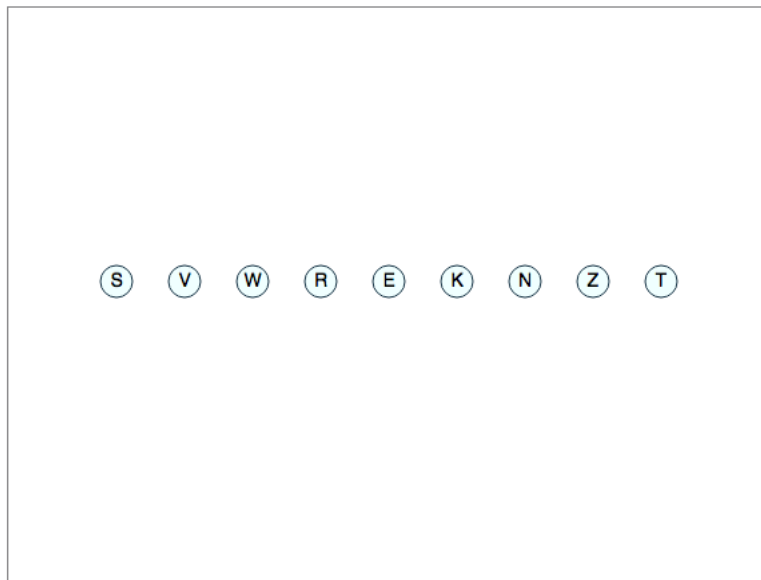
Bottom-right of the screen   The text reminds you about the decisions you need to make in Stage 1. You can propose new links and cut existing links, or you can choose not to propose or cut any links. In either case, you need to click the "Submit" button to confirm your decisions.

Please decide which players (if any) you wish to propose or cut links with

Press 'Submit' to confirm your decisions

Submit

Please click the 'Next' link below to continue to a detailed description of Stage 2.

Stage 2 - Yes/No responses   4/7

In Stage 2, you decide whether to accept or reject link proposals from other Turkers.

Top-right of the screen   In every round, you have 45 seconds to complete Stage 2.
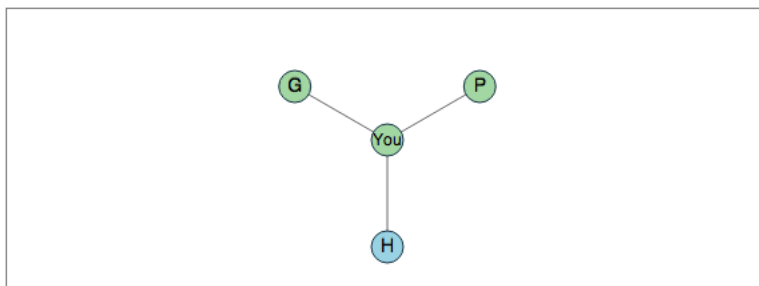
Yes/No responses - Round 7   27 seconds left

The second row is the same as in Stage 1: your actions in last 5 rounds and the "Table of Points" link.

Your last 5 actions: A A B B A   Table of Points

Top-left of the screen   This is the same as in Stage 1: a figure that shows your current neighbors. Note that the figure is not updated yet with yours and others' link decisions in Stage 1. The colors of the circles denote the action chosen by each Turker in the previous round.

Middle-left of the screen   This table allows you to make your decisions in Stage 2.

The first three columns from the left ("Neighbor", "History", "Unlink") are the same as in Stage 1.

The "Others" column lists the Turkers you are not linked with.

Now look at Turkers R, K and Z: under the "Link" column a "Y/N" ("Y" for Yes, "N" for No) button appears. This means that R, K and Z have sent you a link proposal. For each proposal, you need to click on "Y" to accept it or "N" to reject it. In the example above, you have chosen to accept the proposal from R and reject the proposal from K, but you have not responded yet to the proposal from Z.

