IS AVATAR-TO-AVATAR COMMUNICATION AS EFFECTIVE AS FACE-TO-FACE COMMUNICATION? – AN ULTIMATUM GAME EXPERIMENT IN FIRST AND SECOND LIFE –

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Abstract. We report results from an Ultimatum Game experiment with and without pre-play communication, conducted both in a real-world experimental laboratory and in the virtual world Second Life. In the laboratory, we replicate previous results that communication increases offers and agreement rates significantly, and more so for face-to-face communication than for text-chat. In Second Life we detect a level shift to more cooperation when there is no communication, either driven by selection on unobservables or environmental effects. The higher cooperativeness in the virtual world lowers the need for additional communication between avatars in order to achieve efficient outcomes. Consistent with this we are not able to detect an effect of allowing avatar-to-avatar communication.

Keywords: pre-play communication, Ultimatum Game, virtual world Second Life

JEL classification: C91, C93, D03

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1. Introduction

The Internet has brought about a broad range of communication technologies that have changed the ways we interact in business and private life. Among the more recent development are "virtual worlds", three-dimensional simulation environments in which persons are represented by their "avatars", customized figures whose appearance can take human or other shapes. Examples are World of Warcraft, a multi-player role-playing online game featuring a complete in-game economy, and Second Life (SL), a purely social environment with no particular stipulated goal of participation. While communication via the Internet may increase social distance between interaction partners compared to real-world face-to-face encounters, the use of avatars and interactive 3D environments is thought to increase the social presence of communicators and thereby facilitate cooperation (Nowak and Biocca, 2003; Qiu and Benbasat, 2005; Lee et al., 2009; see also Short et al., 1976, for the concept of social presence).

In this paper, we report results from an experiment designed to compare the effectiveness of communication for promoting cooperation and efficiency, considering face-to-face communication in the real world and avatar-to-avatar-communication in a virtual world. Our working horse is the Ultimatum Game, introduced by Güth, Schmittberger, and Schwarze (1982) and by now a widely used standard tool to study bargaining behavior in experiments. In the game, a first mover proposes how to split a monetary amount, and a second mover either accepts the split or rejects (leading to zero payoffs for both players). While any split can be supported through a Nash Equilibrium, there is only one subgame-perfect Nash Equilibrum in which the responder accepts any proposal and the proposer offers a split which gives her the full amount.[1] However, the typical result in Güth et al. (1982) and its many replications is that responders reject small offers (often any offer under 50% of the pie), and the average offer is somewhere in the range of 30-40% of the pie (with the modal offer being 50%). The Ultimatum Game has been successfully employed to study the effect of pre-play communication on bargaining behavior. For example, Roth (1995) conducts experiments in which during pre-play communication players have no information yet about the game they are going to play, and finds that the pure existence of the pre-play communication phase significantly increases offers and agreement rates later in the Ultimatum Game.[2]

Our main experimental setup consists of a 2x2 experimental design, varying between first and second life in one dimension and communication (or not) in the other. In the laboratory, we ran Ultimatum Games without pre-play communication, and with the typical real-world

[1] If the set of possible splits is discrete, then there is a second subgame-perfect equilibrium in which the responder accepts all possible offers but zero, and the proposer offers the minimal feasible positive amount.

[2] The communication effect might work through strategic channels (e.g. learning about the personality type of the responder) or social channels (e.g. affecting the distributional preferences of the proposer). Schmidt and Zultan (2005) and Zultan (2012) show that both channels seem to be active. In a Dictator game experiment (where the receiver cannot reject the proposal), Greiner, Güth, and Zultan (2012) provide evidence for purely social effects of pre-play communication. Brosig, Ockenfels, and Weimann (2003) study different communication scenarios in public good games, and find that cooperation increases with the richness of channels (for example, face-to-face video conferencing has stronger effects than text-chat).

communication modus: unrestricted face-to-face pre-play communication. The other two treatments were run in the virtual world Second Life,[3] a baseline treatment with no pre-play communication, and a treatment allowing for the typical Second Life communication: participants see each others' avatars and text-chat using SL's interface.[4] This 2x2 design was augmented by an additional text-chat treatment in the laboratory, which allowed us to explore avatar-to-avatar communication technology in the laboratory. In all communication treatments, participants were informed about the game they are going to play only after the communication phase. By using our own "island"[5] in Second Life, as well as a laboratory-like session organization with an experimenter present, participants recruited from a commercial research panel with intensive demographic information verification, and minimally different instructions compared to the laboratory, we took care to minimize potential methodological problems specific to Second Life experiments, like missing control over public knowledge or not knowing participants' real world identity (see Duffy, 2011, for a discussion). Our provisions represent a significant improvement in control compared to existing experimental studies on Second Life, which often recruited on the spot, had no reliable demographic background information, and were conducted on "foreign" servers with limited control.

Our data from the real-world laboratory treatments replicate the results obtained in previous studies in that text-chat communication increases offers and agreement rates in Ultimatum Bargaining, and face-to-face communication does so to an even larger extent, leading to an agreement rate of 100% in our data. In Second Life, the effect of ("face to face") avatar-to-avatar communication on offers is positive, but small and insignificant. The reason seems to be that we observe much more cooperation in our baseline no-communication treatment, yielding agreement rates of 90%. In other words, there is an observed higher general cooperativeness in the virtual world that appears to lower the need and effectiveness of additional communication using avatars to achieve efficient outcomes.[6] Acceptance thresholds (defined as lowest accepted offers) seem not to significantly affected by communication in either environment. However, in Second Life we observe a significantly higher share of non-monotonic responder strategy profiles, also rejecting offers which make them better off than the proposers.

We can report a number of further findings. First, not surprisingly, we find differences in demographics between the two subject pools, reflecting the broader subject population accessible

[3] At the time of the experiment in 2008, Second Life had about 1.24 million active users, with an average of about 60,000 users concurrently logged into the world at any time. By June 2013, the number of active users is estimated at about one million, with 30,000 to 50,000 concurrently logged in. About 10,000 users sign up ever day, but user retention is low. This data comes from blogs which provide up-to-date statistics (http://danielvoyager.wordpress.com/sl-metrics/) and historical data (http://www.metaverse-business.com/secondlifemetrics.php) on Second Life.

