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Sergio Lo Iacono

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Corresponding Author:

Dr. Sergio Lo Iacono
sloiac@essex.ac.uk
Wivenhoe Park, Colchester
CO4 3SQ
University of Essex
United Kingdom

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Abstract

Despite the theoretical relevance attributed to the spillover effect, little empirical research has focused on testing its causal validity. Addressing this gap in the literature, I propose a novel experimental design to test if the overall density of social links in a community promotes trustworthy and trusting behaviors with absolute strangers. Controlling for social integration (i.e. the individual number of social connections), I found that density fosters higher levels of trust. In particular, results show that people in denser communities are more likely to trust their unknown fellow citizens, encouraging isolated subjects to engage with strangers. However, evidence did not support the idea that community social embeddedness causes an increase of trustworthiness, indicating that the spillover effect works only with respect to trust.

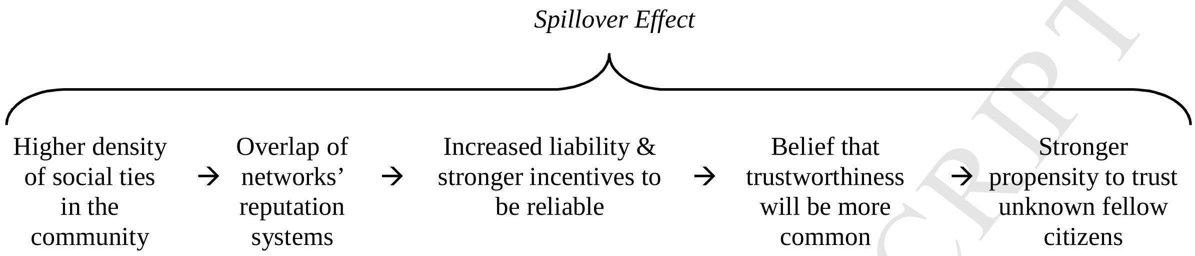
Keywords: Generalized Trust; Spillover Effect; Social Connections; Density; Social Cohesion.

1. Theoretical Background

In current academic and policy debates, there is a widespread agreement on the importance of social cohesion in the development of pro-social attitudes. A number of research initiatives have collected data (e.g. the Community Life Survey in the UK or the Social Capital Community Benchmark Survey in the US) to facilitate the elaboration of effective policy guidelines meant to improve the wellbeing of local communities. Along these lines of inquiry, scholars have examined how dense and more cohesive neighborhoods can promote individual cooperation (e.g. Browning et al., 2004; Elliott et al., 1996; Helliwell and Putnam, 2004; Ross and Jang, 2000; Sampson and Morenoff, 2002). Most noticeably, Sampson's (1988, 1991, 2006, 2012) and Putnam's (1993, 2000) theories and empirical analyses on the density of social ties, trust, collective efficacy and social disorder indicate the relevance of community social embeddedness to foster pro-social behaviors.

A particularly interesting point of this branch of the literature concerns how generalized trust (that is, trust towards strangers) is developed. Society-centered arguments in this regard tend to be based on the so-called *spillover effect* (Putnam, 2000; Stolle, 2003; Van der Meer, 2003). This relies on the following logic: each social network entails a reputation system that is valid and compelling for people within the network (as well-discussed, for instance, in Fu et al., 2008). When the density of social ties in a community reaches a certain level, the degree of potential contact among residents grows, creating an overlap among the different reputation systems. This implies a more fluid flow of information and a higher probability of knowing other people's deeds. As a consequence, liability increases for all people in the community, while defection with fellow citizens is discouraged: even a deceitful interaction with a stranger might harm our prestige in the community, as the other party could be connected to several other fellow citizens. In this sense, the form of social control that a network-based reputation system exercises on members of the network will overcome its boundaries and spillover, constraining *also* the actions of individuals who are outside the network (and potentially more isolated). Ultimately, this will lead people to think that being trustworthy is the best course of action, and placing trust will appear as a “safe bet” in most of the cases (see Figure 1).

Figure 1 – The theoretical argument behind the spillover effect



Surprisingly enough, despite the prominence of the spillover effect in countering social isolation’s detrimental consequences, the neighborhood effects literature has mostly overlooked this mechanism. In fact, as Stolle (2003) pointed out, only very few studies have specifically addressed the relationship between the overall density of social ties in the community and the emergence of generalized trust, reporting a weak or insignificant positive correlation (Marschall and Stolle, 2004; Paxton, 2007; Van der Meer, 2003). For instance, using information from the 1975-1976 Detroit Area Study and 1970 Census tract data, Marschall and Stolle (2004) found no significant impact of average informal links and associational connections at the neighborhood level on individuals’ propensity to trust.

However, these contextual analyses rely largely on cross-sectional observational data, which are inadequate to assess causal effects as they poorly address endogeneity issues. In particular, the impossibility to manipulate the independent variable does not allow us to rule out unobserved confounders or establish the actual cause or effect in the relationship. In addition, these studies employ measures of neighborhood or community social density that are calculated as aggregate averages of respondents’ number of social ties. These indicators are an easily calculable and quite reasonable approximation of community social density, but they are strongly dependent on individual measures of social connections, making extremely difficult to distinguish the actual impact of one from the other.

On the other hand, although experimental research can effectively assess the internal validity of the spillover effect, no design seems to have directly investigated it. Instead, most experiments concerning the role of social networks have focused on how individuals' level of social integration (i.e. the number of individuals' social links) and distance (i.e. how "close" subjects are) affect players' altruistic and cooperative decisions – as measured in Dictator Games, and Prisoner's Dilemmas[1] (d'Exelle and Riedl, 2010; Branas-Garza et al., 2010; Goeree et al., 2010; Leider et al., 2009), which *do not allow us to separate trusting behaviors from trustworthy ones* (Yamagishi et al., 2005).
In addition, experiments that do separate trusting and trustworthy behaviors (employing Trust Games – hereafter TG) do not aim to test the spillover effect and suffer of several limitations: (1) the overall density of the social networks in the community is not the treatment variable or it is not taken into account (Bracht and Feltovich, 2009; Charness et al., 2011; Di Cagno and Sciubba, 2010; Huck et al., 2012) (2) no information flow across networks is allowed, impeding the formation of network-based reputation systems (Bellemare and Kroeger, 2007; Ermisch et al., 2009; Fehr et al., 2002; Glaeser et al., 2000; Sapienza et al., 2007) (3) the TGs are played with the same partner (Buskens et al., 2010) or between friends or neighbors (Karlan et al., 2009), but not strangers.

Nevertheless, prior research has brought to light several evidence supporting the plausibility of the spillover effect. For instance, Gallo and Yan (2015) report a solid and positive correlation between higher density levels and cooperative behaviors in repeated Prisoner's Dilemmas, while Buskens and colleagues (Barrera and Buskens, 2009;

1 Research from evolutionary game theory has also found support for the "indirect reciprocity mechanism" (i.e. cooperation with strangers on the basis of their reputation - Gallo and Yan, 2015; Milinski et al., 2002; Nowak and Sigmund, 2005; Pfeiffer et al., 2012), suggesting that "those who have been cooperative previously […] tend to receive more cooperation. Thus, having a reputation of being a cooperator is valuable, and cooperation is maintained: it is worth paying the cost of cooperation today to earn the benefits of a good reputation tomorrow" (Rand and Nowak, 2013:417). This is certainly encouraging for the spillover effect, as it shows that being aware that our past actions will be known to other people lead us to be more cooperative in general. In other words, when the reputational structure in the community is strong enough, pro-social behaviors among unknown fellow citizens should be fostered. Evolutionary game theory, however, does not investigate if the overall density of social networks in a community can sustain such reputational structures and effectively boost trustworthy and/or trusting behaviors with absolute strangers.

Buskens et al., 2010; Buskens and Raub, 2002) show the relevance of third-party information exchange on trusting and trustworthy decisions. In particular, their study (Buskens et al., 2010) indicates that the network learning effect (i.e. change in behavior due to truster's knowledge of trustee's past behavior through social connections) promotes trustfulness, whereas the network control effect (i.e. change in behavior due to truster's *opportunity* of sanctioning a trustee in future interactions on the basis of information received from the network) fosters trustworthiness.

Although such experimental findings remark the importance of reputation and information flow within a community for the development of prosocial conducts, they leave unclear if a high overall density of social networks in a community creates reputational systems that spillover. Also, current observational evidence is unable to show if this mechanism has an effect that is distinguished from the one reported for individuals' social connections (or social integration – i.e. the number of individual social links). In other words, do people living in communities characterized by a higher average number of social ties tend to be more trusting and reliable with strangers regardless of their individual social connections?

Addressing these gaps in the literature, the present study aims to provide a solid test to the spillover effect. In this sense, we conduct an experiment where subjects play a series of TGs with anonymous others and are able to report their games' experience to their social links, simulating the functioning of the "grapevine". Changing the average number of social links among subjects modifies the level of interconnectedness in the community, allowing us to (1) check if in communities characterized by a higher overall density of social ties network-based reputation systems spillover, fostering trustworthy and trusting behaviors with strangers; (2) test if the spillover effect is independent from the social integration effect by changing the average number of social links across treatments, while keeping constant the number of individual social links[2].

2 Note that we employ fixed networks. This means that social links are assigned at the beginning of the game and they do not change thereafter. Given the purpose of this study, this is a particularly adequate analytical strategy because it allows us to separate the role of the overall social density in the community from the one of individual social integration.

