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Abstract

Communication is often critical for economic cooperation and enhancement of trust. Traditionally, direct face-to-face communication has been found to be more effective than any form of indirect, mediated communication. We study whether this is still the case given that many people routinely use texting and online social media to conduct economic transactions. In our laboratory experiment, groups of participants communicate either (i) face-to-face, (ii) through the most popular online social network - Facebook, or (iii) using text messaging, before participating in a public goods or a trust game. While people talk significantly more under traditional face-to-face, discussions through Facebook and text messages prove as effective as face-to-face communication in enhancing cooperation and increasing trust. For all three media, discussions that focus on the game or use more positive emotion words are correlated with enhanced trust. It appears that young American adults are now just as adept at communicating and reducing social distance online as they are in person.

Keywords: communication technology; laboratory experiments; public good games; trust games
JEL Classification: C91, C92, D03, D71

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1 Introduction

1.1 Motivation

Communication between agents is often critical for economic cooperation. Experiments demonstrate that communication helps parties cooperate in social dilemmas and public goods settings (Ledyard 1995), solve coordination problems (Ochs 1995), avoid disagreements in bargaining (Roth 1995), and establish trust in partnerships (Charness and Dufwenberg 2006). Conversely, communication between competing producers in an industry may harm society by reducing competition and raising prices (Davis and Holt 1992).

Traditionally, research has found that direct face-to-face communication is far more effective in achieving cooperative outcomes than any kind of indirect communication (Davis and Holt 1992). Roth (1995) suggests two distinct reasons for why face-to-face communication may be more effective than indirect or anonymous interactions. The *uncontrolled social utility* hypothesis suggests that face-to-face communication utilizes "all of the social training we are endowed with" (p.295) and improves efficiency by reducing social distance (Hoffman et al. 1996). The *communication* hypothesis attributes the higher effectiveness of face-to-face communication to the many non-linguistic channels of communication, such as facial expressions, tone of voice or body language, that are present in face-to-face communication (Roth 1995).

The recent revolution in online communication has resulted in radical changes in the way people communicate with each other. Individuals, especially younger gener-

ations, are spending more and more time emailing, texting, instant-messaging, Skyping and Facebooking, relative to traditional face-to-face communication.[1] Whereas face-to-face contact was traditionally necessary to achieve cooperative goals, avoid disagreements, and build trust, it might be the case that online social networks such as Facebook have become just as effective in creating social ties and enhancing trust. Research in communication studies finds that Facebook users are more trusting, have many more relationships, and receive more social support than non-users (Hampton et al. 2011). As online communication becomes more commonplace, humans may be learning how to communicate more effectively, even in fairly anonymous settings. Just as human beings have learnt to recognize facial and body cues when speaking face-to-face, humans may becoming more attuned to other cues present in online messaging: the use of CAPS, acronyms (ttyl, lol), abbreviations, emoticons, the 1337 language, etc. This calls into question whether face-to-face is still more effective than common forms of online communication in both enhancing social utility and in providing multiple communication channels.

In this study we aim to test whether the routine use of online communication by young adults has made these online communication media as effective as traditional face-to-face communication. In our laboratory experiment, groups of participants communicate either face-to-face, through a Facebook group, or using online z-Tree chat (essentially text messaging) before participating in a public good or a trust game.

[1] According to the Pew Research Internet Project (2011, 2015), 95% of young American adults (18-24 years old) own a cell phone and 97% of these cell owners use text messaging: sending and receiving an average of 109.5 text messages per day. Overall, 73% of adult cell owners use the text messaging function on their phone. 92% of teens go online daily - including 24% who go online "almost constantly". Facebook is the dominant social networking platform among both adult and teen online users. See http://www.pewinternet.org/.

These two distinct but economically-relevant games are chosen to test the robustness of our findings to variations in strategic situations. Both games are conducted under the same set of communication treatments and under a common experimental protocol. We study non-binding communication (i.e. "cheap talk"), where agreements cannot be enforced by written contract or law.

We focus on three main research questions in this study. First, does traditional face-to-face communication still outperform online media at enhancing efficiency in public goods provision, and at fostering trust in the trust game? Second, comparing different forms of online communication, do richer and less anonymous formats (Facebook) increase cooperation and trust more than anonymous text messages? Third, what are the features of effective communication? Does effective communication primarily decrease social distance or does it focus on how to play the game? In particular, does communication content differ significantly between face-to-face and online media?

To address these questions, we first compare pre- and post-communication performances in public goods and trust games for groups who communicate via different media. We further analyze communication logs regarding their social context (irrelevant social interactions and emotions) and game-relevant context (discussion of games and strategies) to see if the social and game-relevant components of communication differ significantly across communication media. We also consider which communication elements are most effective in enhancing trust and trustworthiness.

1.2 Relationship to the Current State of Knowledge

Economic experiments conducted pre-2000 universally find that face-to-face communication is far more effective at achieving cooperative outcomes than any kind of indirect communication. Face-to-face communication has been shown to greatly enhance cooperation in multi-person social dilemmas, such as public goods (Dawes et al. 1977; Isaac and Walker 1988) and common pool resource games (Ostrom et al. 1994). But using the same game setting as Ostrom et al. (1994), Rocco and Warglien (1996) find that communication via electronic means was nowhere near as effective: the chaotic and disorderly nature of online communication seems to have played an important role in explaining the breakdown in cooperation. Online conversations lacked the sequentiality of face-to-face conversations: most subjects sent their time writing messages on top of each other instead of reading the messages of others and then responding. The inferiority of alternative communication modes has also been reported for coordination games and bargaining experiments (Cooper et al. 1992; Radner and Schotter 1989).

Experimental results reported since the year 2000 tend to reinforce the superiority of face-to-face communications but some studies indicate that the gap is narrowing. Brosig et al. (2003) compare performances in a public goods game following 15-minute communication sessions using alternative communication media. They find that video-conferencing did as well as traditional face-to-face communication, both yielding stable 100% contributions until the final periods.Bochet et al. (2006) compare outcomes between face-to-face recurrent communication and text communication through an online chat room (preserving anonymity and excluding facial

expression) in a public goods experiment, and find that chat room communication is almost as efficient as face-to-face.[2] Both Brosig et al. (2003) and Bochet et al. (2006) attribute the effectiveness of online communication to the individuals' ability to discuss cooperative strategies and to express commitments to these strategies. However, for a dictator game with communication through video-conferencing, Greiner et al. (2012) find that conversations about purely social factors increase giving.

In the context of a trust game, Fiedler and Haruvy (2009) study the effect of anonymous communication in Second Life (virtual reality world) using avatars and text chat. They find that anonymous and irrelevant pre-play communication in groups of three or four had a large and positive effect on trust (the amount sent), and - for university students, but not for Second life residents - a positive effect on the proportion returned.[3] Bicchieri and Lev-On (2011) find that game-relevant online anonymous chat has the same positive effect on trust as game-relevant face-to-face chat, while "irrelevant" communication, both face-to-face and online, had a much smaller effect on trust and trustworthiness. Charness and Dufwenberg (2006) find strong effects of written free-form messages in experimental games studying trust in partnerships. Chen and Li (2009) find that communication through online chat is effective in inducing group identity, indicating that online communication may now induce social utility in a similar fashion to face-to-face.

The literature cited above suggests that both the communication and social utility

[2]Communication occurred at the beginning of every period under face-to-face communication and every three periods under chat room communication.

[3]Consistent with Fiedler and Haruvy (2009), Greiner et al. (2014) also find that communication had little effect on Second Life residents in an ultimatum game experiment, suggesting environmental or selection effects among Second Life residents.

channels suggested by Roth (1995) are important for effective communication and explain the large impact that face-to-face communication has on behavior. It further appears that online communication, when it allows for unrestricted verbal exchanges (and is sometimes enhanced with visual elements), is approaching face-to-face in providing sufficiently rich communication channels and in triggering social utility.

One aspect that is missing in the current experimental literature is linking the familiarity of communication media with its effectiveness. Another common limitation of many studies is their focus on just one strategic situation. Our experiment is designed to address both of these limitations. We hypothesize that, as online communications has proliferated, people are learning to communicate as effectively and to develop social utility as fully through texting or Facebooking. We assess this hypothesis by comparing face-to-face communication with communication mediated through a popular online social network (Facebook) and communication through text messages. Furthermore, we study the impact of communication media on two, rather than one, frequently studied strategic games.

2 Experimental Design and Hypotheses

2.1 Design

Structure of the Experiment and Treatments. The experiment is designed to compare, in a unified framework, the effectiveness of face-to-face communication to two online communication media most commonly used by American adults: the social network Facebook and unrestricted text messages (implemented through z-

Tree online chat). As we are interested in the effectiveness of communication media among active users of online technologies, all subjects (regardless of treatment) are US university students with a Facebook account.[4]

We choose several design features to provide a rigorous comparison of face-to-face and online communication media. First, we use two distinct representative games often employed to measure cooperation and trust: the voluntary contributions mechanism for provision of public goods (hereafter VCM; e.g., Ledyard (1995)), and the investment, or trust, game (hereafter TG; e.g., Berg et al. (1995)). Second, in contrast to earlier studies that often provide recurring communication sessions, we allow for only one communication session. Third, given the finding by Bicchieri and Lev-On (2011) on the lower effectiveness of group communication compared to dyadic (two-person) communication, we employ group communication for both games.

The experiment adopts standard procedures for both the VCM and TG sessions. Each session involves eight or twelve participants and consists of three parts: Part 1, the pre-communication gameplay stage; Part 2, the communication stage, and Part 3, the post-communication gameplay stage.

The **pre-communication gameplay stage (Part 1)** involves participants interacting, through a computer, either in a four-person ten-period VCM or in a two-person one-shot trust game. The objectives of this stage are to (1) familiarize the participants with the key strategic elements of the game, and (2) establish pre-communication benchmarks.

Part 1 is followed by the **communication stage (Part 2)**, which differs across

[4]As documented in Footnote 1, young adults are by far the most active adult users of online communication technologies. A college student subject pool is therefore ideal for this experiment.

communication treatments as explained below. For this stage, participants in all treatments (other than the No Communication baseline) are matched into four-person discussion groups and informed that "the people in your discussion group are picked at random from your session participants and are not necessarily the same people that you were matched with in Part 1 of the experiment.... After the communication time is over, you will participate in the same set of decision-making experiments as in Part 1, with the group of people you just communicated with" (see Experimental Instructions in Supplementary materials).[5] We picked four-person discussion groups for both the VCM and TG for three reasons: (1) to allow for communication within the exact group of people who will then be interacting with each other in Part 3 of the VCM; (2) to keep the size of communication groups the same between the VCM and TG, while being able to assess the effect of communication within the group of potential (but not certain) Part 3 matches in TG; (3) to provide additional challenges in the TG, given Bicchieri and Lev-On (2011) finding that dyadic communication has a much more pronounced effect on trust and trustworthiness than group communication.

We implemented four communication treatments using a between-subjects design:

1. **No Communication Baseline (NC).** Communication is absent from Stage 2. After the pre-communication stage, participants are told that the experimenter needs a few minutes to set up for the next stage. During the ten-minute

[5]The instruction quote above uses the exact language from the VCM treatments. For the Trust Game treatments, "are not necessarily the same people that you were matched with in Part 1" was replaced with "do not necessarily include the person you were matched with in Part 1;" and "with the group of people you just communicated with" was replaced with "with one of the people you just communicated with".

"setup" time, participants are allowed to open their internet browsers and surf the web but they cannot communicate with each other.

2. **Face-to-Face Treatment (FTF).** Participants interact with one another for ten minutes, sitting around a table facing each other. In the TG sessions, communications are audio-recorded with the participants' consent. We chose to audio-record only the TG sessions in case the process of recording conversations had an effect on communication and subsequent play. This possible confound is absent from our VCM design.

3. **Facebook-to-Facebook Treatment (FB).** Participants are initially asked for the email addresses connected to their Facebook accounts. The experimenter then invites each participant to join a specific Facebook group, created and moderated by the experimenter, so that they can communicate with their new group members for ten minutes. Communication in the Facebook group is done via wall posts and comments on these posts. Group members can see the names and profile pictures of the other people in their group. They can click on the profile of their group members and see what information or photographs they have made viewable to other Facebook members. They can make "friend requests" to their group members but there is no requirement to do this. Once the communication time is over, the experimenter removes all the participants from the Facebook group and asks all participants to log-out from Facebook. Once the experiment is over, the Facebook group is deleted.

4. **Online Chat Treatment (Chat).** Participants interact with their new group

members for ten minutes via the z-Tree software's online text messaging option, "Chat box". Participants are only identified using their Subject ID and the experimenter monitors the communication among participants via the experimental software.

The communication treatments were chosen for the following reasons. NC serves as the performance benchmark. FTF provides the traditional upper bound for effective communication media: it allows for ample verbal and non-verbal communication in addition to social utility channels. The FB discussion group has fewer communication channels (no real-time voice or facial expression), but is non-anonymous in that it discloses participants' names, images and the basic information publicly available on their Facebook profile, all of which could reduce social distance.[6] Chat is fully anonymous and hence has more barriers for reducing social distance relative to both FTF and FB, but still allows for unrestricted verbal communication. Finally, all three media are commonly used, with text-messaging and Facebook leading in popularity among online communication formats (see Footnote 1).

Once the communication stage is over, the participants participate in **Part 3: post-communication gameplay stage**, which is identical to the first stage. In the No Communication treatment, the participants were randomly reshuffled into new four-person groups (for VCM) or pairs (for TG). In all treatments with communication, participants in this part were matched with all or one of the group members they just communicated with, depending on the game (VCM: all; TG: one).

[6] Charness and Gneezy (2008) show that disclosing a counterpart's name increases giving in the dictator game. Mago et al. (2014) find that displaying photos decreases social distance between group members in a contest experiment.