[4] Text-chat was the predominantly used communication device in SL at the time of the experiment in Spring 2008, though voice talk (which also brings in some part of a person's first life into her second life) was introduced in August 2007.

[5] An island in Second Life is basically a piece of the Second Life world ("grid") controlled by a unique server. It allows the owner to have almost complete control over virtual access to and properties of this area (like simulated gravity, allowed scripting, etc.).

[6] One may term this finding a "ceiling problem", since there is no much room left for cooperation improvements.

in SL. (Our results hold when controlling for observable demographics.) But it seems that SL residents regard SL's local currency, Linden$, as much more valuable than what would be implied by the going exchange rate to US$. When asked for their acceptable hourly wage to work as a "greeter" in Second Life (a common job adding realism to shopping experiences), participants demanded on average US$17.84 per hour when asked to state it in US$ terms, while their requested hourly wage was US$ 1.42 (L$377) when asked in terms of SL's currency Linden$.[7] This apparent money illusion indicates extremely high private transaction costs between their first and second life, despite the existence of a public currency market with a very stable exchange rate.[8] Interestingly, we do not find different risk attitudes in a Holt and Laury (2002) risk elicitation instrument when SL participants make decisions over Linden$ versus equivalent US$.

Our experimental study complements a small existing experimental literature on social behavior in virtual worlds and differences to laboratory studies. Most attention has been paid to the study of trust games. The experimental results are quite mixed. Fiedler and Haruvy (2009) compare trust in standard laboratory sessions to conditions where laboratory participants use the Second Life interface with provided avatars and where SL residents recruited "in-world" use their own avatars. They find that while the SL communication interface increases trust (but not trustworthiness) in the laboratory, SL residents trusted and returned significantly less. Füllbrunn, Richwien, and Sadrieh (2011) directly compare First- and Second-Life trust game behavior by recruiting passer-bys on real-life university campus and in SL to play ad-hoc trust games. They find higher trustworthiness, but significantly lower trust in the virtual world. Atlas and Putterman (2011) conduct trust-games exclusively in SL, and find high levels of both trust and trustworthiness sensitive to visual and textual cues. In terms of communication, Fiedler, Haruvy, and Li (2011) find stronger effects of pre-play communication on partner selection and cooperation in SL than in the laboratory, while Fiedler (2009) reports increased trust and decreased trustworthiness in SL, compared to no communication and simple Skype-text-chat. Chesney, Chuah, and Hoffmann (2009) conduct Dictator, Ultimatum, Public Good, Guessing, and Minimum Effort games in Second Life with SL residents recruited on the spot, and compare their results to the ones previously found in typical experimental laboratory studies (which used different instructions and incentivization). They find that, compared to the lab studies, choice distributions look in general very similar in the SL data. In the Ultimatum Game in particular, no differences were found in proposers' offers or responders' thresholds compared to a previous UK study. In our no-communication treatment in SL we observe similar behavior as Chesney et al. (2009). However, we directly match laboratory sessions and SL, and find a strong level shift in proposer behavior, but not in responder behavior.

[7] Based on previous Ultimatum Game results, the implied stake size differences would predict if any difference then lower offers in Second Life, but we actually observe the opposite.

[8] Linden$ can be freely bought and sold at LindeX, Second Life's money exchange website, featuring a continuous double-auction with small fee charges per transaction.

Our study also contributes to the debate about whether virtual worlds are suitable environments to run economic experiments. Bainbridge (2007) and Atlas (2008) praise the advantages of cost effectiveness and access to a diverse subject pool, Harrison, Haruvy, and Rutström (2011) emphasize the potential to create choice environments which feel like natural ones. Duffy (2011) raises a number of issues in recruitment, screening, retention of subjects and control over their knowledge and communication (issues we address in our experimental design). He also notes that the relationship between the "in-game" value of Linden-Dollars and the equivalent US dollar amount is not clear since price indices for virtual worlds do not exist. We measure willingness-to-accept for jobs carried out in Second Life both in terms of Linden$ and US$, and find a drastic overvaluation of Linden$. In conjunction with the level shift in cooperation which we find in our study, this indicates that generalizations from results obtained in virtual worlds like Second Life are to be made cautiously (even though overvaluation of L$ may serve as an argument for the cost effectiveness of SL experiments). Our analysis indicates that controlling for basic observable demographics like gender, age, and occupation is not enough to explain behavioral differences between First and Second Life. As Harrison, Haruvy, and Rutström (2011) point out, one major problem in generalizing from Second Life is not that it is harder to compare with laboratory results (since the laboratory is as much an artificial environment as is Second Life), but that there may be an unobserved, potentially uncontrollable selection in the subject pool which hampers the generalizability of treatment effects. Interestingly, similar concerns have been recently raised about laboratory experiments with student subject pools (e.g. Cleave, Nikiforakis, and Slonim 2013, Slonim, Wang, Garbarino, and Merrett 2013).

2. Experimental design and procedures

We conducted five experimental treatments, three in the standard experimental laboratory and two in Second Life. In the lab, we ran one treatment with no pre-play communication (Lab-NC) and one treatment with unrestricted face-to-face pre-play communication for 5 minutes (Lab-F2F), plus an additional treatment in which participants could communicate by chat but were still anonymous (Lab-Chat). In Second Life we ran one treatment with no pre-play communication (SL-NC) and one treatment in which participants could text-chat and see each other's avatar before making choices (SL-A2A).[9]

The laboratory sessions took place from December 2007 to March 2008 in Harvard Business School's Computer Laboratory for Experimental Research (CLER). Participants were recruited from the lab's subject pool via email invitations and signup at the CLER website. Participants received a US$10 showup-fee according to the lab rules, plus their income from the Ultimatum Game. At the beginning, participants were provided with general instructions and randomly matched to pairs and roles. In the no-communication treatment Lab-NC, responders were sent to small group rooms next to the main lab, while proposers stayed in the main lab. In the chat

[9] The instructions used in treatments Lab-F2F and SL-A2A are included in Appendix A.

communication treatment Lab-Chat, participants were allowed to text-chat for 5 minutes with their assigned anonymous partner before responders were sent to the small rooms. In the face-to-face communication treatment Lab-F2F, participants went to the small group rooms in pairs. They were free to discuss any topic for 5 minutes, after which the proposers were called back to the main lab. The remainder of the sessions was the same for all laboratory treatments. Participants now received instructions on the Ultimatum Game. All decisions were elicited via a computerized input mask programmed in zTree (Fischbacher 2007). After proposers made their offer decisions, they were sent back to the small group rooms, and responders came to the main lab and made their decision. Responders were paid out immediately thereafter and dismissed. About ten minutes later, proposers were called back into the main lab, were informed about responder decisions, paid out and dismissed.