2. Experimental Setup & Hypotheses

2.1 Subjects

The experiment was programmed with Z-tree (Fischbacher, 2007) and conducted at the *****lab (University of *****). The lab is equipped with 32-networked computers (separated by partitions to ensure privacy and anonymity) to allow interactive experiments. Participants were sampled through the *****lab recruitment system (currently including over 1,500 subjects), which provides a more heterogeneous sample pool than experiments using only students (see table 1 for sample characteristics and descriptives of main variables). In total, 158 subjects took part to the experiment[3] over 10 different sessions[4].

2.2 Design

Each experimental session was preceded by a brief Qualtrics questionnaire gathering information on individuals' demographics (e.g. age, gender, ethnicity) and general attitudes[5] (e.g. social trust, risk propensity). Each subject is given an ID number (e.g. 002) and invited to a session, which is randomly assigned to a treatment (i.e. "high", "low", or "no" density). Within every treatment, subjects are randomly allocated to a certain level of social integration, so that each player has *n* links[6] with other participants[7]. Links are all directed (i.e. they have a specific direction) and are of two types: directed links with known ID of alter, and directed links with unknown ID of alter. This differentiation should help subjects to realize that their ID can be known to other participants.

3 Each treatment had 32 subjects, except for the baseline treatment, which had 30 participants.
4 Each session had exactly 16 participants. Only one session for the baseline treatment had 14 participants.
5 More details concerning the Qualtrics questionnaire and Z-tree programming are available upon request.
6 Throughout the paper "links" are considered as "incoming links". Hence, if subject A is linked with subject B, it means that subject B gives information to subject A.
7 Notice that in the no density treatment *all* subjects have 0 links. Thus, subjects are all assigned to the same level of social integration.

Table 1 – Descriptives and operationalization of concepts

Variables' description	Mean	S.D.	Range	Subjects (Obs)
Generalized Trust – Amount sent as first mover	43.84	33.15	0-100	158 (790)
Trustworthiness – Percentage returned as second mover	.30	.23	0-1	158 (694)
Age	28.13	12.70	19-83	158 (1580)
Gender				
1 = Male; 0 = Female	0.35	0.48	0-1	158 (1580)
Education				
1 = First degree level qualification or higher; 0 = Other	.56	.50	0-1	158 (1580)
1 = High school Diploma or equivalent; 0 = Other	.34	.47	0-1	158 (1580)
1 = AS level or lower; 0 = Other	.10	.29	0-1	158 (1580)
Religion:				
1 = Belonging to a Religion; 0 = No Religion	.43	.49	0-1	158 (1580)
Race				
1 = White; 0 = Other	.64	.48	0-1	158 (1580)
1 = Mixed; 0 = Other	.08	.26	0-1	158 (1580)
1 = Asian; 0 = Other	.11	.31	0-1	158 (1580)
1 = Black; 0 = Other	.11	.32	0-1	158 (1580)
1 = Other Minority; 0 = Other	.06	.23	0-1	158 (1580)
Trust Strangers: 1 = Cannot be trusted at all 5 = Can be trusted a lot	2.25	.84	1-5	158 (1580)
Generalized Trust: 0 = You can't be too careful 10 = Most people can be trusted	4.20	2.12	0-10	158 (1580)
Most people are fair: 0 = Most people try to take advantage of me 10 = Most people try to be fair	4.53	2.18	0-10	158 (1580)
Most people are helpful: 0 = People mostly look for themselves 10 = People mostly try to be helpful	4.73	2.12	0-10	158 (1580)
Risk propensity: 0 = Unwilling to take risks 10 = Fully prepared to take risks	5.88	2.06	0-10	158 (1580)
Altruism (it is very important to help people around me): 1 = Not like me at all; 6 = Very much like me	2.34	1.02	1-6	158 (1580)
First mover in past round				
1 = he/she was first mover; 0 = he/she was second mover	.5	.5	0-1	158 (1422)
Cumulative Disappointment	.21	.41	0-1.98	158 (1422)
Role played more frequently				
1 = Played more as Second Mover; 0 = Other	.41	.49	0-1	158 (1580)
1 = Played equally as First and Second Mover; 0 = Other	.22	.42	0-1	158 (1580)
1 = Played more as First Mover; 0 = Other	.37	.48	0-1	158 (1580)

An experimental session consists of 10 rounds, each constituted by four stages. In the first stage, players are randomly matched with a "stranger" (that is, individuals with whom they had no previous interaction) and play a one-shot TG. The TG is conducted between two players, the truster (or first mover) and the trustee (or second mover). The truster is given an endowment (100 experimental points, equivalent to £1, per round[8]) and has the choice to send any amount of money to the trustee. This sum is multiplied by 3 by the researcher. Then the trustee decides if returning all, a part or none of the money he received. Subjects are matched with a different player each round. Differently from the classic version of the TG, in this setting, players have the possibility to identify each other through the ID numbers, which is always displayed during the game[9] (apart from this, players' identity is fully anonymized). Each round, subjects play the TG either as a first mover or a second mover. The allocation to one of the two roles is randomized[10]. By letting participants experience both roles, we aimed to (1) simulate more accurately real-life conditions (2) facilitate subjects' understanding of the information flow among participants and the reputation structure.

In the second stage, all players visualize a short summary of the round and their payoff (screenshots of the game are available in the Appendix). In the third stage, subjects who played as first movers report to their social links the ID number of the trustee they have played with as well as the sum of money he returned[11]. Finally, in the last stage, players get the reports from their social links. The information is saved and automatically displayed in future rounds if the subject is matched with that trustee.

In sum, this means that when playing the TG, the truster will know how many other

8 All subjects received also £ 2.50 for showing up.

9 To simulate a real-life evolution of interactions, in the first round all subjects play with the link whereof they know the ID. However, since such interactions do not involve absolute strangers and do not concern reputational effects, they are excluded from the analysis.

10 Allowing participants to play both as trusters and trustees can be problematic as the order of roles experienced by subjects can significantly affect their behavior in the game. Thus, I randomized role order to control for this source of bias.

11 Subjects cannot choose not to report, and the information reported will always be truthful. This means that we assume a perfect information flow among players that are connected among each other. This condition is necessary to avoid confounding effects across treatments. However, it represents an approximation of real-life situations, and it should be further explored in future studies (as pointed out by Rand and Nowak, 2013).

people are reporting to him (i.e. his own in-degree value), the ID of the trustee, and the trustee's past behavior (in the case he received a report on it from his links in past rounds). However, he will not be aware of the number of people he is reporting to (i.e. his own out-degree value), and the trustee's social links.
On the other hand, the trustee will know only how many people are reporting to him, and the ID of the truster[12]. Also, at the end of the TG (that is, in the second stage), the trustee will be informed if the truster had any reports on his past behavior.

The repetition of these steps across several rounds is necessary to simulate the evolution of the flow of information, allowing for the different reputation systems to overlap and let actors perceive that their cooperative or uncooperative behaviors can be spotted out. More specifically, this setup gives us the opportunity to examine if players act differently with strangers in more socially embedded environments (where their unreliable behavior is more likely to be identified), and how the number of individual social links can change their conduct in the game.

In this respect, three main treatments are applied. In the baseline or "no density" treatment, no information flow is possible since subjects are given 0 links. In this treatment, participants will only play the TG, and they will not take part to stages three and four. Differently, in the "low density" treatment (T1), half of the group will have 2 links (each node has indegree equal to 2 - subgroup A), while the other half will have 1 link (each node has indegree equal to 1 - subgroup B) (Figure 2). Thus, the overall density (given by the ratio between the actual number of links of all subjects in the community over the number of all the possible links within that community) will be equal to 0.13 (in a range going from 0 to 1)[13].

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12 Notice that subjects always play with different participants each round and reports contain only first movers' experiences. Hence, even if second movers know first movers' ID they cannot sanction them or give the opportunity to other players to sanction them in future interactions.
13 See the Appendix for more information on the formula.

Figure 2 – Treatment 1 (Low Density)

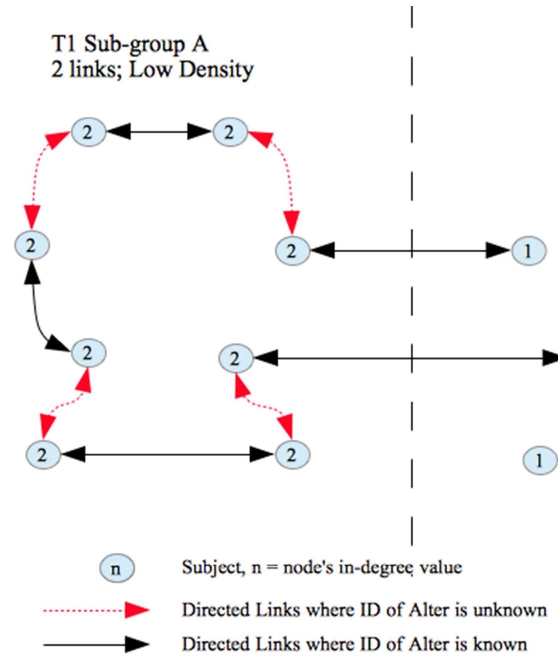
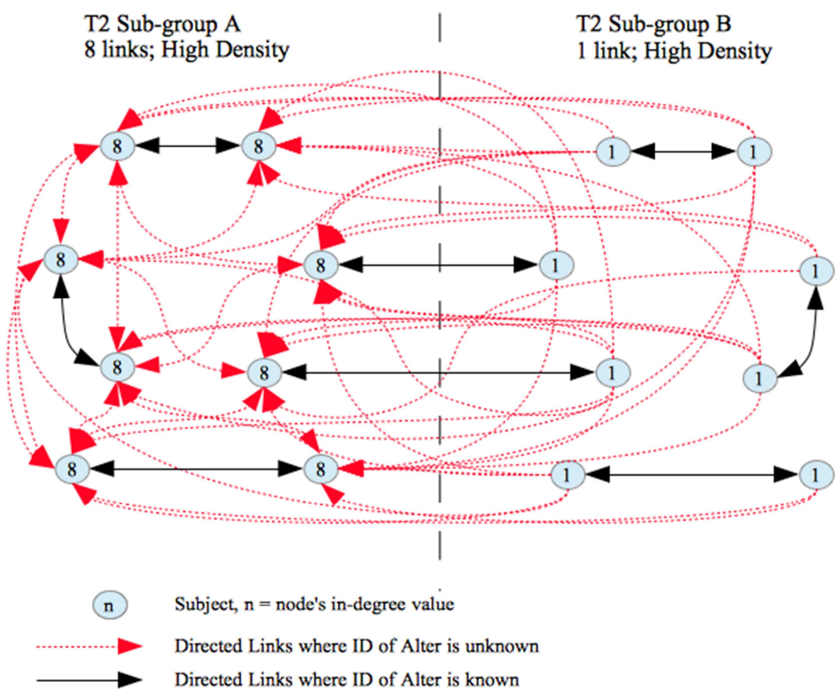