At the end of Part 3, we conducted a short exit questionnaire (available in Supplementary Materials B) which asked the participants basic demographic information in addition to questions on their use of online technologies. Specifically, the questionnaire included two questions relating to Facebook: (1) How often do you use Facebook? and (2) How many Facebook friends do you have?

Specific design details for the VCM. The VCM game is played in four-person groups. Each participant has 10 tokens to allocate between a private and a public fund. The payoff function is given by $\pi_i(x) = 10 - x_i + 0.5 \sum_{j=1}^{4} x_j$, implying a Marginal Per Capita Return of 0.5. Subjects participate in 10 periods of a pre-communication VCM game in fixed groups, followed by one ten-minute communication session with a new (rematched) group, and then a post-communication game for another 10 periods with this new group. This design is in line with classical experiments on the effect of communication in the VCM (Isaac and Walker 1988), except that we have one long communication period instead of several shorter periods.

Specific design details for the TG. The structure of the underlying trust game is identical to Berg et al. (1995). A sender and a receiver are each given 10 dollars. The sender can send any part of its endowment to the receiver. The amount sent is tripled. The receiver then decides on how much of the money received to send back to the sender. We conduct one trust game before communication, and one after communication (with counterparts drawn from the communication group, as explained above). Senders remain senders and receivers remain receivers throughout the whole session.

Procedures Participants were recruited from a student population at a US university using the ORSEE recruitment software (Greiner 2004). Only individuals who had a Facebook account were eligible to participate. The game and the chat part of the experiment were implemented via z-Tree (Fischbacher 2007). A standard web browser was used for the communication session in the Facebook treatments. To standardize procedures across treatments, at the beginning of each session participants in all treatments were asked to open a web browser before initializing the z-Tree software. Experimental instructions were read out loud, distributed as hard copies, and displayed on the participants' screens. Full instructions are provided in Supplementary Materials A. All communication sessions were recorded: using a human observer (for the VCM) or an audio recorder (for the TG) under FTF, computer logs under FB, and z-tree chat session logs under Chat.

2.2 Hypotheses

Our hypotheses address the three main research questions formulated in the introduction. First, does traditional face-to-face still have a larger impact than online communication in enhancing efficiency in public goods provision, and in boosting trust and trustworthiness in the trust game? Second, comparing online communication formats, is there evidence that richer and less anonymous formats (Facebook) increase cooperation and trust more than anonymous text messages (z-Tree chat)? Third, what are the mechanisms underlying the effectiveness of communication? Is it explained primarily by reducing social distance, or by the ability to effectively discuss relevant aspects of the strategic situation, or by both? Further, does the

volume of communication matter for cooperation and trust?

The corresponding hypotheses are as follows. The null is:

Hypothesis 0. *Among a population of young adults, there is no difference in the effectiveness of direct face-to-face (FTF) communication compared to communication mediated through familiar online media (FB and Chat) in the simple VCM and TG laboratory games.*

The alternative hypothesis is based on the traditional view that the media with richer social utility and communication channels are more effective:

Hypothesis 1. *The media richer in social and communication channels are more effective in enhancing efficiency in VCM, and trust and trustworthiness in TG. That is, (a) FTF is more effective than either FB or Chat; and (b) FB is more effective than Chat.*

The next set of hypotheses relate to the mechanisms behind effective communication. Because we had limited records of face-to-face communication sessions under VCM, these hypotheses only refer to the TG.

Hypothesis 2. *Comparing communication media, all three media are indistinguishable in communication volume and in the proportions of game-relevant and social content.*

Hypothesis 3. *Irrespective of communication media, more game-relevant content increases trust and and trustworthiness.*

Hypothesis 4. *Irrespective of communication media, more social content increases trust and trustworthiness.*

3 Experimental results

We conducted 13 VCM experimental sessions with 124 students, and 12 TG experimental sessions with 96 students, for a total of 220 participants in 25 sessions (each session had between 8 and 12 students). The students were mostly undergraduates, from various majors, at a U.S. university. For both VCM and TG, the gender split was close to 50/50. All participants had Facebook accounts; most (71% for the VCM and 69% for the TG) reported using Facebook every day and most (84% for the VCM and 72% for the TG) reported to have more than 100 Facebook friends. Average earnings were about $21 for the VCM and about $23 for the TG, including the $5 show-up fee. The sessions lasted for an average of 70 minutes.

3.1 VCM Results

Table 1 provides the VCM experiment summary by treatment; Table 12 in the Supplementary Materials C provides a more detailed summary by experimental session. Figure 1 shows the dynamics of average contributions per treatment, and Table 2 displays average contributions by treatment in the pre-communication and post-communication stages. Figures 4–7 in Supplementary Materials D show the trend of average contributions of each group by treatment.

Figure 1 suggests that the contributions to the public good in the pre-communication stage (periods 1-10) are not significantly different across treatments. Indeed, this is supported by two-tailed Wilcoxon-Mann-Whitney (hereafter WMW) tests [7] using

[7] Unless stated otherwise, all Wilcoxon-Mann-Whitney tests are conducted after dropping the final period in Stage 1 and in Stage 3. This is done to avoid end-game effects. All of our results are

Table 1: VCM Design Summary by Treatment

Treatment	# Session	# Subjects	# of Comm. Groups
NC	2	24	6
FTF	5	40	10
FB	3	32	8
Chat	3	28	7

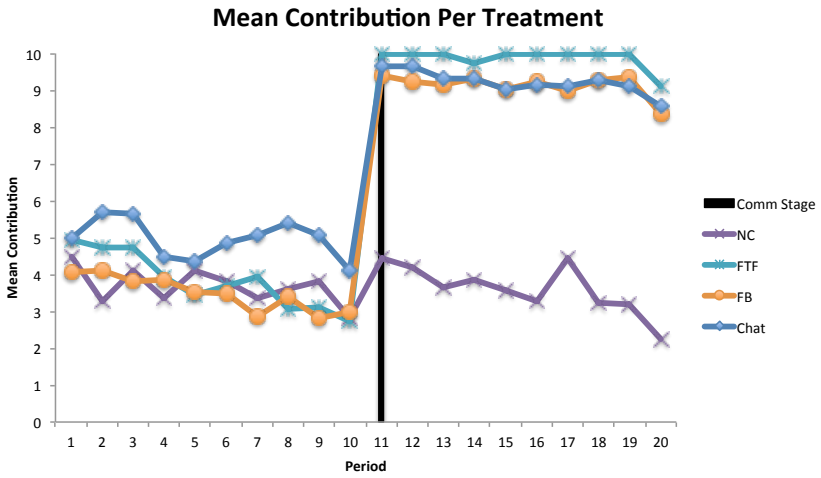

Figure 1: Mean Contribution Per Treatment

group averages as independent units of observation (NC vs. FB, $p = 0.9498$; NC vs. FTF, $p = 0.8748$; and NC vs. Chat, $p = 0.2342$). Because the pre-communication contributions are so similar, we test for the effect of communication by simply comparing the contributions in the post-communication stage.

After communication, contributions to the public fund increased in all communication treatments (Figure 1 and Table 2), while contributions did not increase in

the same, both in terms of magnitude and statistical significance, if we include the final periods. Also, we report exact p-values, not asymptotic p-values.

Table 2: Average Contribution per Treatment by Stage

Treatment	**Pre-Communication**	**Post-Communication**
NC	3.69	3.63
FTF	3.85	9.89
FB	3.49	9.14
Chat	4.97	9.22

Part 3 compared to Part 1 of the NC baseline. The differences between pre- and post-communication contribution levels are both economically and statistically significant in all three communication treatments. Relative to their pre-communication averages, contributions increased by 157% in the FTF treatment, 162% in the FB treatment, and 86% in the Chat treatment. A two-tailed Wilcoxon Signed Rank test indicates that pre- and post-communication contributions are significantly different from each other (FTF: $p = 0.002$; FB: $p = 0.0078$; Chat $p = 0.0312$). To summarize:

Result 1. *Voluntary contributions significantly increased after communication in all three communication treatments, whereas they did not increase without communication.*

Comparing post-communication contributions across the three communication treatments, we find little differences across the treatments. An average contribution of 9.88 tokens in the FTF treatment is not significantly different from that of 9.14 tokens in the FB treatment (two-tailed WMW using post-communication VCM groups as units of observation: $p = 0.6334$) and from an average contribution of 9.22 tokens in our Chat treatment ($p = 0.8868$). All three communication treatments are significantly different from the NC baseline (FTF: $p = 0.0002$; FB: $p = 0.0046$; Chat:

$p = 0.0024$).

Result 2. *There were no significant differences in the post-communication contributions between Face-to-Face, Facebook and Chat treatments. For all three communication treatments, these contributions were significantly higher than under No Communication.*

Furthermore, from Figure 1 observe that after communication the average contribution to the public fund reached close to the maximum of 10 tokens, and did not decrease till the last period after communication. This is true for all communication treatments. This observation is strengthened if per-group contribution dynamics are considered; see Figures 5 - 7 in Supplementary Materials D. We notice a general trend towards full sustained contributions for all three communication treatments. In fact, 23 out of 25 communication groups fully contributed until the penultimate period, with only occasional deviations. In comparison, none of the six groups under no communication could achieve or sustain levels close to full contribution.

Why was communication so successful in producing and maintaining full contributions? To understand this, we briefly turn to the contents of the VCM discussions. While we did not obtain full records of face-to-face communication sessions for the VCM, observers were present and took notes on the contents of communication of each group; we also kept full records of the FB and Chat discussions. We analyzed all group communications to address two simple questions: (1) Was there game-relevant discussion? And, (2) Did the group discuss and agree on fully contributing all 10 tokens to the public fund?

Without communication, none of the six groups under the NC treatment were able

to fully contribute to the public fund in any period of the post-communication stage. In contrast, in all three communication treatments, the overwhelming majority of groups discussed the game and agreed on the full contribution level (10 tokens each). Specifically, under FTF, all ten groups agreed on the full contribution level and fully contributed until the penultimate period (except for a momentary decline for Group 1 in Session 2). In the FB treatment, seven out of the eight groups agreed on the full contribution level and followed the agreement through; one FB group (Group 1 of Session 9) did not have any game-relevant discussions and did not contribute fully. In the Chat treatment, six out of seven groups agreed on the full contribution level and fully contributed until the penultimate period; one group (Group 2 of Session 8) agreed on full contributions but did not follow through with their plan. We conclude:

Result 3. *Under all three communication media, all but one group who agreed on a full contribution strategy fully contributed to the public good until the penultimate period. One-time communication allowed for full and sustained cooperation in the VCM game.*

In sum, our results on the VCM are in favor of failing to reject null Hypothesis 0 (no differences) and rejecting alternative Hypothesis 1 (face-to-face superior). Contrary to what most research on communication has traditionally found, we do not observe that direct face-to-face communication is more effective in achieving cooperative outcomes than either non-anonymous (Facebook) or anonymous (Chat) online communication. In fact, we observe full and sustained cooperation in almost all VCM groups following just one non-recurring communication session where the idea of full contributions was discussed.

3.2 Trust Game Results

We turn to the TG results next. Table 3 provides a summary of the experiment by treatment,[8] and Table 4 summarizes the results. From Table 4, we see that all forms of group communication increased both the amount sent and the amount returned. In Part 1, before communication, in line with the NC baseline, senders in the three communication treatments sent an average of \$5.55, while receivers returned an average of \$9.00. In Part 3, after group communication, senders in the three communication treatments sent on average \$3.58 more while receivers returned, on average, \$8.33 more than before. This contrasts sharply with non-positive changes in the amounts sent and retuned in Part 3 in the NC baseline. See Table 5 for the average changes by treatment.

Table 3: Trust Game: Treatment Summary

Treatment	**# Session**	**# Subjects**	**# of Sender-Receiver Pairs**	**# of Comm. Groups**
NC	3	24	12	6
FB	3	24	12	6
FTF	3	24	12	6
Chat	3	24	12	6

Figures 2 and 3 illustrate the behavior of senders and receivers in the TG before and after communication. The figures display the amount each sender sent after it has been tripled (in light grey) and the amount that the corresponding receiver returned, for each sender-receiver pair before and after communication, by treatment.[9] While

[8] Table 13 in Supplementary Materials C provides a more detailed summary by session.

[9] Figures 8 - 11 given in Supplementary Materials E, show the frequencies of amounts sent by

Table 4: Average Amount Sent and Returned

BEFORE COMMUNICATION			
Treatment	**Sent ($)**	**Returned ($)**	**% Returned**
NC	6.58	10.17	54.85
FTF	5.83	10	58.76
FB	4.17	5.75	51.16
Chat	6.67	11.25	51.99
AFTER COMMUNICATION			
Treatment	**Sent ($)**	**Returned ($)**	**% Returned**
NC	6.17	7.92	48.25
FTF	9.17	17.08	59.03
FB	8.42	16.42	63.61
Chat	9.83	18.50	62.50

Table 5: The Change in Average Amount Sent and Returned From Part 1 to Part 3

Treatment	**Sent ($)**	**Returned ($)**	**% Returned**
NC	-0.42	-2.1	-5.41
FTF	3.33	7.08	0.27
FB	4.25	9.82	12.17
Chat	3.17	7.25	10.51

we observe a considerable number of senders sending the full amount of 10 in both Parts 1 and 3 even in the NC baseline, we see an increased number of senders sending 10 tokens in all communication treatments after communication. Comparing the amount sent by senders, and the amounts returned by receivers, between Parts 1 and 3, we document statistically significant differences for all communication treatments (FTF, FB and Chat), for both senders and receivers ($p \leq 0.01$, Wilcoxon Signed Ranks test). Conversely, we observe no significant changes under NC for either senders or receivers ($p > 0.1$ in both cases).[10] We conclude:

senders and amount returned by receivers, by treatment.