The Second Life participants were recruited in May 2008 through the commercial market research provider Market Truths Limited. Market Truths maintained a panel of Second Life research participants, and did extensive double-checking to make sure that the real-life demographic data they obtained from their subjects was correct. Invitation emails were sent out to the panel, and participants could choose from a list of sessions for signup. Within Second Life, the sessions took place on an "island" under our control. We restricted access to the island to those participants' avatars who had signed up to the session. Participants were received in a virtual laboratory building, the interior of which closely resembled the CLER layout (see screenshot 1 in Appendix B). They received a Linden$400 showup-fee, plus their income from the Ultimatum Game. At the beginning, participants received general instructions and were randomly matched to pairs and roles. In the no-communication treatment SL-NC, participants were teleported to private "decision rooms" (distant enough from each other to prevent any chat communication) and made their choices. In the avatar-to-avatar communication treatment SL-A2A, participants were first teleported in pairs to "discussion rooms" (see screenshot 2 in Appendix B) where they were free to discuss any topic for 5 minutes, before being teleported to their private decision room. In their decision room, participants received instructions on the Ultimatum Game. Decisions were made on an interactive wall in the decision room, which resembled the zTree input mask used in the laboratory sessions (see screenshot 3 in Appendix B). After all decisions were made, participants were informed of their payoffs and paid in Linden$ via the Second Life money transfer mechanism.

In all treatments, participants played a one-shot Ultimatum Game, in which one participant, the proposer, makes an offer how to split a monetary pie, and another participant, the responder, decides whether she accepts this offer or rejects. In case of acceptance, the pie is distributed as proposed; if rejected both participants receive nothing. The pie size in the lab sessions was US$20, and Linden$ 1000 (~ US$ 3.77) in Second Life. This corresponds to a relation of 5.3 : 1, while the opportunity cost relation we measured in the post-experimental questionnaire (reported below in Section 3.1) was about 12.6 : 1. Offers could be made in multiples of $1 (L$50) in the laboratory (in SL). Responder decisions were elicited using the strategy method, i.e. in all conditions responder participants had to state their response to each of the 21 potential offers, before knowing the actual offer. Only then they were informed about the actual offer, and the decision they made for that case determined the payoff of both participants.

Both in the lab and SL the experiment was followed by a short post-experimental questionnaire. In the lab we asked for demographics (gender, age, occupation) and for familiarity with virtual worlds in general and Second Life in particular. With Second Life participants the survey was somewhat longer and administered via an Internet page. Here too, participants were asked for gender, age, and occupation. We also received information on gender and age from the panel recruiting agency Market Truths, allowing for consistency checks, plus information on the Second Life age of a participant's avatar and the real person's home country.[10] Further, the questionnaire asked participants some questions on their usage pattern of Second Life (e.g. how much time they spend in Second Life, and whether they try to earn money in SL). For the remaining two questions participants were randomly assigned to one of two conditions. In one condition, the questions were framed using US dollars as currency, while in the other condition Linden$ were used. The first question was about the wage per hour we would need to pay the participant such that she would work as a "greeter" for us.[11] (A greeter staffed by a human is a very common job in ecommerce in Second Life, providing shoppers with some personal experience and interaction.) The second question consisted of the Holt & Laury (2002) measure of risk attitudes: participants have to make 10 choices between two lotteries, namely $p[\$6.00]\oplus(1-p)[\$4.00]$ vs. $p[\$11.50]\oplus(1-p)[\$0.30]$ in the US$ condition, and $p[L\$1600]\oplus(1-p)[L\$1000]$ vs. $p[L\$3100]\oplus(1-p)[L\$80]$ in the Linden$ condition (i.e. same stakes of US$ condition, at exchange rate of 265 Linden$ per US$), with $p \in \{0.1, 0.2, ..., 0.9, 1.0\}$. Answers were, however, hypothetical, with no real payoffs made for responses to the questionnaire.

Overall we had 94 participants in the lab sessions (26 in treatment Lab-NC, 28 in treatment Lab-Chat, and 40 in treatment Lab-F2F). In SL we had 78 participants in valid pairs (40 in the SL-NC condition and 38 in the SL-A2A condition). In some further sessions we had technical problems with the recording of responder decisions such that they were lost. The proposer decisions of these sessions are still valid data, so we use them in our analysis (7 additional proposers in SL-NC, and 2 additional proposers in SL-A2A). The post-experimental survey was completed by 92% of our SL respondents, leaving us with 80 responses to all questions.

[10] We did not find discrepancies between the participant data we obtained in the survey and the data we received from Market Truths, which assures us in our confidence about having collected truthful demographic information.
[11] The exact wording of this question was: "Imagine that we would ask you to work for us as a greeter for this study. Your job would be to receive participants and to answer questions. What is the minimum amount in [US$ | Linden$] we would need to pay you per hour such that you work for us? (Assume that we already fixed the salary. Thus, your decision would have no influence on the actual wage, only on the fact whether we offer you the job at the fixed salary or not.)"

3. Results

3.1. Demographics

Our laboratory participants were on average 22.2 years old, 56% of them were male and 97% were students of local universities. About 72% had heard about virtual worlds before, 48% knew the virtual world Second Life, and 11% had entered Second Life at least once.

The average age of our Second Life participants was 26.9 years (significantly higher than in the lab, Wilcoxon Signed Ranks test, $p<0.001$), 42% were male (weakly significantly less than in the lab, Fisher Exact Test, $p=0.073$), and only 25% were students (Fisher Exact Test, $p<0.001$), while 42% were employed full- or half time, others being unemployed or in training. Thus, the demographic characteristics of our subject pools are quite different, which mirrors one of the advantages of the Internet in general and Second Life in particular as an experimental test bed, allowing access to a broader pool of participants. On average our SL respondents spent 51 hours per week in Second Life, and the average age of their avatars was 390 days. About 81% of the SL participants stated that they try to earn some money in Second Life .