Figure 3 – Treatment 2 (High Density)



Finally, in the "high density" treatment (T2) half of the group will have 8 links (each node has indegree equal to 8 - subgroup A), whereas the other half of the group will have (again) 1 link (each node has indegree equal to 1 - subgroup B). The overall density of social links will be equal to 0.3 (Figure 3). As a result, subjects in T1 subgroup b and T2 subgroup b will share exactly the same network's features (e.g. number of social links, network's structure etc.) apart from the level of overall density, allowing us to estimate its impact while controlling for alternative factors.

Notice that subjects in both treatments will be told that they are in an environment denoted by a low or high density of social links, under the assumption that people who live in such conditions are broadly aware of the level of social embeddedness of the community.

2.3 Hypotheses

Given experiment's settings, participants are likely to have a good perception of how interconnected people are when they are allocated to a treatment with a high density.
This feeling of interconnectedness should make subjects aware of the stronger level of social control, as they are likely to realize that there are more opportunities of information exchange. This implies more chances that untrustworthy behaviors will be found out and potentially punished. In this sense, using Buskens et al.'s terminology (2010), the realization that there is a pervasive network control effect (i.e. the opportunity of sanctioning trustee's defective behavior in future interactions on the basis of information received from links) should drive subjects to assume that the best strategy for all players is to be trustworthy, leading them to (1) act in a more reliable manner and (2) believe that trusting is a "safe bet".

Network learning effect (i.e. truster's knowledge of trustee's past behavior through social connections) is another important aspect that can change participants' strategies in the game. Though having more information *per se* does not necessarily create a higher propensity to trust (Hardin, 2002), the nature of the information can relevantly change our

behavior: reports telling us that other players did not behave reliably in past rounds should lead us to be more skeptic, while positive reports[14] should lead us to believe in the good will of other people. That is, a prevalence of positive reports would reinforce pro-social attitudes (Buskens and Raub, 2002; Buskens et al., 2010).
As a consequence, people in the high density treatment will have a boost to trust due to the information available to them: as we expect trustworthy behaviors to be more common in high density environments, reports will tend to have a positive content rather than a negative one, facilitating the placement of trust.

People with a high level of social integration (i.e. number of individual links) will also have incentives to be more trusting and trustworthy because they are more likely to have a strong feeling of embeddedness. This should create a good understanding of the network control effect. On the other hand, no network learning effect should influence their behavior, since no element in the experiment affects their chances to receive one type of report over the other (unless they are also in the high density treatment): while people with more social links will have more information about other actors' behavior because of their broad social connections, the content of such reports will be neither prevalently positive nor negative.

Ultimately, if the spillover effect is working (whether because of control or learning effects), we should observe that the higher overall level of social embeddedness has an effect on pro-social attitudes towards absolute strangers. In more formal terms, we should expect that:

(H1) subjects in low and high density treatments will be significantly more trusting (i.e. give money as first movers) and trustworthy (i.e. they will return more money as second movers) than subjects from the baseline treatment.

14 Second movers' behavior is considered negative (or not cooperative) when subjects returned roughly less than 30% in one of their past interactions, while it is defined positive (or cooperative) when subjects always returned roughly more than 30% in their past interactions. The 30% threshold has been chosen because of the multiplying factor in the game, which is equal to 3. Thus, when subjects returned less than 30% of what they received, they are giving back less than what it has been originally sent to them.

Also, if this effect is independent from the one of individual social integration, then

(H2) subjects having the same number of individual social links but playing in a setting with a higher overall density will tend to be more trusting and trustworthy.

3. Measures, Controls, and Statistical Model

As already mentioned, we use as an indicator of trustworthiness the amount of money returned by second movers, and as an indicator of generalized trust the amount of money sent by first movers (Berg et al., 1995).

Table 2 - Correlation between trusting behavior with strangers and survey questions measuring generalized trust

	Trusting behavior (Average amount sent as first mover) *Partial correlation – controlling for Risk Propensity and Altruism*
Trust strangers	0.184***
Generalized trust	0.198***
Most people are fair	0.172***
Most people are helpful	0.216***
Subjects	158

*p <0.05, ** p <0.01, ***p <0.001

Previous studies in the literature have pointed out that trusting behaviors in the TG do not necessarily correspond to trusting attitudes as measured in surveys (Glaeser et al., 2000). Also, the action of giving might imply other motivations and attitudes, such as stronger altruism or higher risk propensity (Eckel and Wilson, 2004). Table 2 shows that in our experiment we have a moderate correlation between trusting behaviors and typical questions employed in surveys to measure generalized trust (in line with Fehr et al., 2003; Sapienza et al., 2007), even when controlling for relevant possible confounders. This advocates the validity of our indicator of generalized trust and its comparability to measures of the same concept in surveys.

Given the iterated structure of the game, observations on the dependent variables (trust and trustworthiness) are going to be repeated. Consequently, to correctly analyze data, I employ a random effect model[15] where observations are nested within subjects[16]. Using this model, I also adjust for baseline covariates (see Table 1) reported in the literature as moderately correlated with the outcomes in order to obtain a more precise estimate of the treatment effect (that is, I remove differences between the dependent variable values which can be due to differences in the baseline covariates among groups). Thus, the random effect model includes measures of race, gender, age, education, risk propensity, and altruism attitudes (derived from the questionnaire). In addition, I employ covariates indicating if subjects played as first or second movers in the past round, and whether participants played more often as first or second movers overall. While the former measure captures if switching roles affects subjects' decisions, the latter grasps if experiencing more frequently one role over the others has an impact on their strategy. Finally, I check if subjects did not receive any experimental points as second movers or did not receive any money back as first movers in previous rounds. I use this measure to build a cumulative index of disappointment (based on Buskens et al., 2010), which expresses the player's disappointment experienced in previous rounds. The index is a weighted sum of previous disappointments, such that the more recent the negative experience is, the stronger is its effect on the current round[17].

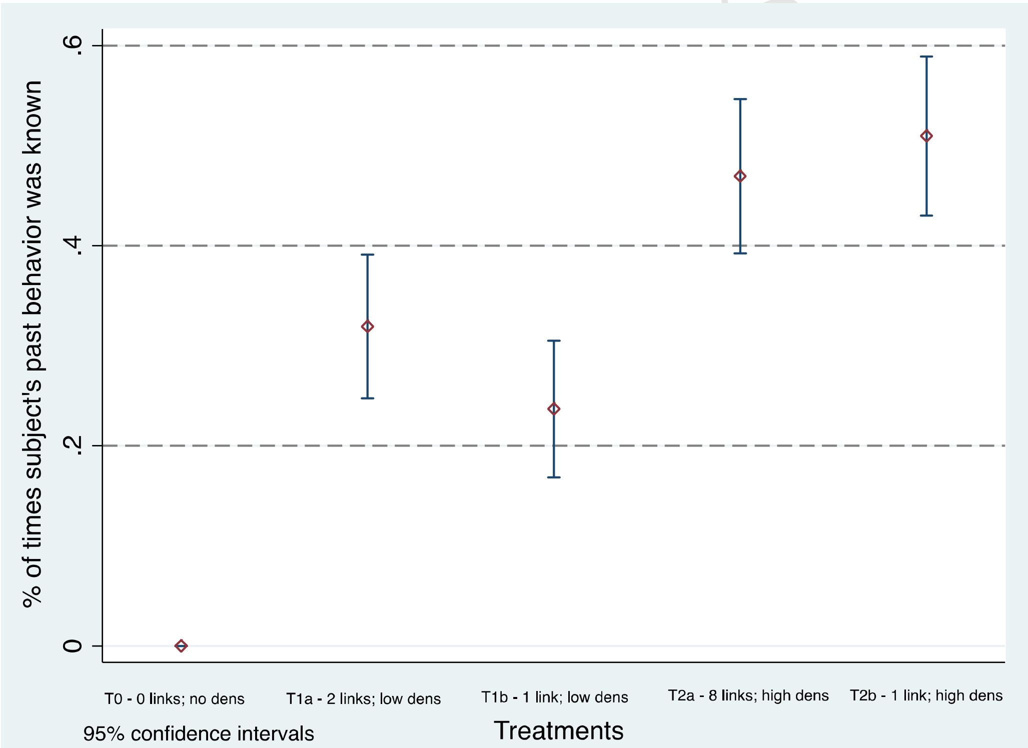
4. Results & Discussion

Let us now begin by checking if our manipulation of links has indeed produced a more effective reputation system in denser environments. Graph 1 shows how often subjects' behavior was known by other players across all rounds, indicating that changing the number of social links increased the information flow as intended. Indeed, subjects in the

15 This is implemented in Stata 13 using "xtreg, re".
16 In principle, as sessions are randomly assigned to different density treatments ("high", "low," or "no"density), observations within a session are not completely independent from each other. Though using a three-level multi-level model (decisions nested in individuals nested in sessions) could address this point, the small number of sessions did not allow us to follow this approach.
17 More information on this index can be found in the Appendix.

high density treatment (T2a and T2b) are more likely to interact with players who are aware of their past behavior than subjects in the low density treatment (T1a and T1b). Clearly, this does not depend on the amount of individual social connections, but on the overall density of social links: having 8 social links or 1 social link is irrelevant in determining how often subjects' past behavior was known, while the higher density of social ties in the community modifies significantly the level of liability (Graph 1). Thus, by increasing density we successfully created a stronger reputation system.