[10]Aggregating individual amounts sent and returned to the level of communication group, or

Result 4. *Compared to the pre-communication stage (Part 1), the amount sent by senders and the amount returned by receivers increased after communication in all three communication treatments. In comparison, the changes in the amounts sent and returned between part 1 and 3 of the No Communication baseline are not statistically significant.*

While the receivers returned more tokens after communication, it could be simply because they were sent more. We now consider if they are also returning a higher percentage than in Part 1. Tables 4 and 5 suggest that the percentage returned has increased from about 50% towards two-thirds, at least under the FB and Chat treatments. However, sign rank tests indicate that the changes in the percentage returned are statistically insignificant under all four treatments (NC: $p = 0.4212$; FTF: $p = 0.2813$; FB: $p = 0.2188$; Chat: $p = 0.5000$). We conclude:

Result 5. *Communication did not affect the percentage sent back by receivers.*

We now turn to comparisons across treatments. Returning to Table 4, we observe a high variability in the amounts sent and returned across treatments, even in the pre-communication stage.[11] To control for pre-communication differences between treatments, we compare changes between Parts 1 and 3, rather than absolute amounts across treatments. Table 6 shows the p-values for WMW tests for changes in the amounts sent by senders (left), and in the percentages returned by receivers (right). In both cases, communication group averages are taken as the independent units of

using parametric tests, produces almost identical results.

[11] In fact, the average amount of 4.17 tokens sent under FTF treatment is weakly significantly different from the 6.17 tokens sent under the NC treatment ($p = 0.0868$), and from the average amount of 6.67 tokens sent by individuals in the Chat Treatment ($p = 0.0530$).

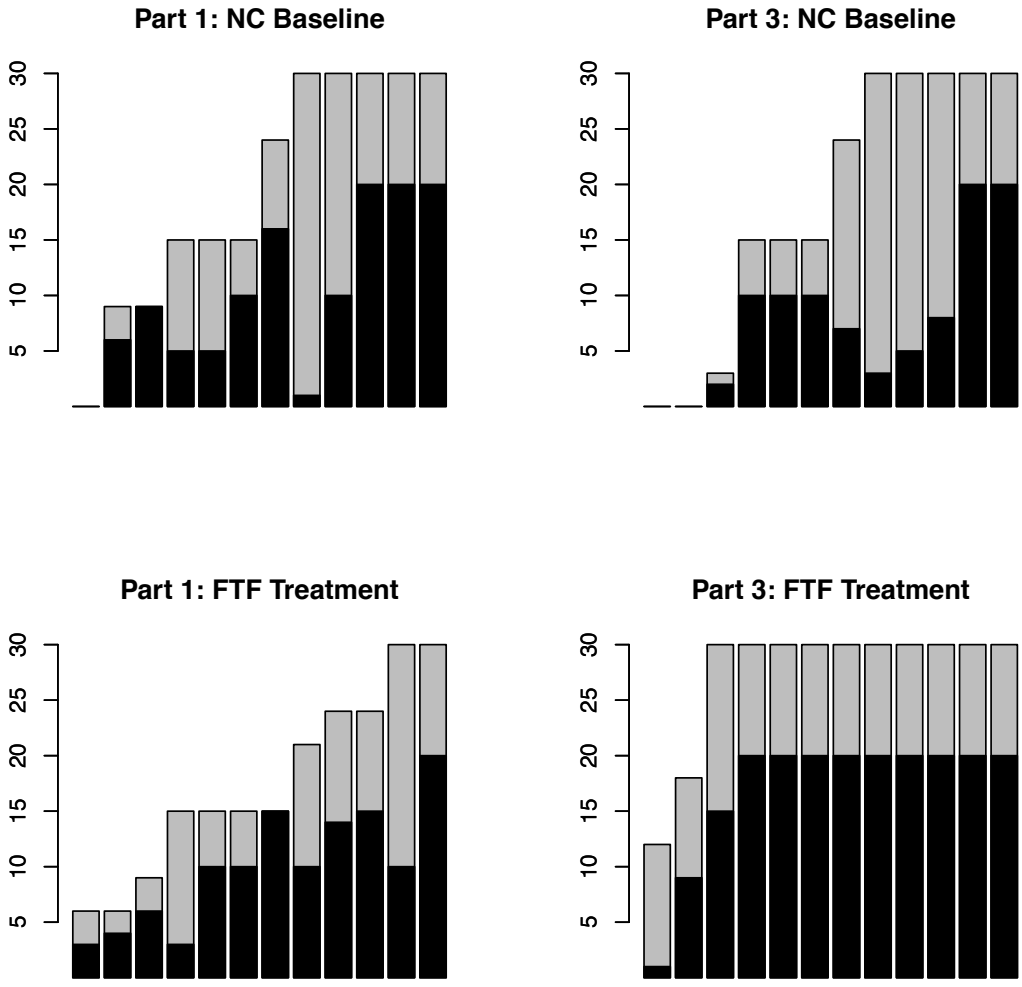

Figure 2: NCand FTF: Amount Sent Tripled (Grey) and Amount Returned (Black), By Match

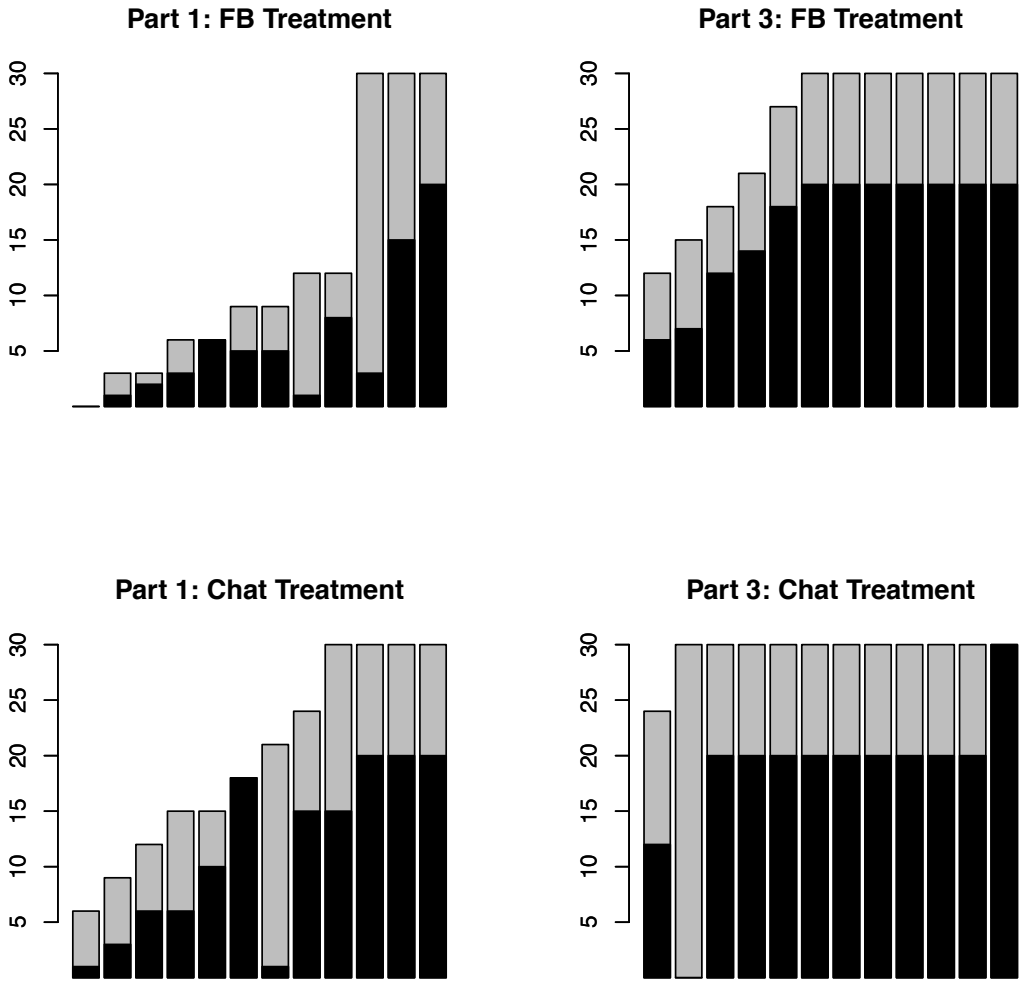

Figure 3: FB and Chat: Amount Sent Tripled (Grey) and Amount Returned (Black), By Match

observation.

Table 6: p-values For Comparison of Changes (Stage 3 - Stage 1)

	Amount Sent				Percentage Returned			
	NC	FTF	FB	Chat	NC	FTF	FB	Chat
NC	-	0.0033	0.0275	0.0033	-	0.7837	0.2733	0.3613
FTF	-	-	0.5204	0.9361	-	-	0.3367	0.3776
FB	-	-	-	0.2971	-	-	-	0.8728

From Table 6 (left), we see that the change from Part 1 to 3 in the amount sent by senders in the communication treatments is statistically different from the NC baseline. Interestingly, none of the communication treatments are statistically significantly different from each other ($p > 0.1$ in all cases). Unlike the senders, the presence of communication does not seem to affect the percentage returned by receivers. From Table 6 (right), we see that changes in the percentage returned are not different under any communication treatment compared to no communication. Furthermore, these changes do not statistically significantly differ across communication media ($p > 0.1$) for all pairwise comparisons. We also note that the percentage returned by receivers was no different across treatments both before and after communication, except for a marginal difference at $p = 0.0907$ between NC and FB after communication (see Table 14 in Supplementary materials C). This suggests a robust tendency of receivers to return between one half and two-thirds of the amount received, irrespective of the treatment.

Result 6. *After communication,*

1. *The amount sent changes significantly more under every communication treatment compared to the No Communication baseline; yet, there are no differences*

in the changes across the three communication treatments.

2. *Changes in the percentage sent back by receivers are no different under any communication treatment than under no communication.*

We summarize these results as follows. Communication had a strong effect on the senders, causing them to trust significantly more tokens to the receivers; many senders sent all 10 tokens after communication. In contrast, communication did not affect the percentage receivers sent back to the senders. However, since the amount sent significantly increased under FTF, FB and Chat treatments, so did the absolute amount returned. Moreover, these results do not differ, qualitatively or quantitatively, across the three communication media. All three communication media were equally effective in enhancing trust, but had no effect on trustworthiness. Hypothesis 0 is not rejected (no differences across communication formats), whereas the alternative Hypothesis 1 is.

4 Communication Analysis for Trust Games

In an attempt to better understand the reasons for the effectiveness of communication under the three communication media, we now turn to a detailed analysis of the conversations in the trust game experiment.[12] In view of Hypotheses 2-4 of Section 2, we address the following questions: First, do different media differ in communication volume and in the composition of messages - specifically, the proportions of "irrelevant" social conversation and game-relevant conversation? And second, what are the

[12]See section 3.1 for a brief analysis of the VCM communications. We did not audio-record the FTF discussions under VCM and therefore cannot perform a quantitative comparison.

key components of conversation that had a significant impact on the enhancement of trust and trustworthiness? Was engaging in game-relevant conversation alone important, or was the social and emotional aspect of communication important as well? Among game-relevant topics, which had a significant impact on sender and receiver behavior?

All TG communication sessions were recorded, using an audio recorder under FTF, computer logs under FB, and z-tree chat session logs under Chat. FTF sessions were then transcribed by a stenographer. We conducted content analysis of communication logs using two complementary approaches: using human coders (similar to Chen and Chen (2011) and Cooper and Kühn (2014)) and using a standard Content Analysis software package *Linguistic Inquiry and Word Count 2007* (LIWC). We will focus on human-coder analysis in subsection 4.1, and turn to the computational analysis in subsection 4.2.

4.1 Game-relevant and social communication

Two independent human coders classified all messages into either social or game-relevant content categories, and into three statement types: (i) proposals and explanations, (ii) questions, and (iii) approvals and agreements. Game-relevant categories included: discussion of norms and goals (money maximization, equal split, fairness), division of payoffs (how much to send and return), and implementation and enforcement issues (not cheating, trust, etc.). Detailed classification categories are available in Supplementary Materials F. We allowed for one content category per message; disagreements between the two coders were rare. A measure of inter-coder agree-

ment for Message Content and Message Type, κ (Cohen et al. 1960), along with the distribution of messages by content category and by statement type, are reported in Table 7.

Table 7: Communication Content by Treatment

	FTF Treatment		FB Treatment		Chat Treatment	
Message Description	Percent Observed	κ	Percent Observed	κ	Percent Observed	κ
Message Content Categories						
Empty Content	0.14		0.94		8.03	
Social Discussion	46.48		31.13		45.58	
Norms and Goals Discussion	7.17		9.91		6.83	
Strategy: Division and Payoff	15.45		29.25		27.11	
-in particular, send 10	3.17		6.13		4.82	
-in particular, send 10, return 20	5.66	0.7798	15.09	0.7186	15.26	0.6047
Strategy: Implementation	9.93		16.04		4.42	
-in particular, messages on cheating	0.97		3.30		0.20	
-in particular, messages on trust	7.31		7.08		1.00	
Payoff/Game Discussion	8.97		7.55		6.02	
Personal Game-Related Discussion	11.86		5.19		2.01	
Message Type Categories						
Empty Content	0		0.94		7.83	
Statement/Proposition	71.57		67.45		66.27	
Question/Doubt/Confusion	21.00	0.7381	18.40	0.7625	13.45	0.5973
Approve/Agree/Ok	7.43		13.21		12.45	

Before analyzing the content, consider the communication volume. Table 8 summarizes the average number of messages (uninterrupted statements) and the share of game-relevant messages per communication group by treatment. We see that FTF groups are characterized by a much higher communication volume: 120.67

messages on average per group as compared to only 35.1 messages under FB and 76.33 messages under Chat. The differences between all three treatments are highly significant according to a WMW test: $p = 0.0011$ (FTF vs FB), $p = 0.01$ (FTF vs Chat), $p = 0.0011$ (FB vs Chat). Interestingly, the share of game-relevant messages is the highest under FB: 69.98%, followed by 56.41% under FTF, and the lowest, 54.06%, under Chat; the difference in shares between FB and Chat is significant ($p = 0.0465$). This indicates that FB, while characterized by a low communication volume, was more efficient and focused on game-relevant conversations compared to the other two treatments. This also reinforces earlier findings from Rocco and Warglien (1996) that anonymous online chats are often characterized by large volumes of chaotic, nonsensical chatter. 8% of the content under Chat was categorized as "Empty Content" but less than 1% of the content in FTF and FB was "empty". This motivates the following finding:

Result 7. *Among the three communication media, Face-to-Face was characterized by significantly higher communication volume, whereas Facebook had the lowest volume but the highest share of game-relevant messages.*

Hypothesis 2 of Section 2 is therefore clearly rejected by the data.