When asked for their acceptable hourly wage to work as a greeter in Second Life, participants demanded on average US$17.84 when asked to state it in US$ terms. However, those who were asked to state their demanded wage in Linden$ terms asked for L$377 on average, which corresponds to US$ 1.42 per hour at the very stable exchange rate in 2008 of about L$265/US$1. Even though there is quite some variance in the demanded wages, the difference is highly significant (Wilcoxon, $p<0.001$) between the two conditions. Possible reasons are that participants were not aware of the currency exchange opportunities, or that their private transaction costs were almost prohibitively high. In either case, they valued Linden$ very differently than US$, which could potentially affect the outcome of experiments in Second Life.

As a first test of this, we elicited risk preferences of Second Life participants using the Holt and Laury (2002)'s elicitation method, either in US$ or in Linden$ (randomly assigned). Holt and Laury (2002) and others find that higher stakes yield more risk aversion. If Linden$ are indeed overvalued compared to equivalent US$, we might observe more risk aversion when the lotteries are stated in terms of Linden$ rather than US$. However, we do not observe such an effect. The average number of safe choices was 5.65 in the US$ condition and 5.74 in the Linden$ condition, not being statistically different from each other (Wilcoxon test, $p=0.980$).[12]

In sum, the subject pools are demographically different between our laboratory and Second Life sessions. Our analysis of Ultimatum Game behavior below will include controls for the

[12] The risk attitudes obtained also do not look different compared to data for real and hypothetical choices in the laboratory (e.g. Holt and Laury 2002). We observe a higher share of inconsistent choice profiles (more than one switching point) of 32% (not different between US$ and Linden$ conditions, Fisher Exact test, $p=0.463$), consistent with higher rates of noise and inconsistency observed in other experiments conducted over the Internet (e.g. Cyranek, Greiner, and Ziegelmeyer 2013). We do not observe a correlation between elicited risk preferences of Second Life participants and their offer and acceptance behavior in the Ultimatum Game.

demographics we were able to observe. When asked to state their willingness to accept for a hourly wage, Second Life residents seem to value Linden$ much more than US$. This, however, seems to have no implications on their decision making under risk.

Previous research has not found strong effects of stake sizes on Ultimatum Game behavior. While there might be some quantitative shifts (responders having lower thresholds with larger stakes, and proposers offering somewhat less), the modal offer in games with high stakes is usually still 50%, and many offers less than 50% are rejected (Roth 1995, Camerer 2003). If the high valuation of Linden$ in Second Life has any stake size effect at all, then we would expect lower thresholds and offers.

3.2. Ultimatum Game decisions

Table 2 displays information on average Ultimatum Game behavior in our treatments. We use Ordinary Least Square regressions to test whether any observed differences in offers, thresholds and payoffs among treatments are indeed statistically significant.[13] Table 3 reports the estimation results of regression models on proposer offers and responder thresholds.[14] In models 1 and 3 we regress each dependent variable only on a constant plus treatment dummies, with the Lab-NC condition as a baseline. The dummies "Is Chat" and "Is F2F" are equal to 1 in Lab-Chat and Lab-F2F, respectively, and 0 otherwise. The dummy "Is SL" becomes 1 in both SL conditions, and the interaction effect "Is SL:Is A2A" measures the effect of avatar-to-avatar communication in Second Life, being 1 only in treatment SL-A2A. In models 2 and 4 we include demographics as controls (the number of observations goes slightly down corresponding to availability of data). The variable "Male" equals 1 for male and 0 for female participants, "Age" represents the participant's age in years, and "Work full/half time" and "Other occupation" are dummies for occupation, with "Student" being the baseline.

TABLE 2: DESCRIPTIVE STATISTICS OF ULTIMATUM GAME BEHAVIOR

Treatment	Lab-NC	Lab-Chat	Lab-F2F	SL-NC	SL-A2A
Avg. Proposer offer (% of pie size)	36%	43%	48%	47%	51%
Avg. Responder Threshold (% of pie size)	26%	20%	18%	32%	28%
Agreement rate	69%	86%	100%	90%	95%
Avg. payoff proposer (% of pie size)	41%	46%	52%	47%	49%
Avg. payoff responder (% of pie size)	28%	40%	48%	46%	46%

[13] In addition to OLS and Tobit regressions (see also next footnote), we applied non-parametric bilateral Wilcoxon Signed Ranks tests to test for treatment differences. The results are reported in Table C.1 in Appendix C, and squarely confirm the analyses reported here.

[14] In principle, offers and thresholds in our Ultimatum Games are censored at 0 and 20. We do not observe any censoring at 20, and very little censoring at 0 (1 out of 95 for offers, and 11 out of 86 for thresholds). We reran all reported OLS regressions as Tobit models and do not find differences in the direction, size, or significance of the estimates unless otherwise noted.

TABLE 3:
OLS REGRESSIONS OF PROPOSER'S OFFER AND RESPONDER'S THRESHOLD ON TREATMENT DUMMIES AND DEMOGRAPHICS

Dependent	Proposer's offer				Responder's threshold			
	Model 1		Model 2		Model 3		Model 4	
	Coeff	StdErr	Coeff	StdErr	Coeff	StdErr	Coeff	StdErr
Intercept	7.23***	[0.58]	5.92***	[1.27]	5.23***	[0.9]	5.04*	[1.96]
Is Chat	1.34*	[0.80]	1.57*	[0.84]	-1.30	[1.24]	-1.75	[1.29]
Is F2F	2.37***	[0.74]	2.45***	[0.77]	-1.63	[1.15]	-1.59	[1.17]
Is SL	2.25***	[0.70]	2.19**	[0.89]	1.17	[1.15]	0.86	[1.52]
Is SL:Is A2A	0.76	[0.61]	0.80	[0.64]	-0.87	[1.03]	-1.23	[1.09]
Male=1			-0.36	[0.48]			1.32*	[0.78]
Age			0.06	[0.05]			-0.02	[0.08]
Works full/half time			-0.34	[0.79]			0.90	[1.58]
Other Occupation			-0.35	[0.80]			0.24	[1.40]
N	95		92		86		83	
Adj. R^2	0.14		0.12		0.06		0.04	

Note: *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

We find, in line with previous results, that pre-play communication significantly increases offers in the Ultimatum Game. In Model 1 on proposers' offers we find a weakly significant positive effect of chat communication, and a stronger and larger effect of face-to-face communication. Moving from the real-world laboratory (with no pre-play communication) to the Second Life laboratory (with no pre-play communication) increases proposer offers significantly. We find a positive but insignificant effect of additionally allowing for avatar-to-avatar communication.