Note that your choice to accept or reject a proposal is highlighted in black.

Bottom-left of the screen   This is the same as in Stage 1: a figure that shows the Turkers you are not linked with. Note that the figure is not updated yet with yours and others' link decisions in Stage 1.
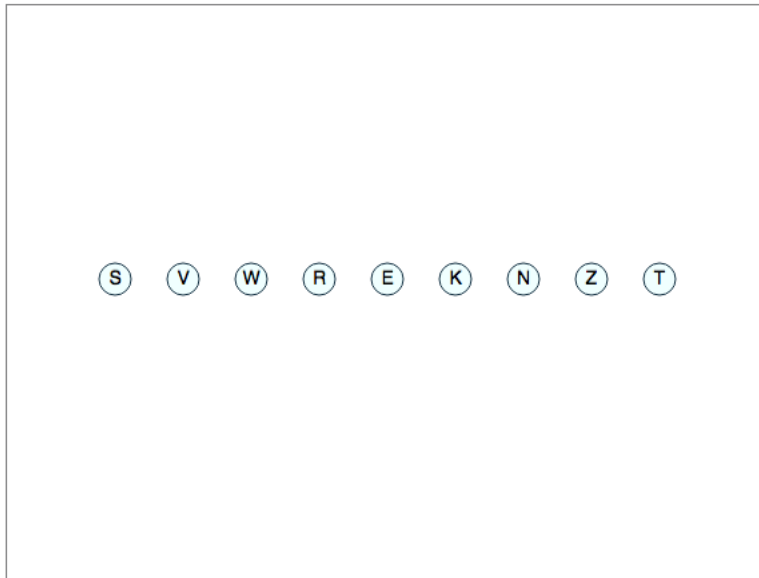
Bottom-right of the screen   The first 3 rows remind you of your responses.

Before you press "Submit", you can change your responses and the text in the second and third rows will be updated accordingly.

You should click the "Submit" button after you have responded to all the proposals. If you do not respond to every proposal by the end of the stage, the computer will automatically reject any proposal that you have not responded to.

Note that it is also possible that no Turker proposes to link with you in Stage 1. In such case you will see the message below and you will need to wait for the other Turkers to complete Stage 2.

You have no link proposals to respond to in this round

Press 'Submit' to continue

[Submit]

Please click the 'Next' link below to continue to a detailed description of Stage 3.

Stage 3 - Action choice   5/7

In Stage 3, you choose either action A or action B.

Top-right of the screen   In every round, you have 25 seconds to complete Stage 3.

Action choice - Round 7   13 seconds left

The second row shows your actions in last 5 rounds. Please move your mouse pointer over the "Table of Points" link to remind yourself about how you get points.

Your last 5 actions: A A B B A   Table of Points

Top-left of the screen   This figure shows your current neighbors after Stage 1 and 2. Note that the figure is now updated with yours and the others' decisions in the previous stages. The colors of the circles denote the action chosen by each Turker in the previous round.
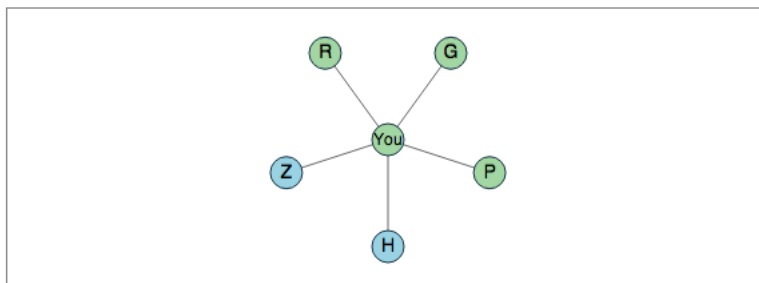
Middle-right of the screen   This table shows your neighbors, the Turkers you are not linked with, and your neighbors' actions in last 5 rounds. Note that the table is updated with yours and the others' decisions in the previous stages.
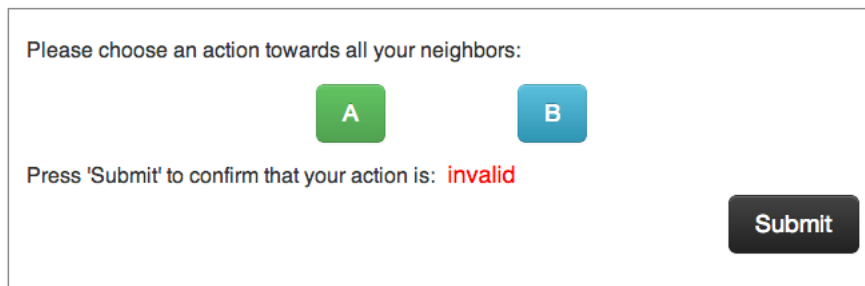