Table 8: Group Communication Volume by Treatment

	FTF Treatment		FB Treatment		Chat Treatment	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Number of messages	120.67	(30.26)	35.17	(6.82)	76.33	(19.36)
Game-relevant messages, share	0.5641	(0.2362)	0.6998	(0.1294)	0.5406	(0.2294)
	Number of obs: 6		Number of obs: 6		Number of obs: 6	

We now conduct ordered logit regression analysis of trust (amount sent) or trustworthiness (amount returned) of individual senders and receivers in the post-communication trust game with the content and volume of communication as explanatory variables. We chose the set of content variables to provide the best fit, therefore, not all content categories are included.[13] Aside from the variables on communication volume and content, the explanatory variables include FB and Chat treatment dummies (FTF treatment is the omitted variable), the pre-communication amount sent for senders or the pre-communication percentage returned for receivers (to control for initial individual differences), and, for receivers, the amount they've been sent. The results are presented in Table 9.

Table 9: Effect of Communication Volume and Relevance in Post-Communication Trust Game

Ordered logistic regression

	Amount sent			Amount returned		
	Coef.	Robust Std. Err.	P > z	Coef.	Robust Std. Err.	P > z
Sender's pre-communication offer	0.1468	(0.4489)	0.7440			
Amount sent to receiver				1.7147	(0.9100)	0.0600
Pre-communication share returned by receiver				2.5017	(2.4383)	0.3050
# messages	0.1702	(0.0598)	0.0040	-0.0700	(0.0261)	0.0070
# game-relevant messages	0.4373	(0.1497)	0.0030	-0.0355	(0.0348)	0.3070
# messages on sending full amount	0.8022	(0.2908)	0.0060	-0.1072	(0.0685)	0.1180
# messages on sending 10, returning 20	1.1802	(0.2702)	0.0000	0.0175	(0.1008)	0.8620
# messages on cheating	-3.3893	(1.3008)	0.0090	0.0603	(0.3921)	0.8780
# messages on trust	-0.2011	(0.2042)	0.3250	0.0767	(0.0899)	0.3930
FB Dummy	32.2219	(11.4221)	0.0050	-6.7277	(2.7986)	0.0160
Chat Dummy	11.9184	(2.6772)	0.0000	-3.6013	(1.3538)	0.0080
	Number of obs: 36			Number of obs: 35		
	Pseudo R2= 0.5400			Pseudo R2= 0.3752		

Notes: In the receiver regression, we dropped one observation where the sender sent zero in Part 1. Standard errors are adjusted for 18 clusters in communication groups. FTF is the baseline/omitted treatment.

We can make several observations of interest. The sender's offer and the percent-

[13]Message type categories, such as the share of questions and approvals, had an insignificant effect on behavior and were dropped from the set of explanatory variables.

age returned by the receivers in the pre-communication game both have a positive but insignificant effect on sender and receiver behavior. For senders, both the overall number and the number of game-relevant messages significantly ($p < 0.01$) increased the amount sent, indicating that both social and game-relevant communications improve trust (since nearly all of the messages that were not game-relevant were coded as social discussions). The treatment dummies are highly positive and significant ($p < 0.01$) for FB and Chat treatments, indicating that, compared to FTF, these online media provided for more efficient communication (remember that message volume was significantly higher under FTF than under either FB or Chat). Further, a discussion on sending the full amount of 10 (which would guarantee efficiency), or sending 10 and returning 20 (which would result in both a fully efficient and egalitarian outcome) significantly increased the amount sent ($p < 0.01$ in both cases). Interestingly, messages on cheating, although stated mostly as appeals not to cheat, significantly reduced the amount sent by senders ($p < 0.01$). Such discussions likely anchored the senders' attention to the receivers' lack of incentives to send anything back. Mentioning trust had an insignificant effect on sender behavior.

As for receiver behavior, communication volume, i.e., the number of both social and game-relevant messages, had a negative effect on the amount returned ($p < 0.01$); however, FB and Chat treatment dummies again had the same (negative) sign as the coefficient on the number of messages, resulting in a similar level of trustworthiness under FTF (longer conversations) as under FB and Chat (shorter conversations).[14] Consistent with the insignificant effect of communication sessions on receiver behav-

[14] Alternative regression specifications without treatment dummies suggest an insignificant effect for communication volume.

ior reported in Section 3.2, we find that the content of communications had little effect on the amount returned: the coefficients on all content variables are insignificant. As expected, the amount returned was positively correlated with the amount that was sent ($p = 0.06$ on the amount sent coefficient). Hence, for receivers, communication appears to have mostly an indirect effect through increasing the amount sent to them.

4.2 Linguistic analysis

The words used in each Trust Game communication session were also analyzed using a Content Analysis software package: *Linguistic Inquiry and Word Count 2007* (LIWC). The software processes each word spoken or written by searching for it from a list of category dictionaries and then incrementing the score of any category that the word appears in. For example, the word "cried" is part of four word categories: (i) sadness, (ii) negative emotion, (iii) overall affect, and (iv) past tense verb. Hence, if "cried" is found in the text for a group, each of these four category scores gets incremented for that group.

We use the output from the software to explore whether differences in the words used by groups are correlated with individual-level differences in trust and trustworthiness. This is a similar idea to Chen and Chen (2011). Tables 10 and 11 present results from regressions for senders and receivers respectively. Since most communication groups use roughly the same proportion of different word categories, a number of explanatory variables are highly collinear and subsequently dropped from the analysis. However, we do observe some intriguing patterns when we explore differences

in the offers by senders (Table 10). We observe a strong positive correlation between the use of numerals and the amount offered by senders but a strong negative correlation between the use of quantifiers, like "few", "more" and "much", and the amount offered by senders. Specificity seems to increase offers by senders. Words categorized under insight, such as "think", "know", and "consider", are also positively correlated to higher amounts sent, suggesting that words indicating cognitive processing lead to higher amounts sent. The more individuals think about and discuss the game, the more likely they are to send higher amounts. Discussions related to time and money are found to increase the amounts sent. As expected, positive emotion words lead to higher amounts sent while negative emotion words lead to lower amounts sent. Words related to social processes like "mate", "talk", and "child" and words that are work-related like "job", "majors", and "xerox" are found to decrease the amount sent. Work-related words can cause sending high amounts appear mandatory, making senders averse to sending high amounts. As for social processes, we don't have a good explanation for why they seem to decrease the amount sent. The other major statistical difference is in terms of the use of punctuation. The use of periods and exclamation marks are positively correlated with the amount sent while the use of question marks are negatively correlated with amount sent. It makes sense that question marks, indicating confusion and possibly doubt, as opposed to using direct punctuation marks like periods and exclamation marks would lead to lower amounts. This is a finding that is generally supported in the computational linguistics literature (Pennebaker et al. 2003; Tausczik and Pennebaker 2010).

Table 10: Trust Regression Results (LIWC)

	Amount Sent				
	All	All With Treatment Dummies	FTF	FB	Chat
	(1)	(2)	(3)	(4)	(5)
Numerals	1.0924***	-4.6152***			
	(0.1634)	(1.0246)			
Pronouns	0.5979***	-2.3413***	-2.1114***	-0.2641	-0.119
	(0.1864)	(0.5036)	(0.4223)	(0.3770)	(0.1190)
Articles	0.4769**	-6.0370***		-1.2335*	
	(0.2227)	(1.2579)		(0.5145)	
Past Tense	-0.9726***	-2.6670**			
	(0.2111)	(0.9778)			
Present Tense	-0.2373*	2.0767***			-0.0403
	(0.1232)	(0.5169)			(0.0403)
Social Processes	-0.7341***	3.4739***	2.4488***		0.0652
	(0.1117)	(0.7344)	(0.4898)		(0.0652)
Positive Emotions	0.3712**	-0.1446		0.4925	
	(0.1608)	(0.4080)		(0.6068)	
Negative Emotions	-0.3988	-8.2607***			
	(0.2311)	(2.1035)			
Insights	1.4599***	-1.5209**			
	(0.3684)	(0.5787)			
Time	0.5439*	-0.8471**	2.6269***		
	(0.2769)	(0.3005)	(0.5254)		
Work	-0.8825*				
	(0.4305)				
Money	1.4958**				
	(0.5832)				
Assent	-0.1207		3.2444***		
	(0.2221)		(0.6489)		
Period	0.1132*		0.8956***	-0.1611	
	(0.0648)		(0.1791)	(0.2742)	
Question Mark	-1.5664***				-0.1391
	(0.2472)				(0.1391)
Exclamation Mark	0.6913**				0.317
	(0.3095)				(0.3170)
Fillers	-1.1577				
	(1.0322)				
Future Tense		-1.6772***			
		(0.2814)			
Negations		10.6860***			
		(3.1390)			
Quantifiers		-7.7147***			
		(1.7883)			
Tentative		5.2819***		0.6726*	
		(1.1856)		(0.3239)	
Certain		-9.0874***			
		(1.9808)			
Facebook Dummy		24.2612***			
		(7.8654)			
Chat Dummy		28.8332***			
		(8.4604)			
Constant	1.2754	58.3938***	-14.3540**	15.6263	11.2807***
	(3.8926)	(10.5842)	(4.8708)	(9.0710)	(1.2807)
R-squared	0.88	0.88	0.95	0.83	0.45
N	36	36	12	12	12

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
NOTE: OLS regression ran. Robust standard errors in parentheses.

Table 11: Trustworthiness Regression Results (LIWC)

	Percentage Returned				
	All	All With Treatment Dummies	FTF	FB	Chat
	(1)	(2)	(3)	(4)	(5)
Numerals	0.0761**	-0.4758*			
	(0.0341)	(0.2438)			
Pronouns	0.041	-0.2209**	-0.1556	-0.0080***	-0.0039
	(0.0437)	(0.0977)	(0.0880)	(0.0007)	(0.0328)
Articles	0.0915	-0.5634*		-0.0494***	
	(0.0619)	(0.2934)		(0.0045)	
Past Tense	-0.0202	-0.2556			
	(0.0492)	(0.2019)			
Present Tense	0.0115	0.2508*			0.0559
	(0.0281)	(0.1332)			(0.0535)
Social Processes	-0.0526*	0.3231*	0.1841		-0.0362
	(0.0271)	(0.1650)	(0.1020)		(0.0348)
Positive Emotions	0.0526*	-0.0662		0.0042***	
	(0.0279)	(0.0790)		(0.0004)	
Negative Emotions	0.032	-0.8342			
	(0.0803)	(0.4879)			
Insights	0.0495	-0.1828*			
	(0.0605)	(0.1005)			
Time	0.0683	-0.1004	0.1944		
	(0.0491)	(0.0778)	(0.1095)		
Work	-0.1169				
	(0.0899)				
Money	0.1659				
	(0.1121)				
Assent	-0.0361		0.2076		
	(0.0279)		(0.1398)		
Period	0.0089		0.058	-0.0116***	
	(0.0104)		(0.0384)	(0.0011)	
Question Mark	-0.1205*				-0.0254
	(0.0591)				(0.0508)
Exclamation Mark	0.0303				-0.115
	(0.0562)				(0.1188)
Fillers	-0.2297				
	(0.1756)				
Future Tense		-0.0487			
		(0.0691)			
Negations		1.2365			
		(0.8080)			
Quantifiers		-0.7985*			
		(0.4552)			
Tentative		0.5567*		0.0116***	
		(0.2934)		(0.0011)	
Certain		-0.8976*			
		(0.5009)			
Facebook Dummy		2.9183			
		(1.8908)			
Chat Dummy		3.3141			
		(2.0184)			
Constant	-0.7943	4.4824**	-1.0072	1.0662***	0.8006*
	(0.9633)	(1.8191)	(1.0262)	(0.0363)	(0.4005)
R-squared	0.53	0.53	0.69	0.99	0.38
N	36	36	12	12	12

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

NOTE: OLS regression ran. Robust standard errors in parentheses.

For receivers, the results, in terms of percent returned, are similar, but smaller in magnitude and in statistical significance (Table 11). We observe fewer correlations between the LIWC categories and the percentage amount returned. This makes sense given our results that communication did not significantly improve the percentage returned by receivers. We do, however, observe that numerals and positive emotions are positively correlated with percent returned while question marks are negatively correlated to percent returned. As in the amount sent, receivers in communication groups discussing specific numeric proposals are more likely to return more, whereas those in groups that are frequently more questioning as well as in communication groups that make returning seem obligatory (Certain category) send back less money. Result 8 below summarizes our findings on the effect of communication content:

Result 8. *1. For senders, irrespective of communication media, game-relevant discussions, especially involving efficient proposals of sending the full amount, had a significant and positive effect on the amount sent.*

2. For receivers, the evidence on the effect of communication is weak. The amount returned by receivers was largely determined by the amount they received from senders. Yet, based on the linguistic analysis, receivers in groups that discussed specific numerical proposals returned a higher percentage of the amount received.