We suspect that the missing effect of communication in Second Life on proposer offers is at least partly driven by a "ceiling effect". Average offers under no communication in SL are already very close to a 50/50 split such that there is little room for positive treatment effects (the average offer in SL-A2A is even above 50/50). Added demographic controls in Model 2 are neither significant nor do they affect the explanatory power of the treatment dummies. This suggests that differences in behavior between laboratory and second life treatments are not a result of differences in observable demographics. As Model 3 shows, responder thresholds decrease with pre-play communication, but not significantly so.[15] We do not find demographics effects on responders' thresholds in Model 4, except that males have a (weakly significant) higher acceptance threshold than females.

[15] In the Tobit version of Model 3, the negative coefficient of "Is F2F" is marginally significant at p=0.099, while all other effects are the same. In the non-parametric tests reported in Appendix C we find significant differences between responder thresholds in treatment SL-NC (where they are highest) compared to the Lab-Chat and Lab-F2F treatments.

TABLE 4:
OLS REGRESSIONS OF PROPOSER AND RESPONDER PAYOFFS ON TREATMENT DUMMIES AND DEMOGRAPHICS

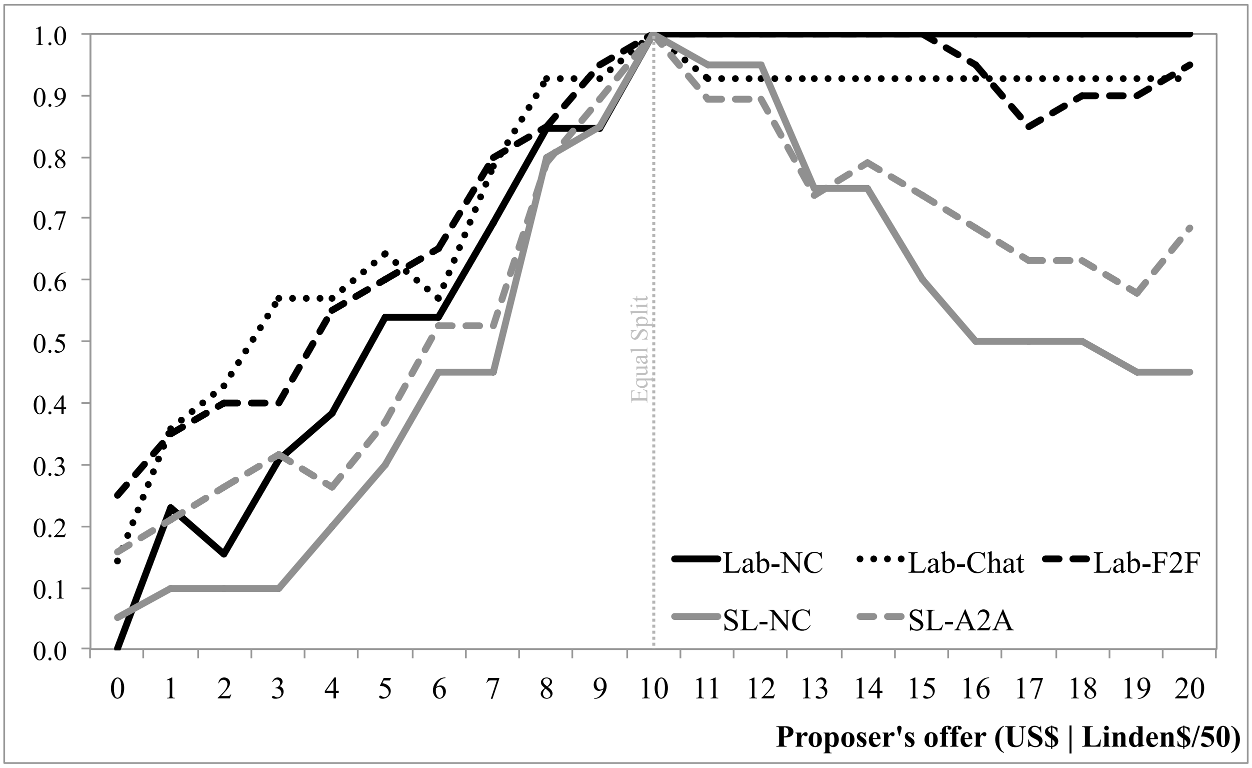
Dependent	Proposer payoff				Responder payoff			
	Model 5		Model 6		Model 7		Model 8	
	Coeff	StdErr	Coeff	StdErr	Coeff	StdErr	Coeff	StdErr
Intercept	8.23***	[1.01]	9.02***	[2.32]	5.62***	[0.83]	6.78***	[1.87]
Is Chat	0.98	[1.40]	0.93	[1.48]	2.31**	[1.16]	2.56**	[1.22]
Is F2F	2.17*	[1.30]	2.17	[1.35]	3.98***	[1.07]	4.00***	[1.12]
Is SL	1.17	[1.30]	1.81	[1.77]	3.48***	[1.07]	3.14**	[1.45]
Is SL:Is A2A	0.34	[1.17]	0.28	[1.26]	0.11	[0.96]	0.23	[1.04]
Male=1			0.02	[0.90]			-0.87	[0.75]
Age			-0.03	[0.09]			-0.04	[0.07]
Work full/half time			-0.81	[1.62]			0.37	[1.51]
Other Occupation			-0.55	[1.52]			0.78	[1.33]
N	86		84		86		83	
Adj. R^2	0.00		-0.06		0.13		0.10	

Note: *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

In Table 4 we report results from OLS regressions of payoffs of proposers and responders on the same set of independents as used above. The treatment effects on responder payoffs (reported in Models 7 and 8) mirror the differences found for proposers' offers. Effects on proposer payoffs are less pronounced, indicating the tradeoff between higher offers (lowering the proposer's payoff) and lower acceptance thresholds (increasing the proposer's expected payoff) when moving from less communication to more; only the effect of face-to-face communication is weakly significant in Model 5.