Bottom-left of the screen   This figure shows the Turkers you are not linked with. Note that the figure is now updated with yours and others' decisions in the previous stages.

Bottom-right of the screen   This is where you choose your action in Stage 3 by clicking either the A or B button.
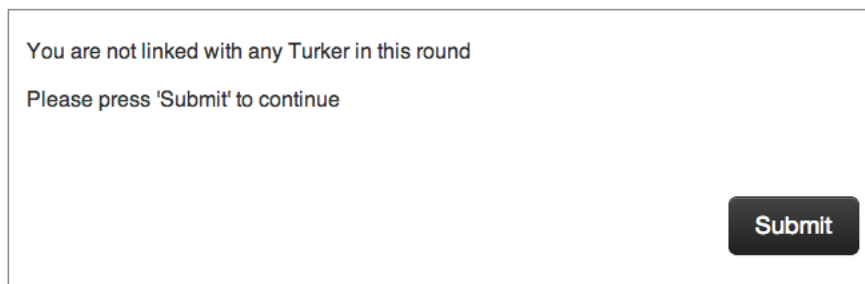
Once an action is chosen, the "Invalid" text will change to indicate your choice. Note that if you do not click any button then the computer will choose action B by default. You click the "Submit" button to confirm your choice.

Note that it is possible that you are not linked with any Turker (i.e. you have no neighbor) as the result of everyone's earlier decisions. In such case, you will instead see the message below, and you should click the 'Submit' button to continue.

Please click the 'Next' link below to continue.

Round results   6/7

After Stage 3, you will see a summary of the points you got with each of the other Turkers in the round.

Top-right of the screen In every round, you have 15 seconds to see the results.

```
Results - Round 7                              11 seconds left
```

The second row reminds you of the action you have just chosen.

```
Your chosen action:   A                          Table of Points
```

Middle-right of the screen This table summarizes the results of the current round.

Neighbor	Action	Points	Others	Points
H	A	3	E	0
P	A	3	H	0
R	A	3	K	0
G	B	−5	V	0
Z	B	−5	N	0
			W	0
			T	0

There are 5 columns, from left to right:

Neighbor: lists the IDs of Turkers who are linked with you.

Action: lists the actions chosen by your neighbors.

Points: lists the points you got with each of your neighbors.

Others: lists the IDs of Turkers who are not linked with you.

Points: lists the points you got with each of the Turkers who are not linked with you, which are always 0.

45

Please click the 'Next' link below to continue.

Your bonus   7/7

At the end of the Experiment, we will randomly select 6 rounds for payment. In each of these 6 rounds, we will randomly pick 2 other Turkers. Note that a Turker who was not linked with you can be picked, and in that case you will get 0 points for the game with that Turker.
To determine your bonus, we sum the number of points you got with each of the picked Turkers in each of the 6 rounds. The exchange rate from Experimental Points (EP) to US dollars is:

$$5 \text{ EP} = 1 \text{ dollar}$$

For example, the table below shows the payment details of an imaginary Turker.