3. For both senders and receivers, positive emotion words significantly increased and question marks decreased the amounts sent and the percentages returned, suggesting a social utility channel through which communication influences be-

havior.

We conclude that we have strong support for Hypotheses 3 and 4 of Section 2 for the senders, but only limited support for the receivers.

5 Conclusion

We presented an experiment that re-examines the traditional claim that face-to-face communication is far more effective in achieving cooperative outcomes than other modes of communication. This research question is timely in a world where communication technologies have changed to the point that many individuals, especially young adults, communicate more online than face-to-face. To tie the effectiveness of communication media with its familiarity, we conducted our experiments on a subject pool of active online users: college students with Facebook accounts, most of whom report using Facebook daily.

Our findings are quite stark. The three communication media that we study – Face-to-Face, Facebook and Chat discussions – all lead to full and sustained contributions in the VCM game, and significantly increase, most often to the maximum, the amount that senders give in the trust game. Contrary to what research on communication has traditionally found, we find no significant differences among the three communication media in terms of their effectiveness in increasing cooperation and trust. It is not the case that our subject pool are inherently cooperative or trusting: without communication, the fail to get anywhere near full efficiency. While Face-to-Face communication is characterized by a much higher volume of messages, Facebook

discussion groups and online Chat prove no less effective in our simple environments. Facebook discussions, which are the smallest in volume, have a higher percentage of game-relevant content, thus leading to the same level of contributions as the other two communication media. Although there are no statistically significant differences across communication media, we do observe patterns and weakly significant differences that are mildly suggestive of an ordinal ranking. Facebook performs just as well as Face-to-Face and sometimes better (Facebook increased contributions in the VCM by a higher % than any other media). Online chat ranks last and we surmise that this may be due to the added layer of anonymity and the chaotic, often irrelevant, content in anonymous online chats (nearly 1 out of every 10 messages was uninterpretable). But again, statistically speaking, there are no differences across communication media.

We also explore the reasons for the high effectiveness of communication. We find that game-relevant discussions are critical in achieving efficient and cooperative outcomes under all three communication media; discussing full contributions under VCM and sending the full amount under the Trust Game had a strong positive impact on implementing these outcomes. However, we also find evidence on the importance of Roth (1995)'s social utility channel, at least for the Trust Game. With the help of a computational linguistics software package, we are able to document a positive effect of the emotional component of language on trust and trustworthiness: participants in groups who expressed more positive emotions send and returned more. Emotions were expressed in face-to-face discussions and via online media, giving evidence of the growing richness of online communication content and the ability of young adults

to decipher these emotions.

One finding that may appear puzzling is a low and insignificant effect of communication on responder behavior in the trust game. Although responders do respond, to a certain degree, to discussions with a high quantitative component (likely discussing specific amounts to send and return) and to those with a high share of positive emotions (Result 8), overall, they send the same percentage of the amount received as under no communication. It appears that the responders' behavior in our experiment was largely driven by their adherence to a social norm of giving back between half (suggesting an equal split of the amount received) or two thirds (implying an equal split of the whole pie, if sender sent the full amount).

In sum, our findings suggest a significant societal change due to the advent of the internet and mobile communication. Indirect communication, traditionally a limited way of communicating, now rivals direct face-to-face communication in inducing individuals to cooperate with and trust one another. While our study illustrates this change using two simple economically relevant games, the implications of our findings almost certainly extend beyond the laboratory.

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List of Supplementary Materials

- A Experimental Instructions
- B Exit questionnaire
- C Additional tables
- D Additional figures: VCM
- E Additional figures: Trust Game
- F Classification categories for contents analysis

Supplementary Material A

VCM EXPERIMENT INSTRUCTIONS – PART I

Introduction

Welcome to the experiment. This is an experiment funded by a research foundation to study decision making. For showing up on time, you will be paid a $5 show-up fee. In addition, you may receive additional earnings as the result of the outcomes in the experimental session. All earnings that you make will be in "computer dollars." At the end of the experiment we will pay you in cash an amount equal to $0.05 for every computer dollar you earn.

Today's session will take about an hour and a half. Please do not communicate with other participants during the experiment.

Click **CONTINUE** when you are ready to go on.

Decisions and payoffs

At the beginning of this decision making experiment you will be matched with three other people, randomly selected from the people in this room, to form a group of four. You will remain in this group of four people for the duration of the whole decision-making experiment. The names of the other members of your group will not be revealed.

At the beginning of each period, you and each other person in your group will receive 10 tokens. You must decide how much of this amount to keep, and how much to contribute to the PROJECT: you can contribute any number between 0 and 10. Only integer values will be accepted. Contributions in one period do not carry over to the next.

Each token that you keep earns you one computer dollar. The sum of your and others' contributions to the PROJECT is multiplied by two and divided equally among all 4 people in your group, and your share will go to your earnings. Thus,

$$Your\ Earnings = Tokens\ kept + \frac{2 * (Total\ group\ contribution\ to\ the\ PROJECT)}{4}$$

Click **CONTINUE** when you are ready to go on.

Examples

In order to help you determine the potential earnings in light of the decisions of you and the other people in your group, you have access to the *Calculator* at all times. This allows you to explore hypothetical situations before actually making decisions.

Let's try it now.

EXAMPLE 1: Suppose that all the other people in your group contributed a total of 13 tokens. If you decide to contribute 5 tokens, the total group contribution to the PROJECT will be 13 + 5 =

18 tokens. Under “If your contribution to the PROJECT is:”, enter “5” tokens and under “If the sum of others’ contribution to the PROJECT is:”, enter “13” tokens. Press **CALCULATE**. This should yield you earnings of 14 computer dollars (5 computer dollars from token not contributed + (2*18)/4 computer dollars from the PROJECT).

Feel free to experiment with the calculator now. You are now free to enter any number between 0 and 30 under “If the sum of others’ contribution to the PROJECT is:” and any number between 0 and 10 under “If your contribution to the PROJECT is:” to explore how your earnings change given different contributions from yourself and others.

ARE THERE ANY QUESTIONS?

Click **NEXT** when you’re done.

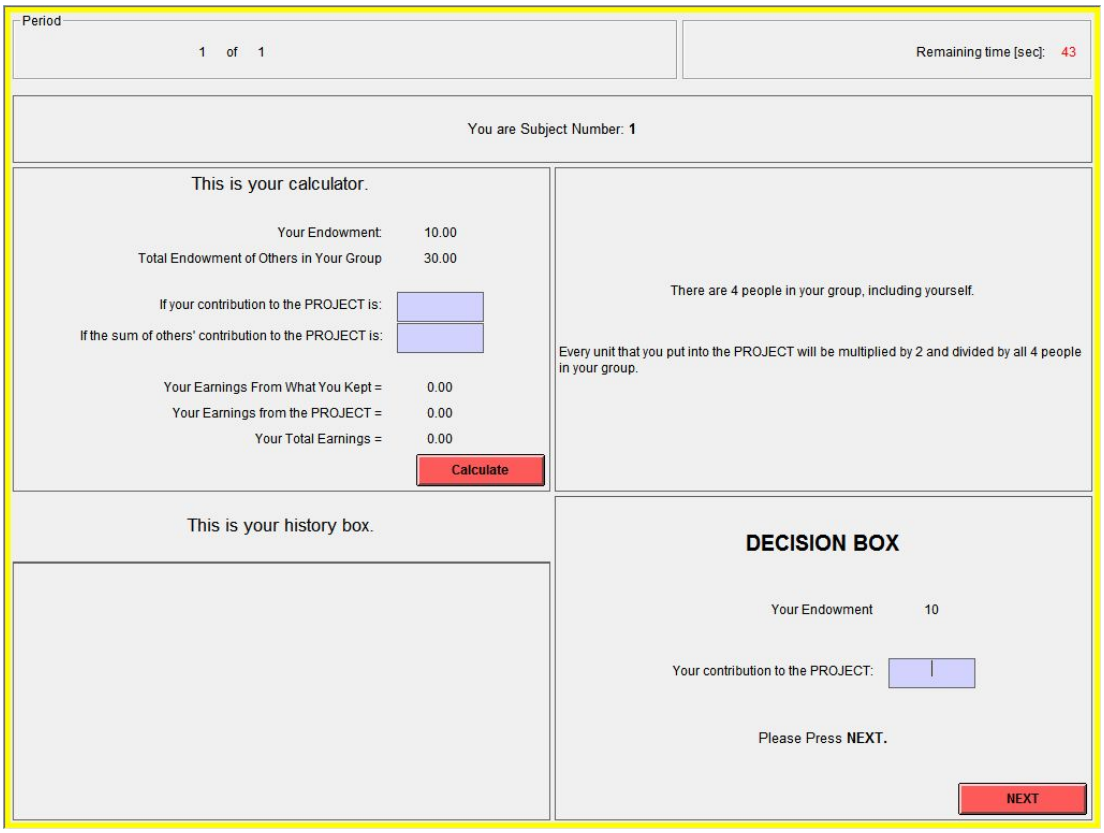
Entering Decisions in Decision Box

Your computer screen will display the period number and your subject number. You are going to make decisions with the other members of your group for 10 periods. Your subject number will be your subject number for the entire experiment.

The left side of your screen will display a calculator which will allow you to test different combinations of contributions by you and your group members. Below that, starting from period 2, there will be a history box that will show your contribution, others’ contribution, and your earnings for each period. When you are ready to make a decision regarding your contribution for the period, input your contribution amount in the lower right side of your screen, in the DECISION BOX, and click NEXT.

Please practice entering your decision in the decision box now. This is for practice, and it will not affect your earnings in the actual experiment.

ARE THERE ANY QUESTIONS?

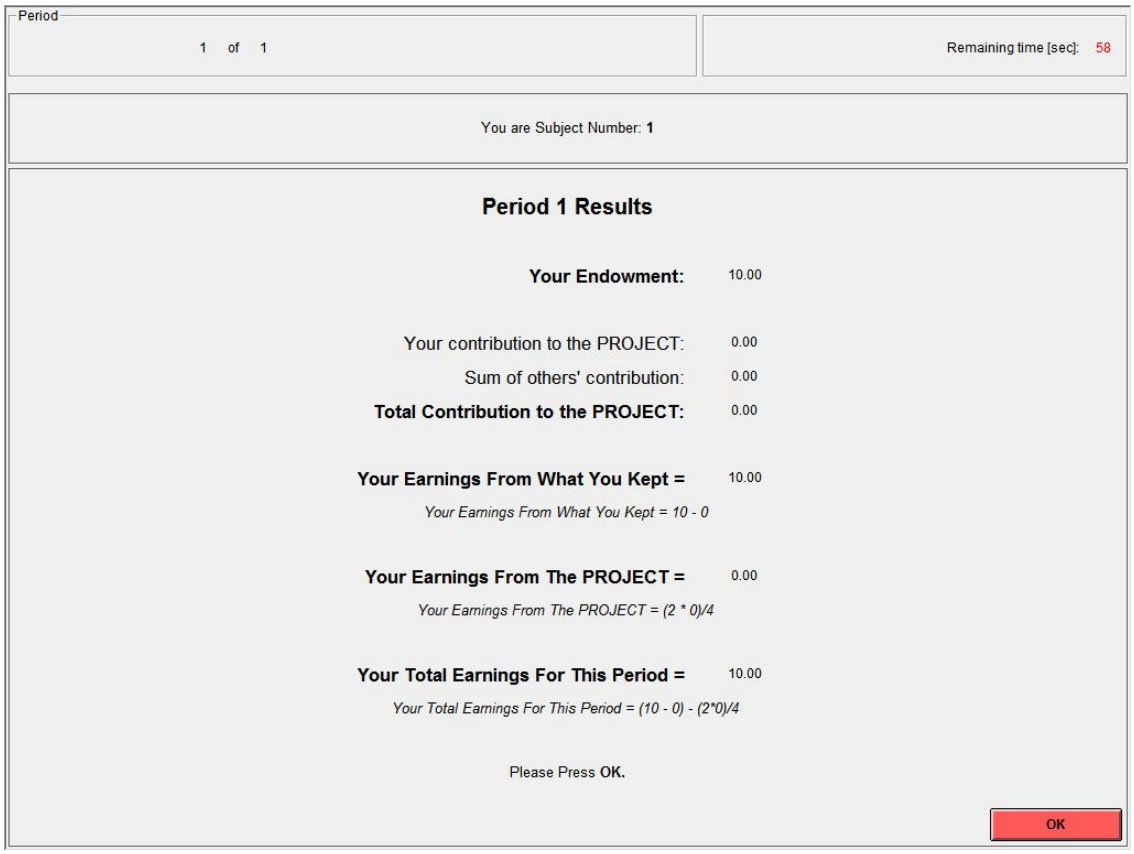


Click **CONTINUE** when you are ready to go on.

Results Screen

Once everyone in the room has entered their contribution to the PROJECT, you will see the results screen.

The results screen shows your contribution to the PROJECT, the sum of all contributions, and your earnings for the period will be displayed.



ARE THERE ANY QUESTIONS?

Click **CONTINUE** when you are ready for a review.

Review
Use the calculator on this screen to answer the following questions.

Suppose you kept 3 computer dollars and your other group members contributed 16 computer dollars each to the PROJECT. What is:

1. The total group contribution to the PROJECT? _____
2. Your earnings from the PROJECT? _____
3. Your earnings for the period? _____

Once the experimenter has checked your work, press **NEXT**.