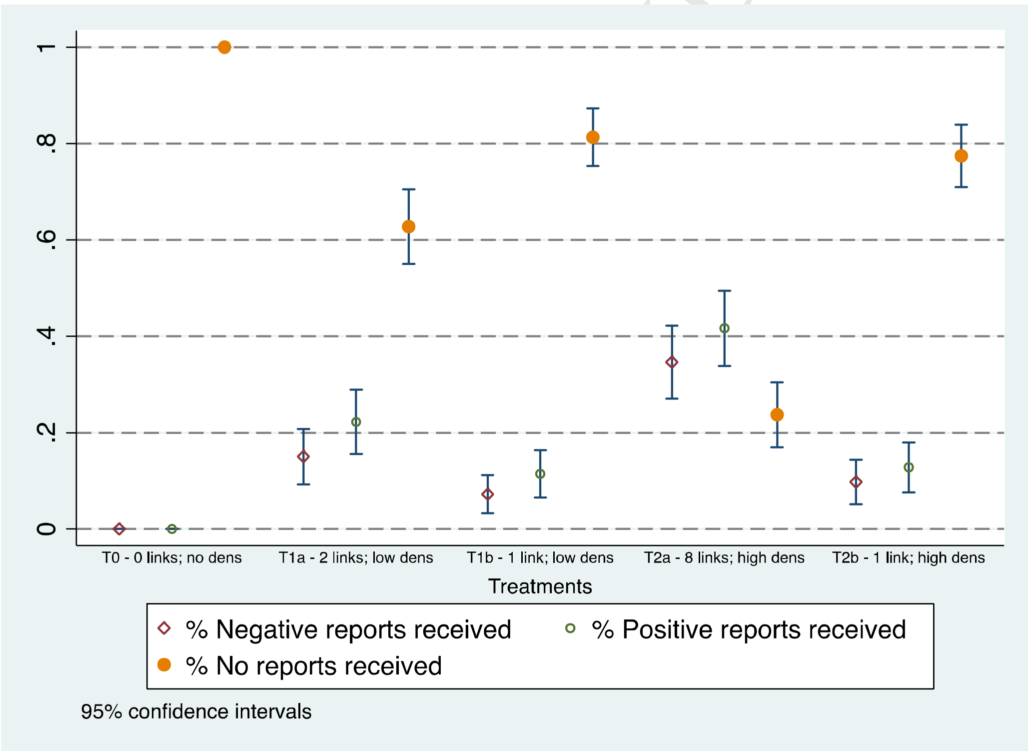
Graph 1 – Average number of times subjects' behavior was known by other players



In respect to the role of information, graph 2 shows the number of times participants receive positive (green), negative (red), or no reports at all (orange). As it can be observed, people with more social links (T1a and T2a) have more information about other actors during the game – the percentage of times they did not receive a report is significantly lower than other treatments. Also, the content of reports received is similar to the one available to other subjects, as predicted. In fact, the ratio between positive and negative reports tends to be roughly the same *across all treatments*.

In this respect, it is relevant to point out that no significant difference between the positivity of reports received from subjects in the low (T1) and high density (T2) treatments emerges. This is in contrast with our theoretical argument and it suggests that the content of reports did not play any part in boosting trusting behaviors in the high density treatment. Indeed, since the content of reports received is essentially the same for all groups, network learning effects are unlikely to have played a role in the game, and eventual differences in trusting behaviors across treatments cannot be due to differences in the positivity of the information received[18].

Graph 2 – Reports received by type

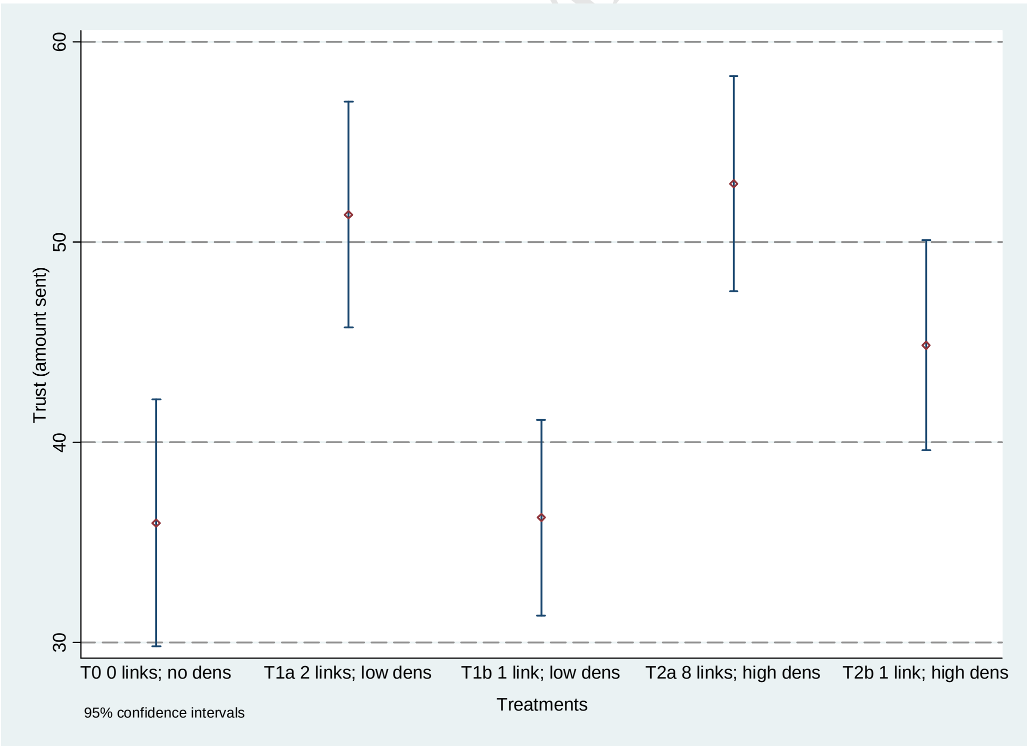


Moving to the analysis of behaviors in the game, graphs 3 and 4 show the average amount of money sent (our measure of trust) and returned (our measure of

18 In addition, the fact that people in the high density treatment did not receive more positive reports entails that subjects in this treatment did not behave more reliably (despite the higher level of social control). This point is further explored in graph 4.

trustworthiness) in the treatments. In accordance with previous literature, evidence support the positive impact of individual's connections on trusting and trustworthy behaviors: subjects with more individual social links (T1a and T2a) are more likely to send and return money to strangers than people in other conditions. This is hardly attributable to the amount of information received, as the number of reports available to players is significantly lower in T1a than T2a (see graph 2) while the propensity to be trusting and trustworthy is essentially the same for the two treatments (see graphs 3 and 4). Their pro-social behavior is more likely related to a greater perception of the interconnectedness of the game, which should allow them to have a good grasp of the network control effects (Buskens et al., 2010): having more social links leads subjects to realize how fluently information flows and how easily defective behaviors can be spotted out. As a consequence, adopting a cooperative strategy when playing as first or second movers is encouraged.

Graph 3 – Trusting behaviors across treatments



As regards H1 and H2, graph 3 suggests that *density promotes trust towards strangers even if we control for individual social connections*. Subjects with a single social link but lower levels of density display a weaker propensity to trust than people with the same number of individual social links but higher density levels: people in T1b (1 link; low density) have a trusting behavior that is virtually indistinguishable from the one of people in the baseline treatment (T0 – 0 social links; no density). On the other hand, subjects in T2b (1 link; high density) have stronger trusting behaviors across all rounds. This trend emerges as statistically significant when we adjust for differences in the baseline covariates among groups by employing the random effect model (Table 3). These more precise estimates are presented in Table 3 Model 1, which shows that subjects in T2b (1 link; high density) give on average 13.8 experimental points more than people in T0 ($p < 0.05$), while players in a low density environments and a single social link (T1b) follow trusting behaviors similar to people in T0. Again, this outcome is probably driven by people's realization that there is a network control effect: subjects in the high density treatment are more likely to have a stronger perception of the level of interconnectedness of the game, leading them to understand that trustees' defective behaviors have more chances to be sanctioned in such environment. Hence, trusting appears to be a "safe" bet.

Model 3 in Table 4 provides an ulterior insight, illustrating a stronger expectation of subjects in the high density group that other actors will be trustworthy. More specifically, it shows that when positive information about other players' past behavior is available, subjects with 1 individual social link playing in a high density treatment (T2b) tend to give 30 experimental points more than subjects with 1 social link playing in a low density treatment (T1b) ($p < 0.01$).