Selected round	Selected turker	Your action	Turker's action	Your points
2	S	B	A	5
2	H	B	A	5
5	W	A	B	-5
5	P	unlinked	unlinked	0
8	W	A	A	3
8	R	A	B	-5
9	N	B	B	-3
9	E	B	A	5
11	Z	A	A	3
11	K	A	A	3
13	P	unlinked	unlinked	0
13	R	B	A	5
Total				16

This imaginary Turker's total earnings are:

$$\text{Total earnings} = 200 + 1 \times \frac{16}{0.05} = 200 + 320 = 520 \text{ cents}$$

Note that the total earnings include the $2 fixed fee and a $3.20 performance bonus.
In the unlikely event that we lose the connection to a Turker during the Experiment, the one-letter ID of that Turker will be removed in all subsequent rounds of the game and you will be

notified in the round when this happens. In the process of determining your bonus, we will not select any disconnected Turker after the round in which we lose the connection to that Turker. It is possible to win an additional Bonus payment in the Final Questionnaire. We will explain this during the Final Questionnaire.

Please click the 'Next' link below to continue to the Tour.

Supporting Information References

[1] Horton JJ, Rand DG, Zeckhauser RJ (2011) The online laboratory: Conducting experiments in a real labor market. *Experimental Economics* 14:399–425.

[2] Rand DG (2012) The promise of mechanical turk: How online labor markets can help theorists run behavioral experiments. *Journal of Theoretical Biology* 299:172–179.

[3] Mason W, Suri S (2012) Conducting behavioral research on Amazon Mechanical Turk. *Behavior Research Methods* 44:1–23.

[4] Suri S, Watts DJ (2011) Cooperation and contagion in web-based, networked public goods experiments. *PLoS ONE* 6:e16836.

[5] Wang J, Suri S, Watts DJ (2012) Cooperation and assortativity with dynamic partner updating. *Proceedings of the National Academy of Sciences* 109:14363–14368.

[6] Mason W, Watts DJ (2012) Collaborative learning in networks. *Proceedings of the National Academy of Sciences* 109:764–769.

[7] Rand DG, Arbesman S, Christakis NA (2011) Dynamic social networks promote cooperation in experiments with humans. *Proceedings of the National Academy of Sciences* 108:19193–19198.

[8] Shirado H, Fu F, Fowler JH, Christakis NA (2013) Quality versus quantity of social ties in experimental cooperative networks. *Nature Communications* 4.

[9] Bostock M, Ogievetsky V, Heer J (2011) D^3 data-driven documents. *Visualization and Computer Graphics, IEEE Transactions on* 17:2301–2309.

[10] Fehl K, van der Post DJ, Semmann D (2011) Co-evolution of behaviour and social network structure promotes human cooperation. *Ecology Letters* 14:546–551.

[11] Holt CA, Laury SK (2002) Risk aversion and incentive effects. *The American Economic Review* 92:1644–1655.

[12] Blondel VD, Guillaume JL, Lambiotte R, Lefebvre E (2008) Fast unfolding of communities in large networks. *Journal of Statistical Mechanics: Theory and Experiment* 2008:P10008.

[13] Kruskal WH, Wallis WA (1952) Use of ranks in one-criterion variance analysis. *Journal of the American Statistical Association* 47:583–621.

[14] Dunn OJ (1964) Multiple comparisons using rank sums. *Technometrics* 6:241–252.

[15] Benjamini Y, Hochberg Y (1995) Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society. Series B (Methodological)* 57:289–300.

[16] Watts DJ, Strogatz SH (1998) Collective dynamics of small-world networks. *Nature* 393:440–442.

[17] Freeman LC (1977) A set of measures of centrality based on betweenness. *Sociometry* 40:35–41.

[18] Bonacich P (1972) Factoring and weighting approaches to status scores and clique identi-fication. *Journal of Mathematical Sociology* 2:113–120.