This will continue for 10 periods. After the 10 periods are over, you may be asked to participate in another decision-making activity. Once all activities are over, the computer will sum your earnings from all activities and you will be paid in cash in private.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART II (FTF)

In some previous experiments, participants found it beneficial to communicate with each other. We will now give you an opportunity to communicate in person.

You will have an opportunity to communicate in groups of four people. You will be facing the other people in your group. The people in your discussion group are picked at random from your session participants and are not necessarily the same people that you were matched with in Part 1 of the experiment. The experimenter will direct you to your discussion group now. **Please do not start communication until the experimenter says so.**

ARE THERE ANY QUESTIONS?

Has everyone joined the group now? You will now be given 10 minutes to communicate with the people in your group. **After the communication time is over, you will participate in the same set of decision-making experiments as in Part I, with the group of people you just communicated with.**

Please start communication now.

[PAUSE]

The communication time is now over. Please stop talking and return to your computer terminals.

You will now participate in the same set of decision-making experiments as in Part I, with the group of people you just communicated with. Again, the experiment will continue for 10 periods. Your earnings from this part of the experiment will be added to your earnings in Part 1 and will be paid to you in private at the end of the experiment.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART II (FB)

In some previous experiments, participants found it beneficial to communicate with each other. We will now give you an opportunity to communicate through Facebook group. In your screens please enter your email address that is connected to your Facebook account.

When you're done entering your email address, please press OK.

Please give the experimenter a few minutes to invite your email addresses to a Facebook group. The experiment will invite you to join a Facebook group. In the email address that you have provided us earlier, you will find a message from Facebook inviting you to a group. You will have an opportunity to communicate in groups of four people. The people in your discussion group are picked at random from your session participants and are not necessarily the same people that you were matched with in Part 1 of the experiment. Prior to starting communication, we will give you few minutes to log in to your Facebook account and join the group. **Please do not start communication until the experimenter says so.**

ARE THERE ANY QUESTIONS? Please raise your hand if you cannot find the invitation in your email, or if you need help joining the Facebook group. On the next page, you will find step-by-step instructions on how to join the group, communicate with the other people in your group, and delete your Facebook account.

[PAUSE]

Has everyone joined the group now? You will now be given 10-15 minutes to communicate with the people in the group via Facebook posts. **After the communication time is over, you will participate in the same set of decision-making experiments as in Part I, with the group of people you just communicated with.**

Please start communication now.

[PAUSE]

The communication time is now over. Please log off your Facebook accounts and close the web browser. The experimenter will remove you from the discussion group momentarily.

You will now participate in the same set of decision-making experiments as in Part I, with the group of people you just communicated with. Again, the experiment will continue for 10 periods. Your earnings from this part of the experiment will be added to your earnings in Part I and will be paid to you in private at the end of the experiment.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART II (C)

In some previous experiments, participants found it beneficial to communicate with each other. We will now give you an opportunity to communicate via computer.

You will have an opportunity to communicate in groups of four people. You will be communicating by sending and receiving text messages to and from the other people in your group. The people in your discussion group are picked at random from your session participants and are not necessarily the same people that you were matched with in Part 1 of the experiment. In your screens, you will see a chat box where you can type messages to people in your group. **Please do not start communication until the experimenter says so.**

ARE THERE ANY QUESTIONS?

You will now be given 10 minutes to communicate with the people in your group via text messages. **After the communication time is over, you will participate in the same set of decision-making experiments as in Part I, with the group of people you just communicated with.**

Please start communication now.

[PAUSE]

The communication time is now over.

You will now participate in the same set of decision-making experiments as in Part I, with the group of people you just communicated with. Again, the experiment will continue for 10 periods. Your earnings from this part of the experiment will be added to your earnings in Part 1 and will be paid to you in private at the end of the experiment.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART II (NC)

In this part of the experiment, you will participate in the same set of decision-making experiments as in Part I, with a new group of people. The people in your group are picked at random from your session participants and are not necessarily the same people that you were matched with in Part I of the experiment. We will need a few minutes to set up your new groups. During this time you may use the web browser to surf the net or check your email or Facebook account if you want. Please do not close the z-Leaf program if you decide go to the web browser.

ARE THERE ANY QUESTIONS?

[PAUSE]

The setup time is now over. Please close the web browsers.

You will now participate in the same set of decision-making experiments as in Part I, with the new group of people. Again, the experiment will continue for 10 periods. Your earnings from this part of the experiment will be added to your earnings in Part I and will be paid to you in private at the end of the experiment.

ARE THERE ANY QUESTIONS?

TG EXPERIMENTAL INSTRUCTIONS – PART 1

Introduction

Welcome to the experiment. This is an experiment funded by a research foundation to study decision making. For showing up on time, you will be paid a $5 show-up fee. You may receive additional earnings based on your and others decisions. All payoffs will be in "computer dollars".

This experiment is composed of several parts. At the end of the experiment, the computer will randomly pick a part for which you will get paid for. We will pay you in cash an amount equal to $1.00 for every computer dollar that you earn.

Today's session will take about an hour and a half. Please do not communicate with other participants during the experiment.

Click **CONTINUE** when you are ready to go on.

Decisions and payoffs

In this part of the experiment, you will be randomly matched with another person. You and the person you are matched with will receive ane endowment of 10 computers dollars each. One of you will be randomly assigned as Person A and the other will be assigned as Person B. Person A will have the opportunity to send some, all or none of their endowment to B. Each computer dollar sent to B will be tripled. B will then decide how much money to send back to A. B can send back some, all or none of what they received from A.

Click **CONTINUE** when you are ready to go on.

Examples

To help you determine the potential payoff you and the other person you are matched with can make, you will have access to the *Calculator* on the left at all times. This allows you to explore hypothetical situations before actually making decisions.

Let's try it now.

EXAMPLE 1:
A decides to send 6 computer dollars, B sends back 4 computer dollars

A's payoff = 8 computer dollars = 10 computer dollars endowment – 6 computer dollars sent to B + 4 computer dollars sent back by B

B's payoff = 24 computer dollars = 10 computer dollars endowment + 3*(6 computer dollars sent by A) – 4 computer dollars sent back to A

EXAMPLE 2:
A sends 3 computer dollars, B sends back 8 computer dollars

A's payoff = 15 computer dollars = 10 computer dollars endowment – 3 computer dollars sent to B + 8 computer dollars sent back by B

B's payoff = 11 computer dollars = 10 computer dollars endowment + 3*(3 computer dollars sent by A) – 8 computer dollars sent back to A

Feel free to experiment with the calculator now. Enter any number between 0 and 10 under "How much A sends to B" and any number between 0 and the amount received from A under "How much B sends to A" to explore how the earnings change. Feel to experiment as many times as you like.

ARE THERE ANY QUESTIONS?

Click **NEXT** when you're done.

Entering Decisions for A

Your computer screen will display your type (A or B) and your ID number. Your type and ID number will be the same for the entire experiment.

If you are assigned as Person A, you will decide how much of your endowment to send to Person B.

While Person A is making their decision, Person B will be asked how much they expect A to send to them. Person B will receive a $1 bonus if their expectation exactly matches A's decision and the bonus will decrease as B's expectation gets further away from A's decision. The lowest value for the bonus is $0.

Please practice entering A's decision in the top left box and B's expectation in the bottom left box now. This is for practice and it will not affect your payoff in the actual experiment.

ARE THERE ANY QUESTIONS?

Entering Decisions for B

After Person A has made their decision, if you are assigned as Person B, you will be informed how much you received from A and you will decide how much of that amount you would like to send back.

While Person B is making their decision, Person A will be asked how much they expect B to send back to them. Person A will receive a $1 bonus if their expectation exactly matches B's decision and the bonus will decrease as A's expectation gets further away from B's decision. The lowest value for the bonus is $0.

Please practice entering B's decision in the top left box and A's expectation in the bottom left box now. This is for practice, and it will not affect your payoff in the actual experiment.

ARE THERE ANY QUESTIONS?

Click **CONTINUE** when you are ready for a review.

Review
Use the calculator on the left to answer the following questions.

Suppose Person A sent 7 computer dollars and Person B sent back 11 computer dollars. What is:

1. Person A's payoff: _____
2. Person B's payoff: _____

Once the experimenter has checked your work, press **NEXT**.

Results will not be shown until the end of the experiment. At the end of the experiment, you will be informed of your decision, the decision of the person you were matched with, and your payoff.

ARE THERE ANY QUESTIONS?

Click **CONTINUE** when you are ready to go on.

EXPERIMENT INSTRUCTIONS – PART 2 (FTF)

In this part of the experiment, you will participate in the same experiment as before, with a different person. In some previous experiments, participants found it beneficial to communicate with each other. We will now give you an opportunity to communicate in person. **After the communication time is over, you will participate in the same experiment as before, with one of the people you just communicated with.**

You will have an opportunity to communicate in groups of four people. You will be facing the other people in your group. The people in your discussion group are picked at random from all of the experiment participants and do not necessarily include the person that you were matched with in Part 1 of the experiment. Your discussion group does include the person you will be matched with in Part 2.

The experimenter will direct you to your discussion group now. **Please do not start communication until the experimenter says so.**

ARE THERE ANY QUESTIONS?

Has everyone joined the group now? You will now be given 10 minutes to communicate with the people in your group.

Please start communication now.

[PAUSE]

The communication time is now over. Please stop talking and return to your computer terminals.

You will now participate in the same experiment as before, with one of the people you just communicated with.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART 2 (FB)

In this part of the experiment, you will participate in the same experiment as before, with a different person. In some previous experiments, participants found it beneficial to communicate with each other. We will now give you an opportunity to communicate through a Facebook group. **After the communication time is over, you will participate in the same experiment as before, with one of the people you just communicated with.**

In your screens please enter your email address that is connected to your Facebook account. When you're done entering your email address, please press OK.

Please give the experimenter a few minutes to invite your email addresses to a Facebook group. The experiment will invite you to join a Facebook group. In the email address that you have provided us earlier, you will find a message from Facebook inviting you to a group. You will have an opportunity to communicate in groups of four people. The people in your discussion group are picked at random from all of the experiment participants and do not necessarily include the person that you were matched with in Part 1 of the experiment. Your discussion group does include the person you will be matched with in Part 2.

Prior to starting communication, we will give you a few minutes to log in to your Facebook account and join the group. **Please do not start communication until the experimenter says so.**

ARE THERE ANY QUESTIONS? Please raise your hand if you cannot find the invitation in your email, or if you need help joining the Facebook group. On the next page, you will find step-by-step instructions on how to join the group, communicate with the other people in your group, and delete your Facebook account.

[PAUSE]

Has everyone joined the group now? You will now be given 10 minutes to communicate with the people in the group via Facebook posts.

Please start communication now.

[PAUSE]

The communication time is now over. Please log off your Facebook accounts and close the web browser. The experimenter will remove you from the discussion group momentarily.

You will now participate in the same experiment as before, with one of the people you just communicated with.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART 2 (C)

In this part of the experiment, you will participate in the same experiment as before, with a different person. In some previous experiments, participants found it beneficial to communicate with each other. We will now give you an opportunity to communicate via computer. **After the communication time is over, you will participate in the same experiment as before, with one of the people you just communicated with.**

You will have an opportunity to communicate in groups of four people. You will be communicating by sending and receiving text messages to and from the other people in your group. The people in your discussion group are picked at random from all of the experiment participants and do not necessarily include the person you were matched with in Part 1 of the experiment. Your discussion group does include the person you will be matched with in Part 2.

In your screens, you will see a chat box where you can type messages to people in your group. **Please do not start communication until the experimenter says so.**

ARE THERE ANY QUESTIONS?

You will now be given 10 minutes to communicate with the people in your group via text messages.

Please start communication now.

[PAUSE]

The communication time is now over.

You will now participate in the same experiment as before, with one of the people you just communicated with.

ARE THERE ANY QUESTIONS?

EXPERIMENT INSTRUCTIONS – PART 2 (NC)

In this part of the experiment, you will participate in the same experiment as before, with a different person. The person you will be matched with is picked at random from all of the experiment participants and is not necessarily the person that you were matched with in the first part of the experiment.

We will need a few minutes to set up your new matches. During this time you may use the web browser to surf the net or check your email or Facebook account if you want. Please do not close the z-Leaf program if you decide go to the web browser.

ARE THERE ANY QUESTIONS?

[PAUSE]

The setup time is now over. Please close the web browsers.

You will now participate in the same experiment as before, with a different person.

ARE THERE ANY QUESTIONS?

B Exit Questionnaire

Feedback

Your ID number is: 1

What is your gender?
- ○ MALE
- ○ FEMALE

What is your major at UH?