Table 3 – Random effect model on trustworthy and trusting behaviors with strangers[19]

	Model 1 DV (*Trust*)		Model 2 DV (*Trustworthiness*)	
Male	12.884**	(4.399)	0.045	(0.029)
Education	3.694	(3.058)	0.018	(0.020)
Age	-0.120	(0.159)	0.001	(0.001)
Religion (ref: no religion)	-7.000	(4.282)	0.015	(0.029)
Race (ref: White)				
Asian	8.007	(6.877)	0.126**	(0.046)
Mixed	-4.224	(7.751)	-0.020	(0.053)
Black	-10.673	(6.737)	-0.063	(0.045)
Other	-11.395	(9.171)	-0.038	(0.060)
Risk aversion	-1.486	(1.025)	-0.013+	(0.007)
Altruism	5.676**	(2.077)	0.026+	(0.014)
First Mover in past round	-0.008	(1.944)	0.003	(0.016)
Played more frequently as First Mover	-4.010+	(2.239)	0.006	(0.015)
Cumulative Disappointment	-5.322+	(2.839)	-0.044+	(0.024)
Treatments (**ref: T0 – no density; no social links**)				
T2 subgroup A (High density; 8 social links)	16.926**	(6.533)	0.114**	(0.044)
T2 subgroup B (High density; 1 social link)	**13.827***	**(6.458)**	**0.041**	**(0.044)**
T1 subgroup A (Low density; 2 social links)	17.855**	(6.722)	0.094*	(0.045)
T1 subgroup B (Low density; 1 social link)	**4.761**	**(6.720)**	**0.061**	**(0.046)**
N (Subjects)	711 (158)		616 (158)	
R2 within	0.046		0.061	
R2 between	0.205		0.201	
R2 overall	0.147		0.127	

Note: All models control for round differences. Standard error in parentheses.
+ p <0.1 *p <0.05 ** p <0.01 ***p <0.001

Overall, this evidence indicates that individuals who are socially isolated but live in denser communities are prone to engage with other citizens, as they are more willing to

19 According to the protocol, individuals had 60 seconds to take their decision (both as first or second mover). Some subjects used consistently less time than others (see Appendix – Figures A and B). Excluding such observations from the analysis does not change significantly results.

take a first step and trust their unknown fellow citizens. Simply put, being part of a close-knit community creates an environment where people with very few connections have incentives to believe in the good will of other people and therefore they are more likely to start novel and potentially beneficial relationships. In this sense, a higher overall density at the community level counters the detrimental consequences of social seclusion, increasing the likelihood of new connections.

Such results support the validity of the spillover effect for trusting behaviors, showing that its impact is separated from the one observed for social integration. In particular, they advocate that when a community is socially embedded, trusting behaviors towards strangers are more common even for individuals who have few social connections. That is, dense webs of relations in a community allow the development of pro-social conducts *also* for individuals who are socially isolated.

Nonetheless, the effect is not as straightforward as theory predicts: though trusting behaviors are more frequent in the high density treatment, no significant difference emerges if we compare directly the high and low groups (performing a Wald test[20] to check the equality of the two coefficients in table 3, we cannot reject the equality hypothesis as $p > \chi^2 = 0.14$). This leaves unclear what density levels create enough incentives to trust and what is the exact threshold that triggers the mechanism[21].

20 This is implemented in Stata 13 using the post-estimation command “test”

21 In this respect, eventual replications of this study might consider more extreme values of overall density or a larger sample size to reduce the standard error and obtain more precise estimates of the effect.

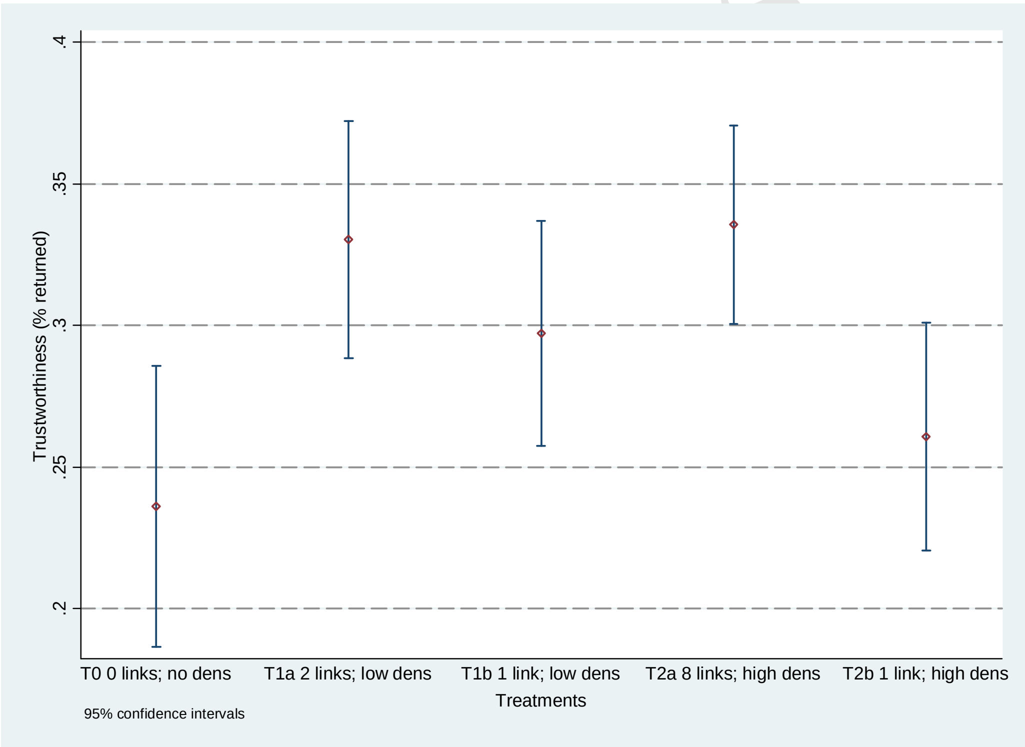
Table 4 - Random effect model on trusting behaviors towards strangers for whom positive reports are available

	Model 3 DV (*Trust*) ***Restricted Sample – Only known cooperators***	
Male	12.080+	(7.273)
Education	-1.349	(4.715)
Age	-0.558*	(0.250)
Religion (ref: no religion)	-0.034	(7.079)
Race (ref: White)		
Asian	3.844	(10.633)
Mixed	-14.393	(15.125)
Black	-21.217+	(11.128)
Other	-31.275*	(12.608)
Risk aversion	1.800	(1.782)
Altruism	2.268	(3.721)
First Mover in past round	7.461	(4.993)
Played more frequently as First Mover	-6.644+	(3.701)
Cumulative Disappointment	-2.146	(8.174)
Treatments **(ref: T1 subgroup B – Low density; 1 social link)**		
T2 subgroup A (High density; 8 social links)	34.197**	(10.409)
T2 subgroup B (High density; 1 social link)	30.463**	(10.884)
T1 subgroup A (Low density; 2 social links)	33.880**	(10.811)
N (Subjects)	139 (83)	
R2 within	0.118	
R2 between	0.350	
R2 overall	0.314	

Note: All models control for round differences. Standard error in parentheses.
+ p <0.1 *p <0.05 ** p <0.01 ***p <0.001

More importantly, graph 4 shows a different trend for trustworthy behaviors[22]: the high density treatment displays a lower average value of trustworthiness than the low density treatment. This is further confirmed in Model 2 (Table 3), where density has no significant impact. In fact, subjects both in low and high density treatments with 1 individual link (T1b and T2b) return an amount of money similar to people from the baseline treatment (T0), for which no density effect can occur. This disconfirms the existence of a spillover effect for trustworthy behaviors.

Graph 4 – Trustworthy behaviors across treatments



22 Identical reputation systems or networks' features seem often to influence trusting and trustworthy behaviors in different manners (as shown, for instance, in Charness et al., 2011 or Di Cagno and Sciubba, 2010), reinforcing the notion that these complementary dimensions of cooperation can rely on distinct motivational structures.

As concerns individual social integration, Model 2 shows that players with more links are consistently more reliable: subjects with 2 (T1a) and 8 links (T2a) tend to return respectively 9.4% ($p < 0.05$) and 11.4% ($p < 0.01$) more than people in T0. Looking at graph 4, it also emerges that, within the high density treatment, subjects with 8 links return more than subjects with 1 link (comparing coefficients in table 3 confirms this at a 0.10 significance level, as $p > \chi^2 = 0.08$).

In evaluating these results, it is important to consider that in the high density treatment subjects give more experimental points (as shown in graph 3 and Model 1). This implies that in such condition second movers also *receive more* experimental points and that, therefore, the temptation to keep the money will be stronger[23]. The decision to give in to the temptation or not should largely depend on how well subjects understand that a treacherous conduct in the present will create the opportunity for sanctions in the future. As argued above, people with more links tend to have a greater experience of the degree of interconnectedness among participants, creating a good understanding of how pervasive the control effect is. Thus, subjects with 8 links are likely to be trustworthy despite the stronger temptation to keep the money because they are probably aware of the potential costs related to a defective action.

By comparison, people with 1 link have a limited cognition of the reputation structures in place during the game. In particular, the low level of social integration does not allow players to grasp firsthand how frequently information is exchanged among players. This appears to lead them to the (wrong) assumption that the chances of future punishment will be small *for them*. By design, being in a high density environment should create a stronger feeling of interconnectedness, which would counter this line of reasoning. However, results indicate that high density is not sufficient to constrain defective actions of trustees with 1 link, or to balance the stronger temptation to keep the money[24].

23 Subjects in T2a and T2b received on average 150.3 and 142.6 experimental points as second movers, while subjects in T1a and T1b received on average 133.5 and 127.2 experimental points.

24 Nevertheless, it is important to notice that this negative propensity is not particularly strong (the difference between T2a and T2b coefficients is significant only at a 0.10 level), and that there is no statistical difference between the amount returned by subjects with 1 link in the low and high density treatments.