Responders' strategies do not have do be monotonic, in the sense that there is only one threshold at which a responder changes his choice from reject to accept. Some non-monotonic strategies might represent preferences incorporating strong inequality aversion such that the participant does not only dislike being worse off, but also dislikes to be better off than the interaction partner. In those cases responder strategies are monotonically increasing before the 50/50 split (switching from reject to accept at some point), but monotonically decreasing after the 50/50 split (switching from accept to reject at some point). We shall call these strategies "non-monotonic". We will call strategies that are non-monotonic but do not follow this pattern (i.e. violate weak monotonicity either before or after the 50/50 split) "inconsistently non-monotonic". Figure 2 displays the average response strategy over treatments. We observe that in the two SL conditions there is much more non-monotonicity in responses than in the lab sessions, with 40%-60% of responders rejecting a split that would give them the whole pie.

FIGURE 2:
SHARE OF ACCEPTANCE FOR DIFFERENT OFFERS PER TREATMENT



Note: The figure shows the frequency of acceptance (y-axis) for all 21 possible proposer offers (x-axis). In the laboratory sessions, offers were integers in the range from \$0 to \$20. In Second Life, offers were multiples of Linden\$ 50 in a range from Linden\$ 0 to Linden\$ 1000 (displayed here on the same x-axis).

TABLE 5: SHARE OF NON-MONOTONE AND INCONSISTENT STRATEGIES IN TREATMENTS, AND P-VALUES OF FISHER EXACT TESTS ON THESE DIFFERENCES

Treatment	**Lab-NC**	**Lab-Chat**	**Lab-F2F**	**SL-NC**	**SL-A2A**
Share of non-monotonic responder strategies	23%	14%	25%	65%	58%
Share of inconsistent responder strategies	23%	7%	20%	25%	37%

p-values of Fisher Exact tests non-monotone responder strategies					**p-values of Fisher Exact tests inconsistent responder strategies**				
	L-Chat	L-F2F	SL-NC	SL-A2A		L-Chat	L-F2F	SL-NC	SL-A2A
Lab-NC	0.648	1.000	0.032	0.075	Lab-NC	0.326	1.000	1.000	0.467
Lab-Chat		0.672	0.005	0.015	Lab-Chat		0.379	0.364	0.098
Lab-F2F			0.025	0.054	Lab-F2F			1.000	0.301
SL-NC				0.748	SL-NC				0.501

Using Fisher Exact tests we test whether frequencies of non-monotonic and inconsistent responder strategies are different across our treatments. Table 5 reports the shares of these strategies for each treatment, and the p-values from the statistical tests. With respect to non-monotonic strategies there is a clear dividing line between treatments: we observe significantly more non-monotonic strategies in our SL treatments than in our laboratory treatments. We do not find significant differences in the use of inconsistent strategies across our treatments (except a weakly significant difference between the extremes SL-A2A (37%) and Lab-Chat (7%)).

4. Conclusions

In order to answer the question whether avatar-to-avatar communication in virtual worlds is socially as effective as face-to-face communication in the real world, we ran Ultimatum Game experiments with and without pre-play communication both in the (first-life) economics laboratory and in the virtual world Second Life (SL).

We find demographic differences between the two subject pools, which reflect the more diverse population accessible in Second Life. SL residents seem to value the local currency, Linden$, much higher than what would be expected given the exchange rates at SL's LindeX money exchange, but do not show different risk attitudes when making decisions over Linden$ or equivalent US$. Corresponding stake size effects would predict less cooperation in the Ultimatum Game in Second Life, but we actually observe the opposite.

In our laboratory sessions we replicate the results obtained in the previous experimental literature, namely that communication increases offers and agreement rates in Ultimatum bargaining, and more so in face-to-face communication than in chat communication. Compared to the laboratory, we observe a level shift towards more cooperation in Second Life when there is no communication, but we cannot detect an effect of avatar-to-avatar communication. Responder thresholds (defined as lowest accepted offers) seem not to be different in Second Life, and are only little affected by pre-play communication. However, in the virtual world we observe a higher share of non-monotonic responder profiles (also rejecting offers which make them better off than the proposers).

When comparing our results in the no-communication treatment in Second Life to the results obtained for a similar condition by Chesney et al. (2009), we only find small differences. Chesney et al. use a pie size of Linden$ 3000 and observe an average offer of 45.7% (Mode 50%, StdDev 18.6%). The corresponding numbers for our experiment with a pie of Linden$ 1000 are 47.4% (Mode 50%, StdDev 9.4%). Further, Chesney et al., who do not use the strategy method for responders, report that offers less than 20% were rejected in 33% of the cases, while the overall observed rejection rate was 6.3%. In our data, 80% of responders have thresholds higher than 20% of the pie, and 10% of all offers were rejected.

That responders reject advantageous unequal offers has been observed before in Ultimatum Games, but usually at a modest amount (see the survey by Camerer, 2003). Hennig-Schmidt, Li, and Yang (2008) find a high share of 52% non-monotonic responder profiles (similar to our 58%-65% in Second Life) in a video-experiment with three-person groups of Chinese students, and discuss the reasons revealed in the recorded group discussions. They find distributional concerns to be the main motivation for refusing advantageous offers, dominating other emotional, ethical, and moral reasons and non-expectancy of high offers. Thus, our finding of more non-monotonic responders in Second Life implies more social concerns, which is consistent with our observation of more generous proposer offers in the same environment.

Our results suggests that social interactions in Second Life are already more cooperative than in the real world ("First Life") when there is no communication. This can be either driven by selection effects (more cooperative people might be more likely to participate in the virtual world) or environmental effects (the exotic and exciting virtual world might make people more cooperative). In any case, the higher general cooperativeness in the virtual world lowers the need for additional communication between avatars to achieve efficient outcomes. Consistent with this we are not able to measure an effect of allowing avatar-to-avatar communication. One possible interpretation of this result is that the social distance (see Hoffman, McCabe, and Smith 2003, Charness and Gneezy 2008) between subjects in the Second Life environment is smaller than between laboratory participants. Communication then reduces the social distance in the laboratory, but does not further diminish it in the virtual world.[16]

Our study also makes a contribution to the discussion on the usefulness of virtual world environments in economic experimental research. Had Werner Güth conducted his seminal 1982 study of the Ultimatum Game in the virtual world Second Life, his conclusions about deviations of behavior from subgame-perfect *homo oeconomicus* play would not have been different. However, the level shift in cooperation and the money illusion in Linden$ suggest that researchers need to be careful in generalizing from results obtained in virtual worlds like Second Life to other populations (even though the high in-world valuation of Linden$ indicate that running experiments in Second Life could be much cheaper than in the economic laboratory). Our analysis shows that controlling for basic observable demographics like gender, age, and occupation may not be sufficient to explain behavioral differences between first and second life. An experimental design able to isolate the effect of selection in the Second Life population compared to the laboratory student population could involve conducting the Ultimatum Game and communication on a 'neutral' platform, and inviting both laboratory subjects as well as Second Life inhabitants to participate using the very same decision environment and interface. Similar to Charness and Gneezy (2008), one could in addition invoke potentially differential social distance reductions by revealing either the real names or the SL-alter-ego names of SL participants, allowing conclusions about the strength of social ties between SL participants in a Second-Life context and in a real-world context.