What type of student are you?
- ○ Freshman Undergraduate
- ○ Sophomore Undergraduate
- ○ Junior Undergraduate
- ○ Senior Undergraduate
- ○ Graduate
- ○ Other

Have you participated in an Economics Experiment before?
- ○ Yes
- ○ No

Have you participated in a Psychology Experiment before?
- ○ Yes
- ○ No

Do you have a Facebook account?
- ○ Yes
- ○ No

How often do you use it?
- ○ Every Day
- ○ Once or Twice a Week
- ○ Not that Often
- ○ Not Applicable

How may Facebook friends do you have?
- ○ Less than 10
- ○ 10 to 50
- ○ 50 to 100
- ○ More than 100
- ○ Not Applicable

END

C Additional Tables

Table 12: VCM: Summary of Experimental Sessions

Date	Time	Session	Location	Treatment	# Subjects	Ave. pay, $
04/08/13	13:30	1	UH Manoa	Facebook	12	21.67
04/10/13	13:00	2	UH Manoa	Face to Face	8	21.25
04/10/13	15:00	3	UH Manoa	No Comm	12	20.25
04/11/13	15:00	4	UH Manoa	Facebook	8	21.88
04/12/13	13:30	5	UH Manoa	Face to Face	8	21.88
04/15/13	13:30	6	UH Manoa	No Comm	12	17.92
04/16/13	15:00	7	UH Manoa	Chat	8	22.63
04/17/13	15:00	8	UH Manoa	Chat	12	22.00
04/18/13	15:00	9	UH Manoa	Facebook	12	20.75
04/19/13	10:30	10	UH Manoa	Chat	8	21.75
04/22/13	10:30	11	UH Manoa	Face to Face	8	22.25
09/16/13	14:30	12	UH Manoa	Face to Face	8	21.88
09/18/13	13:00	13	UH Manoa	Face to Face	8	21.63

Table 13: Trust Game: Summary of Experimental Sessions

Date	**Time**	**Session**	**Location**	**Treatment**	**# Subjects**	**Ave. pay, $**
2-Dec-13	16:00	1	UH Manoa	FB	8	21.40
3-Dec-13	9:00	2	UH Manoa	NC	8	23.25
3-Dec-13	14:30	3	UH Manoa	FB	8	19.35
4-Dec-13	14:30	4	UH Manoa	Chat	8	22.25
6-Dec-13	13:00	5	UH Manoa	FTF	8	23.25
6-Dec-13	15:00	6	UH Manoa	Chat	8	25.25
10-Dec-13	15:00	7	UH Manoa	NC	8	24.25
13-Dec-13	15:00	8	UH Manoa	FTF	8	26.00
24-Feb-14	9:30	9	UH Manoa	FB	8	22.00
24-Feb-14	13:00	10	UH Manoa	Chat	8	21.50
28-Feb-14	13:00	11	UH Manoa	FTF	8	26.00
21-Mar-14	10:30	12	UH Manoa	NC	8	18.00

Table 14: Trust Game: p-values for the WMW test for the Differences in Percentage Returned between treatments

Communication Groups as Units of Observation								
	Before Communication				After Communication			
	NC	FTF	FB	C	NC	FTF	FB	C
NC	-	0.9356	0.6831	0.6285	-	0.3195	0.0907	0.1634
FTF	-	-	0.6285	0.6289	-	-	0.5283	0.3408
FB	-	-	-	0.8719	-	-	-	0.6742