In summary, having a low level of social integration in a high density environment seems to create only a partial understanding of the network control effect. Indeed, subjects in this condition realize that other players have incentives to be trustworthy, and hence they give more as trusters. Yet, they do not apply the same logic to themselves when they are playing as trustee[25]. That is, they act as if their untrustworthy behaviors are unlikely to be spotted out, and the network control effect works only for players with more links. This is probably due to the fact that while a higher density environment fosters the belief that participants are embedded in a thick web of social relations, the low level of social integration prevents players from realizing that they are part of this web.

If we think to cooperation as a sequential combination of trusting and trustworthy behaviors, results indicate that density promotes only the first part of the cooperative action. Living in a socially embedded community will lead us to trust others regardless of our personal connections, but it will not be enough to convince us to be more reliable. Density creates a spillover effect that incentivizes new opportunities and connections, but it does not provide solid foundations for their sustainment over time – a constructive proposal will always fail to generate something more without reciprocation. In this sense, social integration plays a central role to promote cooperation: individuals with more social links not only trust more, but also they are more trustworthy, possibly transforming occasional positive interactions in stable and durable relationships. In other words, while density boosts individuals that are less connected in the community to open up and bet on the good intentions of their fellow citizens, only the presence of a relevant number of well-connected individuals increases the chances of reciprocation allowing the formation

25 To some extent, our results contradict previous research. In particular, our findings suggest that network control effect can drive people with low social integration in a high density environment to trust more but not to be more trustworthy. Differently, Buskens et al. (2010) report that, in repeated binary TGs played in triads with the same trustee, the network control effect has a significant impact on trustworthy behaviors but not on trusting ones. There are several differences in the two experimental designs, which might produce divergent understandings of the control effect, and, therefore, different results. In this experiment, players are placed in a large community, matched with a different partner each round (i.e. they play with absolute strangers), and have only partial access to partner's playing history as trustee. On the other hand, in Buskens et al.'s (2010), subjects are part of a small network, are always matched with the same partner, and (in the full information condition, where the network control effect is possible) trusters have complete knowledge of trustees' past history. Such differences are likely to change how pervasive and effective the control effect appears to participants, leading quite plausibly to different trusting and trustworthy behaviors.

of positive cooperative circles in the long-term.

5. Conclusion

Addressing the lack of experimental research on the validity of the spillover effect (Putnam 2000), this study proposed a novel design to test if the overall density of social links in a community fosters our trustworthy and trusting behaviors with absolute strangers.

Controlling for social integration (i.e. the individual number of social connections), we found that density does foster higher levels of trust. In particular, it emerged that (1) people in the high density treatment gave more to strangers than people in the baseline group (where no social links or density effects were possible), while people in the low density treatment behaved similarly to individuals in the baseline group; (2) subjects in the high density treatment gave more than subjects in the low density treatment when they knew that the other player behaved cooperatively in past rounds. Such results are likely to be due to players' belief that other subjects will reciprocate when there is a denser reputation system in the community – being aware that our past actions can be known to others will lead us to think that trusting is indeed a "safe" bet.

However, we found no evidence to support the idea that the overall density of social links causes an increase of trustworthiness, and we concluded that the spillover effect works only in respect to trust. That is, experiencing a low level of social integration in a high density environment seems to foster the belief that only other participants (with more links) are affected by the network control effect and have incentives to be reliable. This is interesting because it indicates that density promotes generalized trust without necessarily stimulating more reliable behaviors in the community. In this sense, in our experiment trust is sustained by the conviction that people have incentives to be trustworthy, rather than actual experiences of such behaviors.

Different levels of social integration in a society imply disparities in the number of individual connections. As it has been shown, this generates different incentives to cooperate: while well-connected subjects will tend to be trustworthy and trusting, badly connected subjects will have a more skeptic and suspicious behavior towards others. Strongly embedded communities address exactly this deleterious outcome by influencing individuals with fewer links to engage with other citizens. That is, a higher overall density of links in a society increases the chances of creating positive cooperative circles, encouraging isolated individuals to open up and start new relationships. On the other hand, social integration is likely to play an important part in the long run by capitalizing on the pro-social propensities created within denser environments. Indeed, the stronger tendency to reciprocate by well-connected subjects should allow these occasional positive interactions to stabilize and form long-lasting partnerships.

Though this study demonstrated the validity of the spillover effect, much more research is required in order to assess the exact extent and limitations of this mechanism. In particular, future studies should explore if in longer iterations of the game trusting behaviors in socially dense environments can sustain themselves even if trustworthiness levels remain the same, or whether reliability increases over time. Along similar lines, research should attempt to establish at which density levels the mechanism triggers, and if there is a specific threshold in this regard. Finally, it would be interesting to disentangle why trustworthy behaviors are not promoted in communities characterized by a high density of social relations, and if this is due to a lack of formal sanctions (e.g. giving the possibility to break relationships) in the current design of the experiment.

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Appendix

The overall density of links in a community is the ratio between the actual links of all nodes in the community over all possible links within that community:

$$Overall\ density\ of\ directed\ links = (a + b)/n * (n - 1)$$

where $n > 2$ and n is the number of nodes (i.e. subjects per session), a is the number of links in subgroup A and b is the number of links in subgroup B.

Cumulative disappointment expresses the player's disappointment experienced in the previous rounds. The measure is a weighted sum of previous disappointments, such that the more recent the negative experience is, the stronger is its effect on the current round. The formula is based on Buskens et al.'s (2010) paper:

$$Cumulative\ disappointment_r = \sum_{i=1}^{r-1} \left(\frac{1}{2}\right)^{i-r-1} * disappointment_i$$

$$disappointment_i = \begin{cases} 1 & If\ player\ received\ back\ 0\ (as\ first\ mover) \\ & or\ received\ 0\ (as\ second\ mover)\ at\ round\ i \\ 0 & Otherwise \end{cases}$$

where r is the current round.

Table A – Mean trust (amount sent) and trustworthiness (amount returned) by treatment.

	Mean Trust	Standard Error	95% Conf. Interval	N
Treatment 2 subgroup A	52.93	2.72	47.56 – 58.30	142
Treatment 2 subgroup B	44.85	2.66	39.60 – 50.10	146
Treatment 1 subgroup A	51.39	2.85	45.75 – 57.03	138
Treatment 1 subgroup B	36.24	2.47	31.36 – 41.12	150
Treatment 0	35.99	3.12	29.81 – 42.16	135

	Mean Trustworthiness	Standard Error	95% Conf. Interval	N
Treatment 2 subgroup A	.34	.02	.30 - .37	150
Treatment 2 subgroup B	.26	.02	.22 - .30	141
Treatment 1 subgroup A	.33	.02	.29 - .37	147
Treatment 1 subgroup B	.30	.02	.26 - .34	138
Treatment 0	.24	.02	.19 - .29	100

Figure A – Average Seconds used to make a decision as First mover (across all rounds)

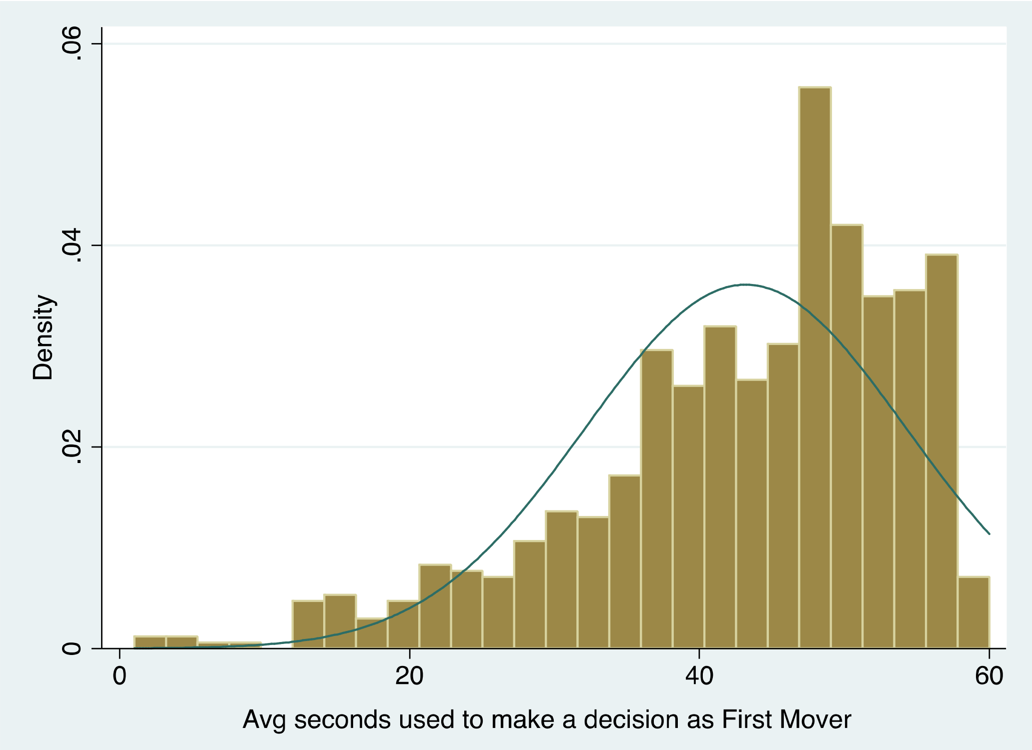


Figure B – Average Seconds used to make a decision as Second mover (across all rounds)