[16] We are grateful to an anonymous reviewer who suggested this explanation.

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Appendix

A. Instructions

A.1 Sample Instructions – Laboratory treatment Lab-F2F

Initial instructions

Welcome to this experiment. Please read these instructions carefully. Please do not communicate with other participants from now until the end of the experiment, except as instructed. If you have any questions, please raise your hand, and an experimenter will come to your place and answer your questions privately. If you do not comply with these rules we will have to exclude you from the experiment and any payoffs.

In this experiment you can earn money. You will be paid in cash at the end of the experiment. Your payoff depends on your decisions and the decisions of other participants in the experiment. The payoffs described in the instructions are in addition to a show-up fee of $10 paid to you independently of your decisions.

Before you receive instructions regarding which decisions you can make in this experiment, you have the opportunity to talk with another (randomly selected) person in the experiment.

The talk takes place in one of the small rooms in the back of the laboratory. You and the other person will be led to one of these rooms. You will have 5 minutes to talk. After 5 minutes the experimenter will stop the conversation.

In the conversation you are not allowed to reveal personal details to the other person. This includes data like name or address. The talk is video-monitored, and revealing personal data is against the rules. However, you are allowed to talk about everything else, for example your studies, your hobbies, or how your day was so far.

After the 5 minutes you will receive further instructions.

Ultimatum Game instructions

In the experiment there are two persons, Person A and Person B. You are Person A, and the participant you just talked with is Person B. The two participants make decisions in the following way:

First, Person A decides about how to split the amount of $20. Specifically Person A states how much of the $20 (s)he wants to give to Person B. Person A can choose any integer number between $0 and $20.

Then, Person A is guided out of the laboratory back to the small room, and Person B enters the lab.

Person B now decides whether (s)he wants to accept or reject the proposal of Person A.* If Person B accepts the proposal of Person A, then Person B receives the amount specified by Person A, and Person A receives the rest, i.e. $20 minus the specified amount. If Person B rejects the proposal, both Person A and Person B receive nothing, i.e. $0.

These decisions will be taken only once; there will be no repeated interaction. At the end of the experiment, both Person A and Person B are privately paid the described payoffs in cash (plus the show-up fee). Person B is paid before Person A, and leaves the laboratory earlier.

* Specifically, the computer shows Person B all possible proposals Person A could make, i.e. all numbers from $0 to $20, in random order. For each of these possible proposals the computer asks Person B whether (s)he would accept or reject this proposal. Finally, the computer looks at the proposal Person A actually made, and looks at the decision Person B made for this case. These decisions will be implemented.

A.2 Sample Instructions – Second Life treatment SL-A2A

Initial instructions

Welcome to this experiment. Please read these instructions carefully. Please do not communicate with other participants from now until the end of the experiment, except as instructed. If you have any questions, please touch help here > and an experimenter will come to your place and answer your questions privately. If you do not comply with the rules stated in these instructions, we will have to exclude you from the experiment and any payoffs.

In this experiment you can earn money. You will be paid in Lindens at the end of the experiment. Your payoff depends on your decisions and the decisions of other participants in the experiment. The payoffs described in the instructions are in addition to a participation fee of L$400 if you complete the entire experiment.

Before you receive instructions regarding the decisions you can make in this experiment, you will have the opportunity to talk to another (randomly selected) person in the experiment. You and the other person will transported to another location where you will have five minutes to talk.

In this conversation, you are not allowed to reveal your identity to the other person. This includes personal data like your real name or address. The talk is monitored, and revealing identifying information is against the rules. However, you are allowed to talk about everything else, for example your hobbies, favorite places in Second Life, or how your day was so far.

After these five minutes, you will move to a private cabin. You will receive further instructions then.

Ultimatum Game instructions

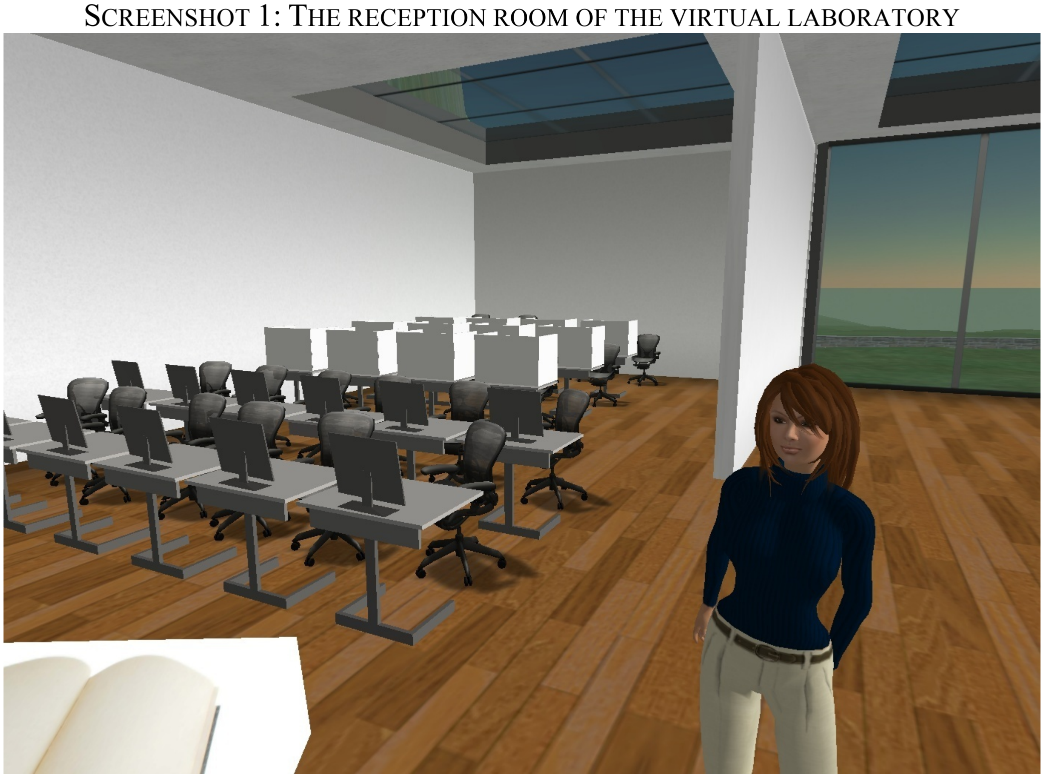
Now you need to make a decision. You are Person A, and the participant assigned to you is Person B. The two participants make decisions in the following way.