D VCM: detailed figures by treatment

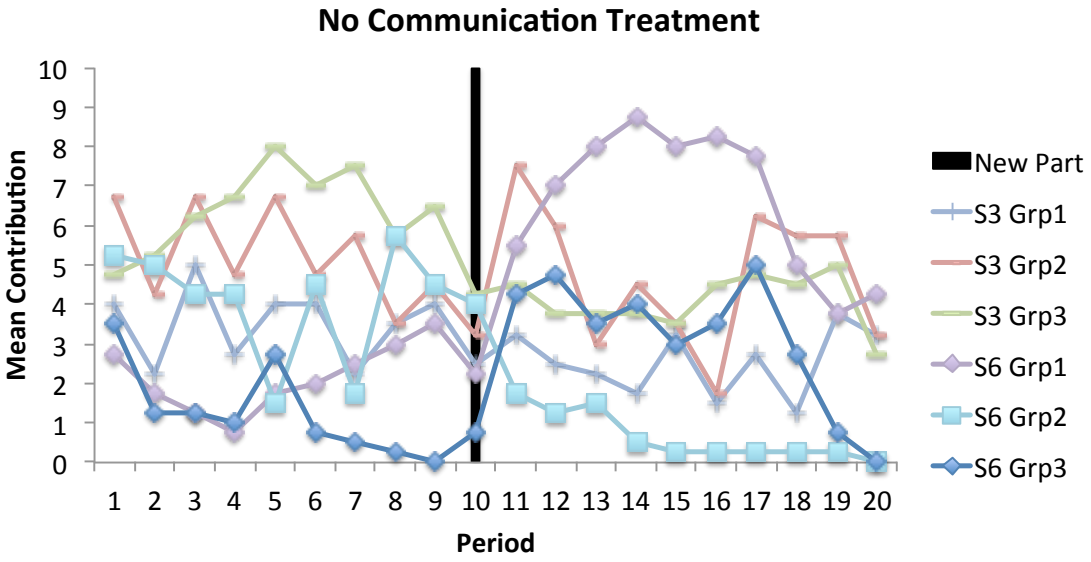


Figure 4: Per Group Average Contribution: No Communication

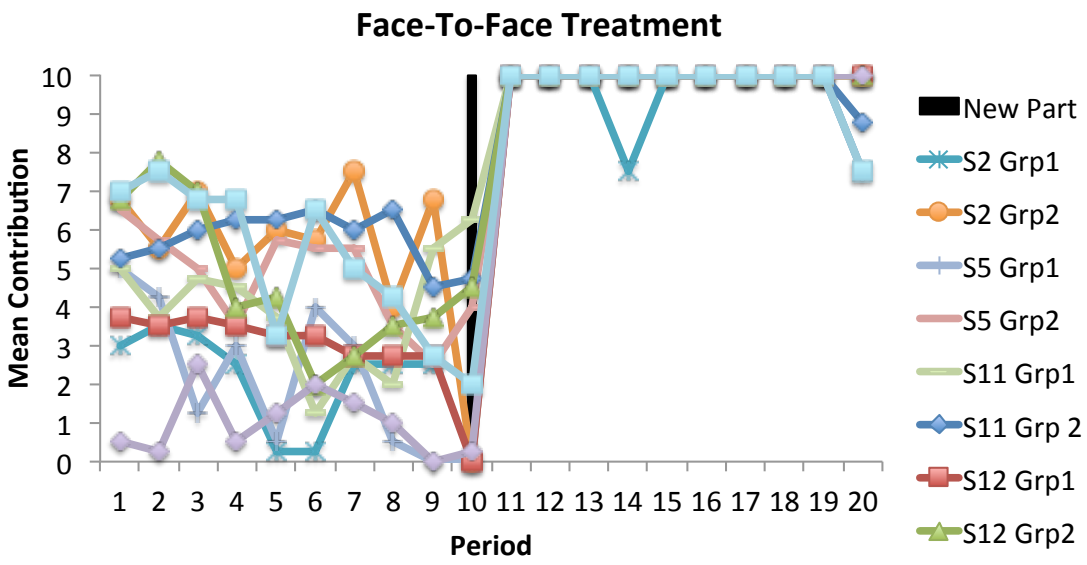


Figure 5: Per Group Average Contribution: Face-to-Face

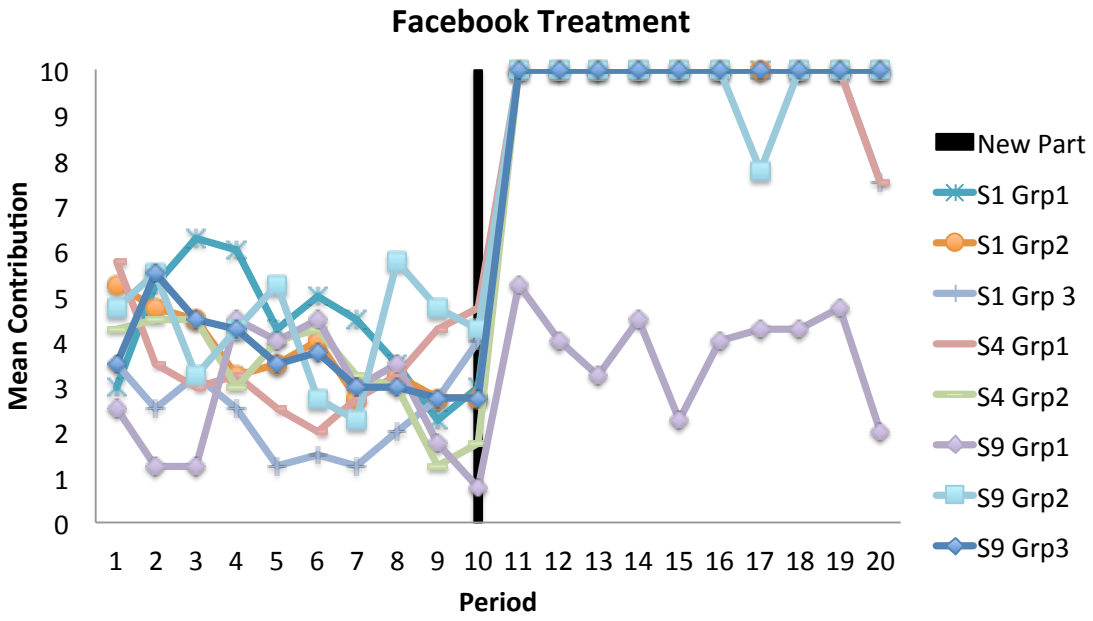


Figure 6: Per Group Average Contribution: Facebook

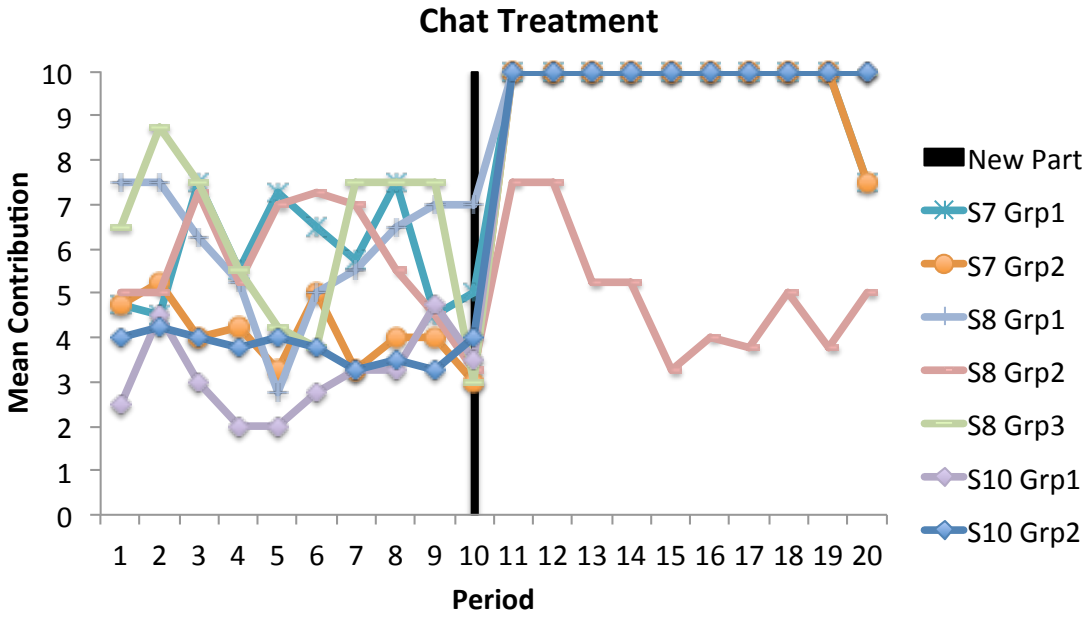


Figure 7: Per Group Average Contribution: Chat

E Trust Game: detailed figures by treatment

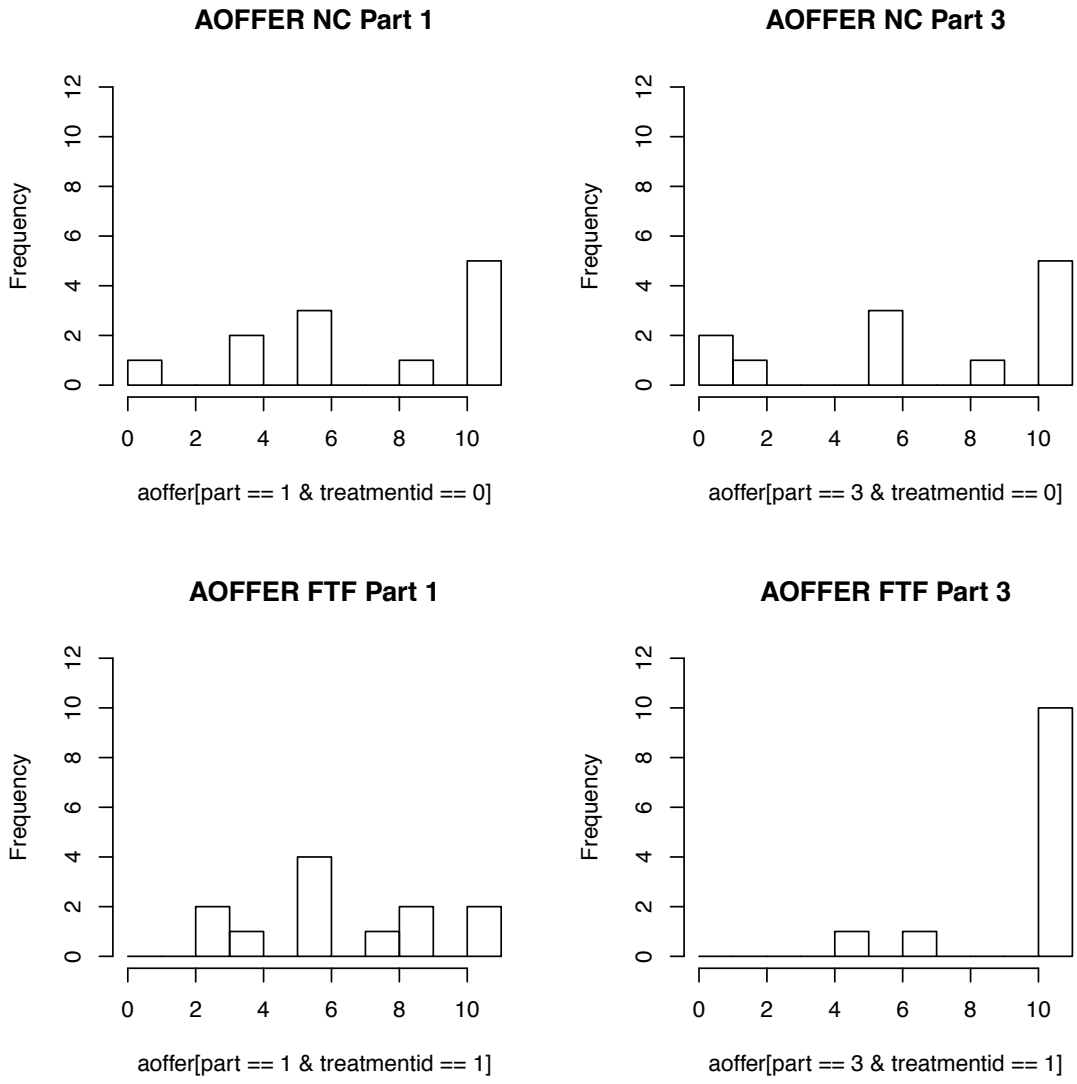


Figure 8: NoCom & FTF: Amount Sent

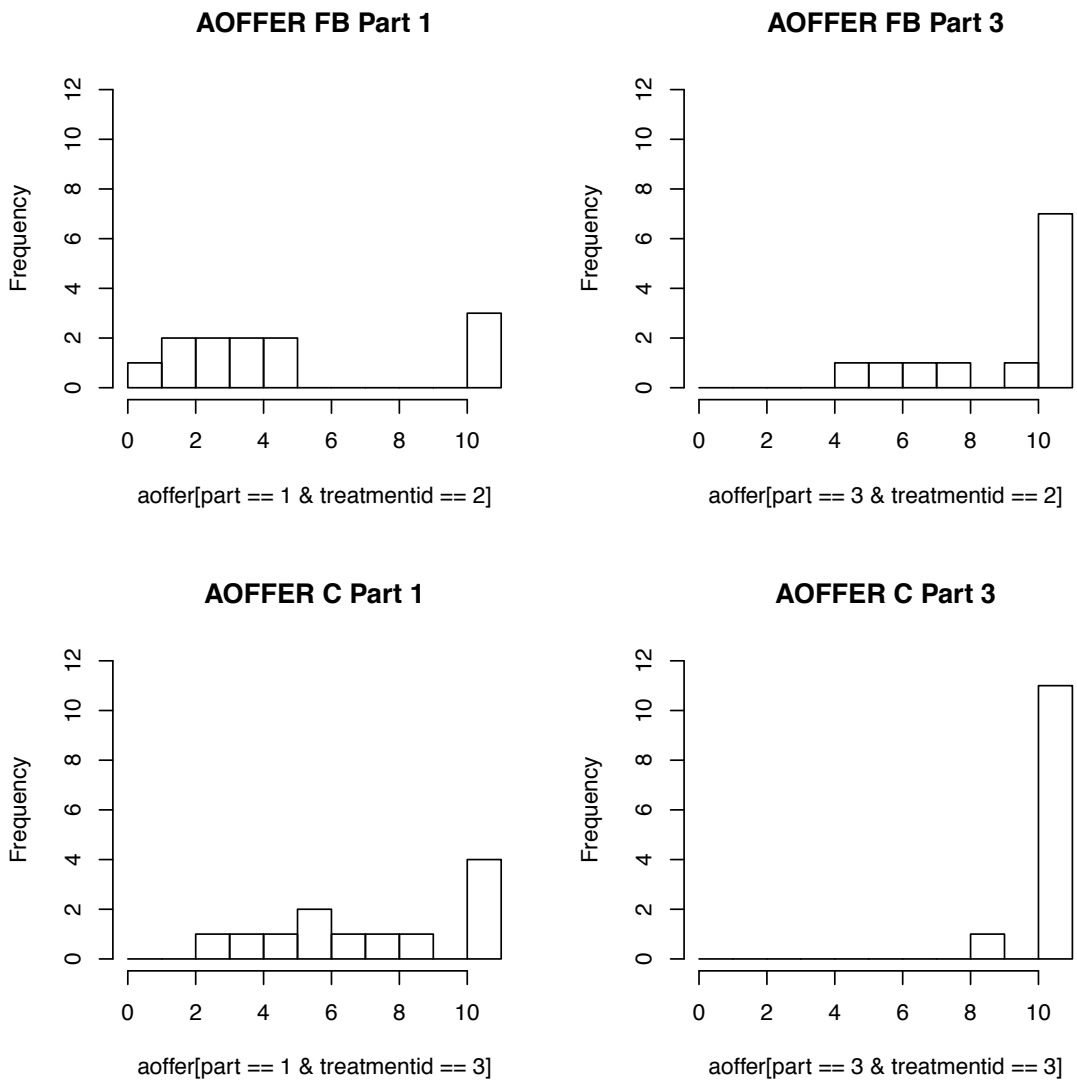


Figure 9: Facebook & Chat: Amount Sent

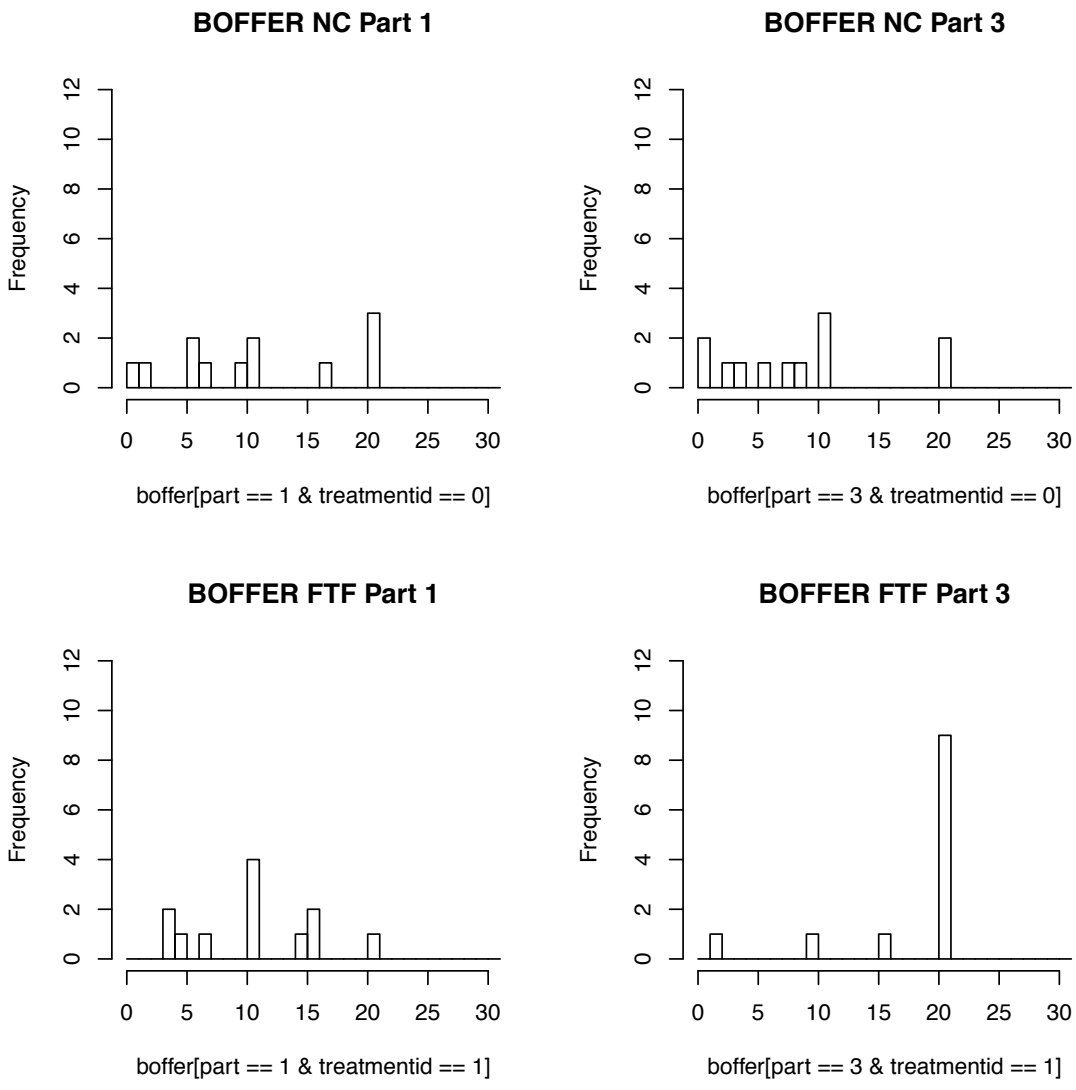


Figure 10: NoCom & FTF: Amount Returned

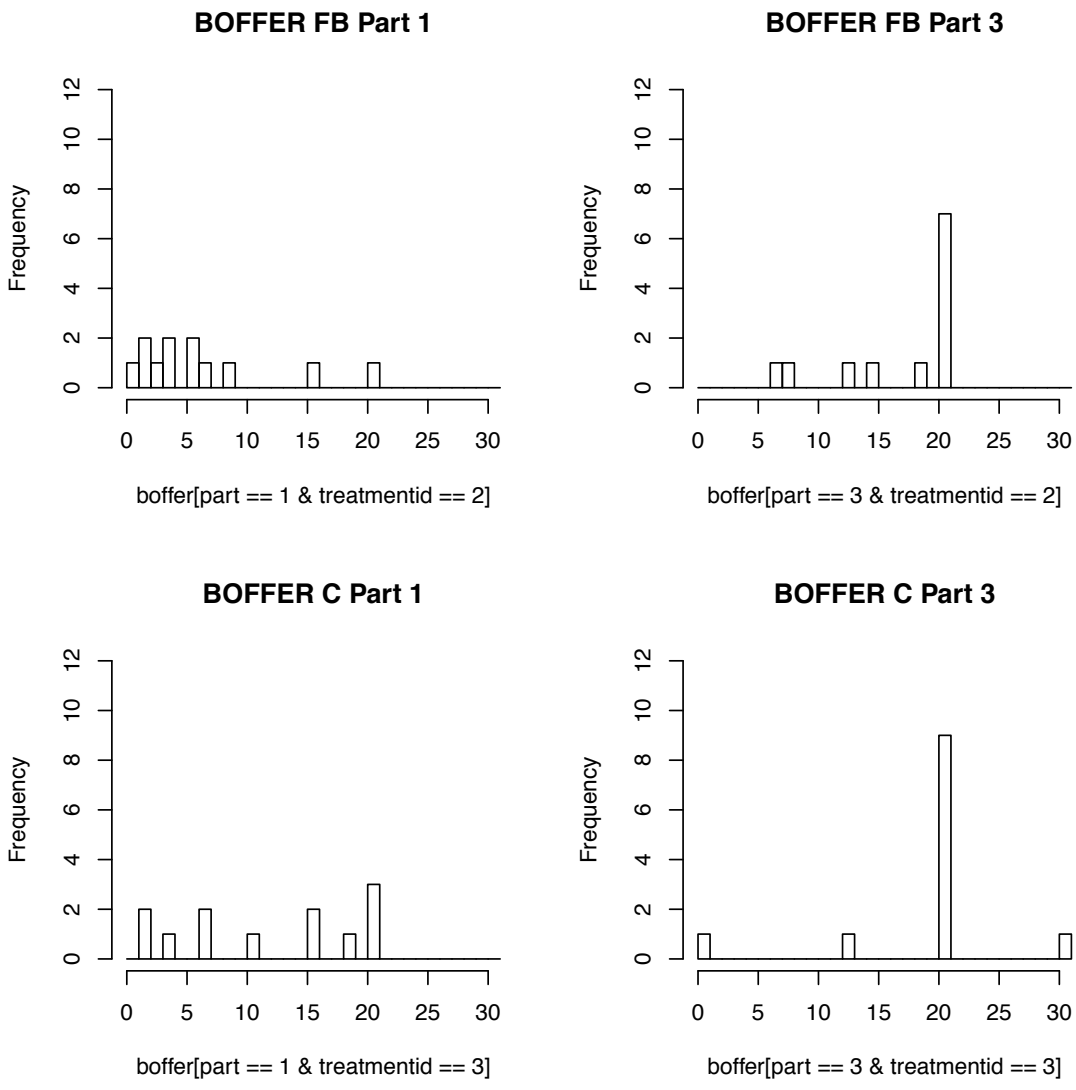


Figure 11: Facebook & Chat: Amount Returned

F Message Contents Classification Categories

Contents Code	Message content
0	empty comment
General Talk	
10	general/other
11	hello
12	breaking ice
13	small talk
14	good bye
15	sharing feelings
16	talk about media (calculator, comm media)
17	thank you/sorry
18	TALK ABOUT EXPERIMENTERS/experiment
19	personal info/friends
Norms and goals discussion	
20	general norms discussion
21	equal split /fair
22	maximize money payoff
23	max payoff and equal split
24	sharing with others, empathy
25	we win
26	most beneficial for all
Strategy: Division and payoffs (What to do, how much will get)	
30	call for strategy proposal
31	send 5
32	send 5 / return 10
33	send 10
34	send 10 / return 20
35	send low
36	send 10 / return 15
37	send any/return half triples
38	send any/return same amount
39	send any/return half
Strategy: Implementation (How to make sure everyone follows)	
40	general/other
41	swear/commit
42	do not cheat/not be greedy
43	empathy/generocity
44	trust
45	everyone needs to be on board/work together
Payoff / game discussion	
50	Earning money general
51	money from guessiong
52	number of people/matching
53	play with THIS discussion group
54	time to discuss
55	we are being recorded
56	what the computer shows
57	last round
Personal game-related discussion	
61	My/your Role
62	i/you send
63	i/you return