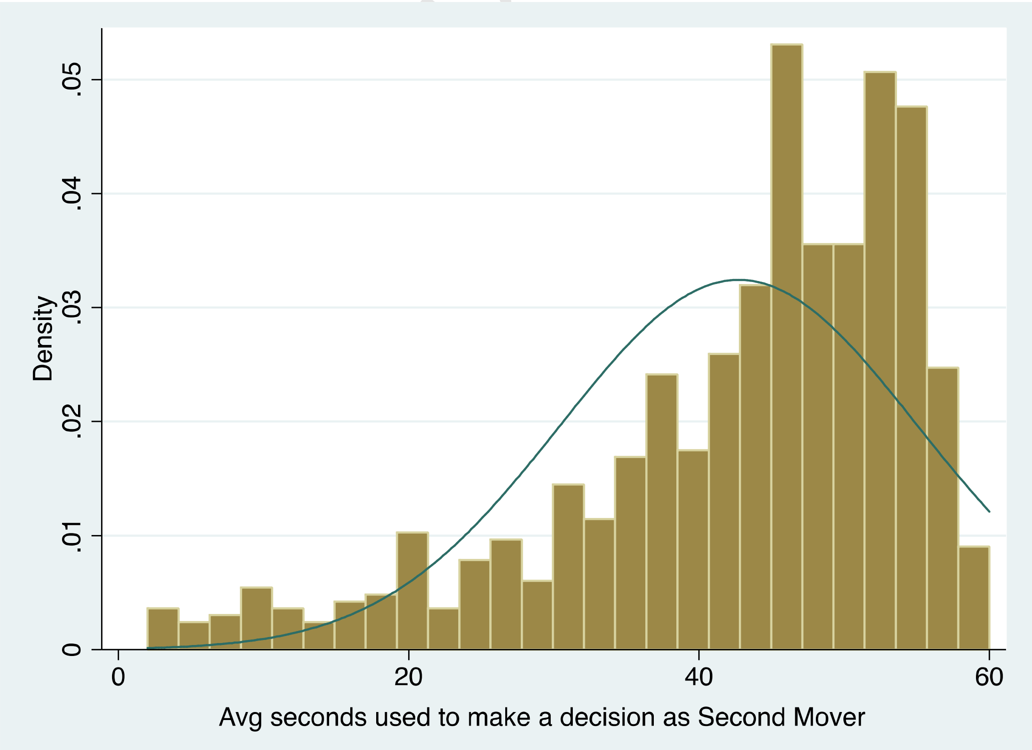


Figure C – 1st Mover Choice (Screenshot)

Figure D – 2nd Mover Choice (Screenshot)

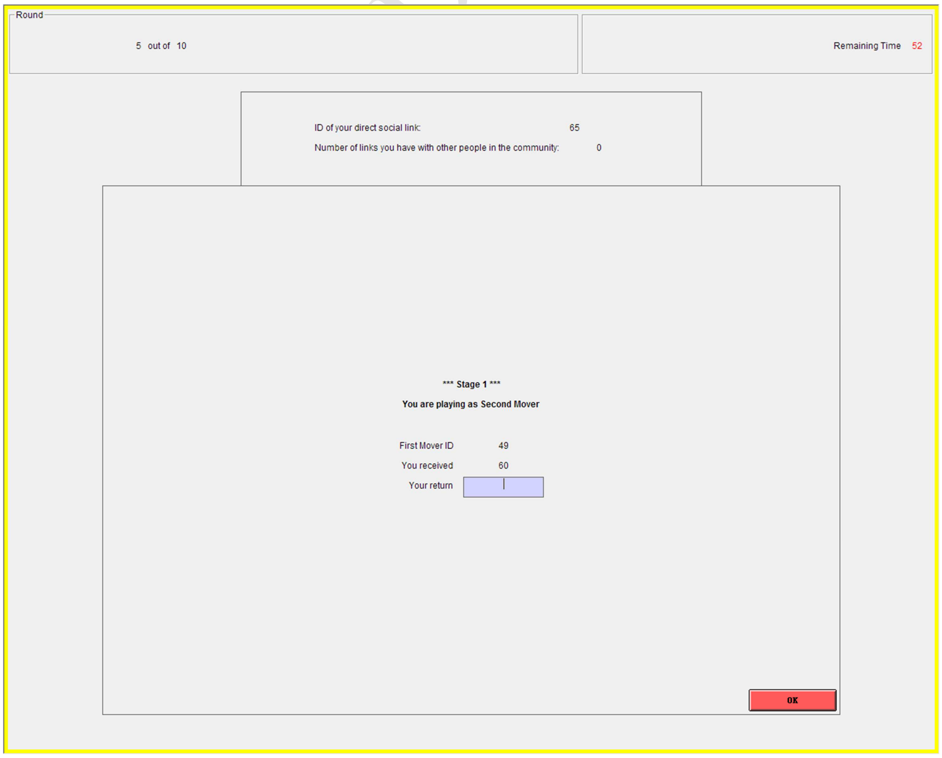


Figure E – 1st Mover Payoff (Screenshot)

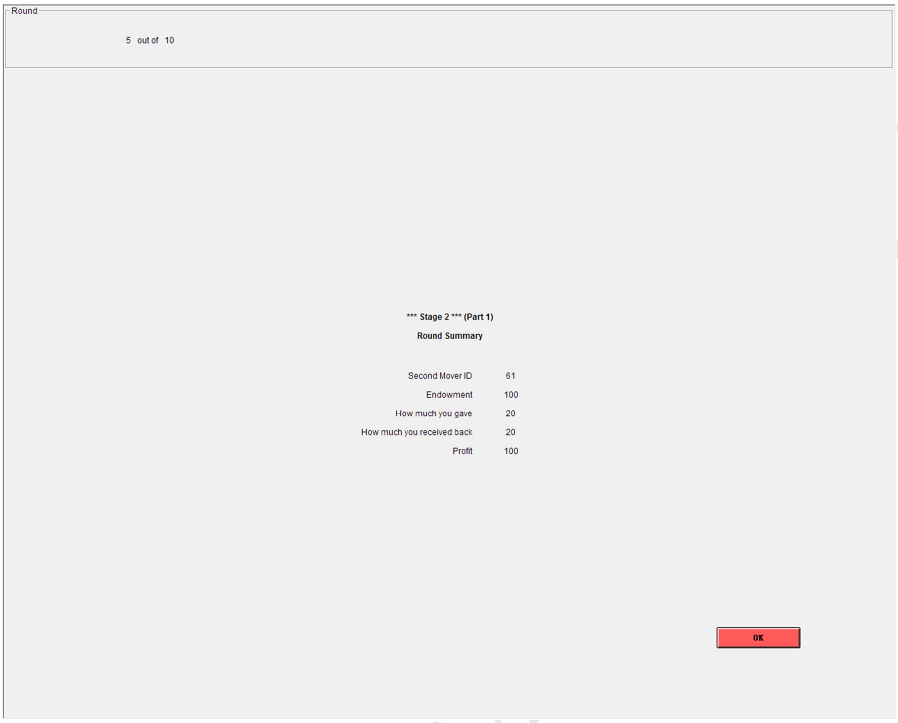


Figure F – 2nd Mover Payoff (Screenshot)

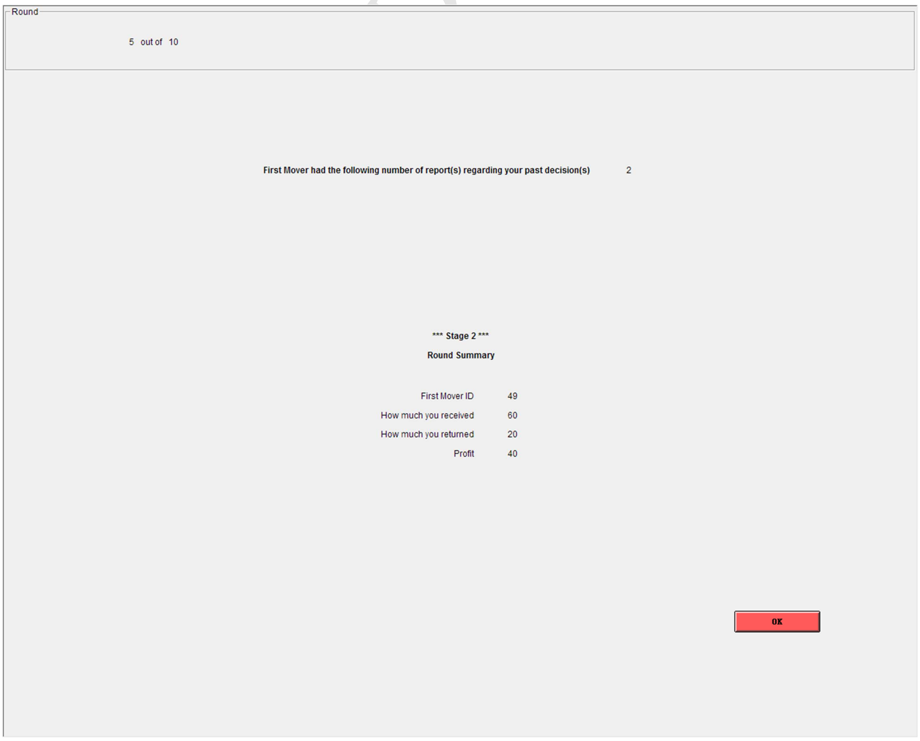


Figure G – 1st Mover Reporting (Screenshot)