First, Person A decides how to split L$2000. Specifically, Person A states how much of the L$2000 (s)he wants to give to Person B. Person A can choose any amount between L$0 and L$2000, in increments of L$100. Then Person B decides whether (s)he wants to accept or reject the proposal of Person A*. If Person B accepts the proposal of Person A, then Person B receives the amount specified by Person A, and Person A receives the rest, i.e. L$2000 minus the specified amount. If Person B rejects the proposal, both Person A and Person be receive nothing, i.e. L$0. These decisions will be taken only once; there will be no repeated interaction. At the end of the experiment, both Person A and Person B are privately paid the described payoffs plus the participation fee.

* Specifically, Person B is shown all possible proposals Person A could make, i.e. all L$100 increments from L$0 to L$2000, in random order. For each of these possible proposals Person B is asked whether (s)he would accept or reject this proposal. Finally, we look at the proposal Person A actually made, and look at the decision Person B made for this case. These decisions will be implemented.

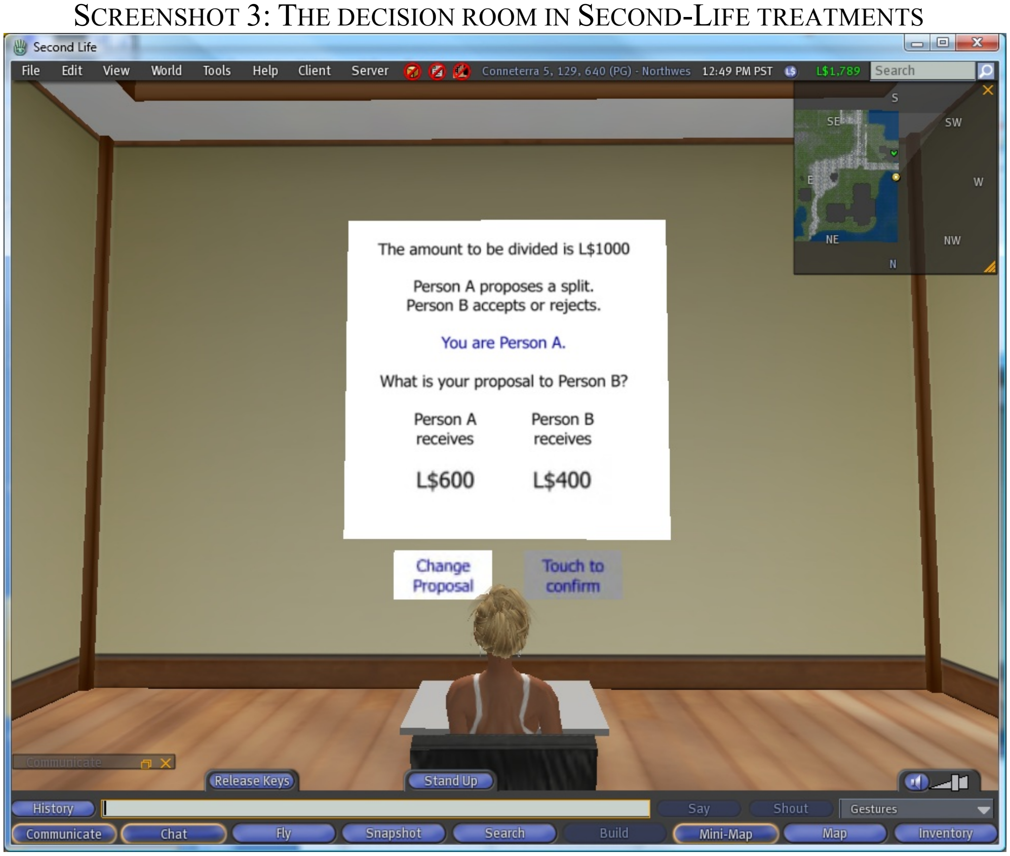
B. Second Life screenshots

SCREENSHOT 1: THE RECEPTION ROOM OF THE VIRTUAL LABORATORY



SCREENSHOT 2: THE DISCUSSION ROOM IN TREATMENT SL-A2A

SCREENSHOT 3: THE DECISION ROOM IN SECOND-LIFE TREATMENTS



C. Additional tables

TABLE C.1: P-VALUES OF 2-SIDED WILCOXON SIGNED RANKS TESTS BETWEEN TREATMENTS

Proposer's offer	L-Chat	L-F2F	SL-NC	SL-A2A	Responder's threshold	L-Chat	L-F2F	SL-NC	SL-A2A
Lab-NC	0.165	0.002	0.004	0.001	Lab-NC	0.259	0.131	0.306	0.832
Lab-Chat		0.079	0.125	0.018	Lab-Chat		0.710	0.037	0.234
Lab-F2F			0.892	0.336	Lab-F2F			0.014	0.113
SL-NC				0.558	SL-NC				0.580
Proposer's payoff	L-Chat	L-F2F	SL-NC	SL-A2A	**Responder's payoff**	L-Chat	L-F2F	SL-NC	SL-A2A
Lab-NC	0.979	0.717	0.967	1.000	Lab-NC	0.134	0.001	0.004	0.004
Lab-Chat		0.882	0.632	0.702	Lab-Chat		0.075	0.081	0.108
Lab-F2F			0.288	0.364	Lab-F2F			0.760	0.915
SL-NC				0.737	SL-NC				0.699