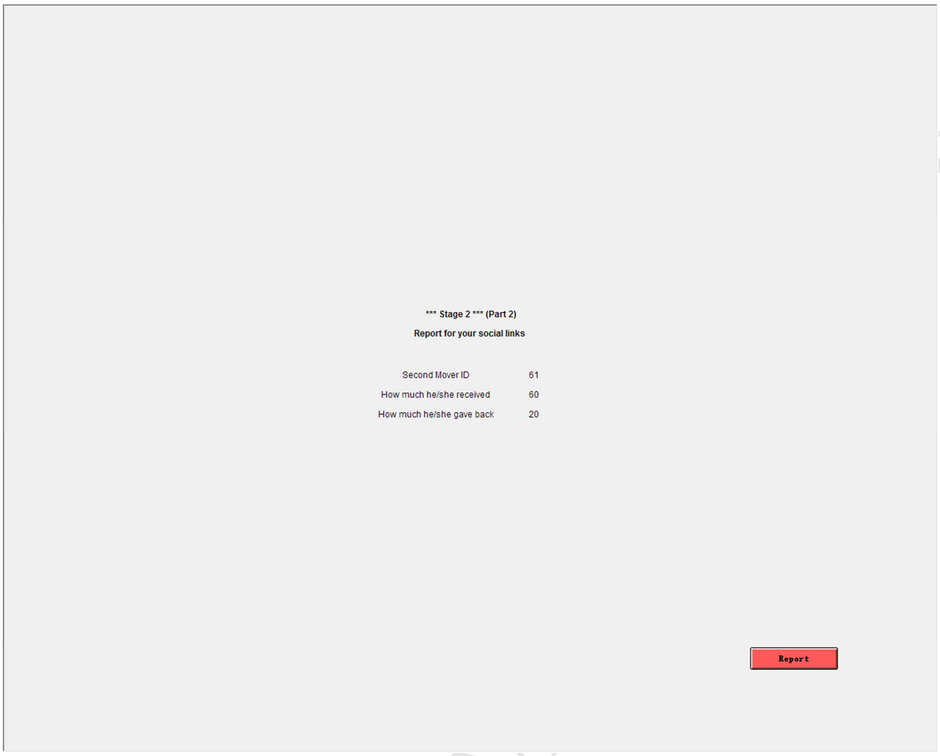
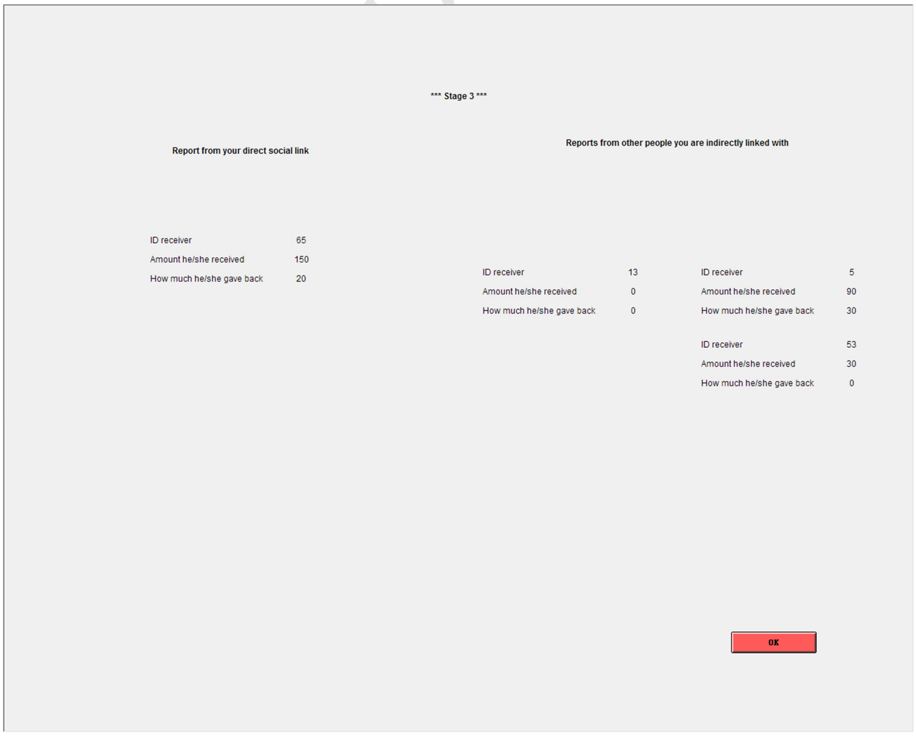


Figure H – 1st or 2nd Mover Receiving Reports (Screenshot)



GENERAL INSTRUCTIONS

There are 3 parts to the Experiment:

• Questionnaire
• Detailed Instructions
• Game

To thank you for participating in this Experiment, we have given you £2.5. In addition, you can earn Experimental Points that will be converted into real earnings. We expect the average total earning to be within the £8 - £12 range, but your actual earnings may vary considerably depending on your performance.

The expected duration of the Experiment is about 60 minutes, and you need to fully dedicate your time to this Experiment for the next 60 minutes. 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 players earn.

Before starting the Experiment, you will be asked to take a brief questionnaire. After the questionnaire, you will be provided with the Detailed Instructions. Note that each participant is shown exactly the same Instructions.

[Questionnaire]

DETAILED INSTRUCTIONS [for Treatment 0 – "No Density"]

The game

You will now play 10 rounds of a "game". At the beginning of each round you will be randomly assigned to a role. There are two possible roles in the game: "First Mover" and "Second Mover". Each round is the same and consists of 2 stages.

If you are playing as a "First Mover", in stage 1 you will be given 100 Experimental Points (equivalent to £1). You can decide to send any amount of Experimental Points to another person we have randomly matched you with. This amount will be multiplied by 3. The other person will then decide whether to return part of the Experimental points or not. The other person is absolutely free to choose either options. Notice that you will play with the same person only once across all rounds.
In stage 2, you will be able to visualize a short summary of the round.

If you are playing as a "Second Mover", in stage 1 you will receive a certain amount of Experimental Points from a player you have been randomly matched with. The amount originally sent by the other player is multiplied by 3. You can decide to return or not any amount of the Experimental Points to the other person. Notice that you will play with the same person only once across all rounds.
In stage 2, you will be able to visualize a short summary of the round.

DETAILED INSTRUCTIONS [for Treatment 1 – "Low Density"]

The game

Each player will now be assigned a numeric ID that is kept the same throughout the game. ID assignments are random and carry no particular meaning. Each player will also be assigned a certain number of social links. Social links are connections with other people taking part to the experiment. You can have social links with people of whom you know the ID (Direct social links) or not (Indirect social links). Each player will have between 1 and 2 social links.

This means that there is going to be a low density of social links among participants.

You will play 10 rounds of a "game". At the beginning of each round you will be randomly assigned to a role. There are two possible roles in the game: "First Mover" and "Second Mover". Each round is the same and consists of 3 stages. If you are playing as a "First Mover", in stage 1 you will be given 100 Experimental Points (equivalent to £1). After, you will be randomly matched with another player whom you will be able to identify by his/her ID. If the other player was matched with one of your social links in a previous round and he/she was playing as Second Mover, you will also be able to see how he/she behaved in that occasion.

You can decide to send any amount of Experimental Points to the other person. This amount will be multiplied by 3. The other person will then decide whether to return part of the Experimental Points or not. The other person is absolutely free to choose either options. Notice that you will play with the same person only once across all rounds.

In stage 2, you will be able to visualise a short summary of the round and report your experience to your social links. Each report will include how much you sent, the amount returned by the other player, and his/her ID. Finally, in stage 3 you will receive reports from your social links who played as First Movers. This information will be saved and automatically displayed in future Rounds.

If you are playing as a "Second Mover", in stage 1 you will receive a certain amount of Experimental Points from a player you have been randomly matched with. The amount originally sent by the other player is multiplied by 3. You can decide to return or not any amount of the Experimental Points to the other person. Notice that you will play with the same person only once across all rounds.

In stage 2, you will be able to visualize a short summary of the round. Finally, in stage 3 you will receive reports from your social links who played as First Movers in the current Round. This information will be saved and automatically displayed.

DETAILED INSTRUCTIONS [for Treatment 2 – "High Density"]

The game

Each player will now be assigned a numeric ID that is kept the same throughout the game. ID assignments are random and carry no particular meaning. Each player will also be assigned a certain number of social links. Social links are connections with other people taking part to the experiment. You can have social links with people of whom you know the ID (Direct social links) or not (Indirect social links). Each player will have between 1 and 8 social links.

This means that there is going to be a high density of social links among participants.

You will play 10 rounds of a "game". At the beginning of each round you will be randomly assigned to a role. There are two possible roles in the game: "First Mover" and "Second Mover". Each round is the same and consists of 3 stages. If you are playing as a "First Mover", in stage 1 you will be given 100 Experimental Points (equivalent to £1). After, you will be randomly matched with another player whom you will be able to identify by his/her ID. If the other player was matched with one of your social links in a previous round and he/she was playing as Second Mover, you will also be able to see how he/she behaved in that occasion.

You can decide to send any amount of Experimental Points to the other person. This amount will be multiplied by 3. The other person will then decide whether to return part of the Experimental Points or not. The other person is absolutely free to choose either options. Notice that you will play with the same person only once across all rounds.

In stage 2, you will be able to visualise a short summary of the round and report your experience to your social links. Each report will include how much you sent, the amount returned by the other player, and his/her ID. Finally, in stage 3 you will receive reports from your social links who played as First Movers. This information will be saved and automatically displayed in future Rounds.

If you are playing as a "Second Mover", in stage 1 you will receive a certain amount of Experimental Points from a player you have been randomly matched with. The amount originally sent by the other player is multiplied by 3. You can decide to return or not any amount of the Experimental Points to the other person. Notice that you will play with the same person only once across all rounds.

In stage 2, you will be able to visualize a short summary of the round. Finally, in stage 3 you will receive reports from your social links who played as First Movers in the current Round. This information will be saved and automatically displayed.