# ICTeCollective – Harnessing ICT-enabled collective social behaviour
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# ICTeCollective Consortium

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## ICTeCollective introduction

ICTeCollective (*Harnessing ICT enabled collective social behaviour*) aims to develop systematic means of exploring, understanding and modelling2 systems where ICT is entangled with social structures. In particular, we will focus on behavioural patterns, dynamics and driving mechanisms of social structures whose interactions are ICT-mediated, from the level of individuals to the level of groups and large-scale social systems. Our unique approach is based on combined expertise in complex systems and the social sciences. By contrast with the majority of complexity studies that start from extremely simplified assumptions concerning social dynamics and concentrate on diagnosing structural features of social systems, we emphasize that ICT networks are dynamic systems of interacting humans and groups, and fully utilize the theories and methods of the social sciences are to be in ICTeCollective.

We will study and relate high quality datasets on ICT mediated social interactions and groups that have already been acquired, and also create new sets of data by conducting experiments with human subjects to examine the properties of social interactions mediated by technological means. The first source of data, electronic records of interactions, is a by-product of how ICT mediated communities operate. In particular, we will use some of the most extensive ICT datasets available at present, such as time-stamped data sets on mobile telephone communications between millions of users, the editing history of Wikipedia documents, and the popularity of Facebook applications. Secondly, entirely new data will be generated and released into the public domain by conducting laboratory experiments on ICT-mediated human interactions.
This project addresses the goals of the FP7 FET-OPEN call by trying to build an integrated picture of ICT-mediated social systems focusing on some aspects that are

i) critical to social interaction,
ii) can be easily tracked in large datasets and confirmed in experiments, and
iii) have a considerable

chance of improving our understanding and usage of ICT, with the possibility of leading to new and exciting technologies that can shape the future of ICT. The particular aspects that we focus on are *activity patterns, social influence*, and *group dynamics*. This choice helps us to address a large number of practical issues such as the driving mechanisms of social interactions mediated by ICT, and how these mechanisms then shape groups and society. All of these are critical to the goals of ICTeCollective.

We define the above terms as follows: *Activity patterns* are temporal sequences of social interaction and communication events, measurable in electronic communication records and representing the "atoms" of social interaction processes. *Social influence* refers to all processes where individuals affect each others' beliefs, behaviour, activities, and representations of reality. *Group dynamics* comprises processes such as emergence, growth, merging, and splitting of groups, and associated behavioural patterns of individuals.

# Executive Summary

The document reports completion of the deliverable 4.6 "The experiment in an online game community". The results of 2 studies are presented. In the 1st experiment the novelty spread over a techno-social network of an online game community is examined. A set of participants of an SMS based game was given special new commands to use with their avatars. The spreading of commands in time depending on the connectivity of players was studied. Subsequently a 2nd study was conducted in the instant messenger users population. Again a set of users received a special gift that could be passed on to other users. The spread of the gift across following days was recorded and analysed.

# Contents

## Aim of the study and procedure description

The 'Leposy' mobile game is a mobile phone mediated interaction game where each player takes care of a virtual pet – 'lepos'. She or he interacts with other players by sending text messages with reserved key words – commands – that are various neologisms, mostly without any meaning outside of the game. The commands affect the interaction partner's lepos. They can be either positive (pet, touch, etc.) or aggressive (kick, bite, etc.); some are neutral. The valence of the command may affect the energy of a lepos. Besides executing actions through commands players can also interact with each other via 'normal' text messages.

The goal of the study was to check how a novelty spreads through a techno-social network when it is introduced through hubs of the network versus low degree nodes. We assumed that hubs will spread news faster and to a larger number of nodes than low degree individuals. To verify this assumption we conducted two studies in which we introduced a novel, neutral command into the Leposy game. To entice players to spread the command there was a prize for the highest number of the command uses within the first 3 days after its introduction (free mobile calls). In each experiment the new command was sent to a selected number of players which were divided into 2 groups: highly and low active users. The activity was measured each time for two days preceding the introduction of the command and amounted to the sum of sent and received commands in that period. In the first experiment, we chose 50 highly and 50 low active users (from 448 to 6181 commands used and from 0 to 264 commands used respectively). In the second one, 45 highly active (from 347 to 6677 commands) and 45 low active users (from 0 to 299 commands). In each experiment an equally numerous control group was chosen by randomly selecting users from a pool including only players that exhibited both outgoing and ingoing activity in the preceding 15 days but excluding those selected for experimental conditions.

## Results

For each user in all experimental groups the following indicators were measured from 4 pm on the day of the experiment (the moment of command introduction) till 12 pm that day:

- The number of reciprocal links (unique interaction partners that were both receiving and sending commands): "degree"
- The number of incoming links (unique interaction partners that sent a command to the given person): in degree
- The number of outgoing links (unique interaction partners that received a command from the given person): out degree
- Total number of sent commands: command out
- Total number of received commands: command in
- Total number of sent text messages: sms out
- Total number of received text messages: sms in
- Total number of outgoing uses of the introduced command: special out
- Total number of incoming introduced commands: special in
- The number of unique interaction partners to which the special command was sent: special out degree

Global totals for the whole population of the game were also counted (Fig 1, 2, 3, 4 & 5).

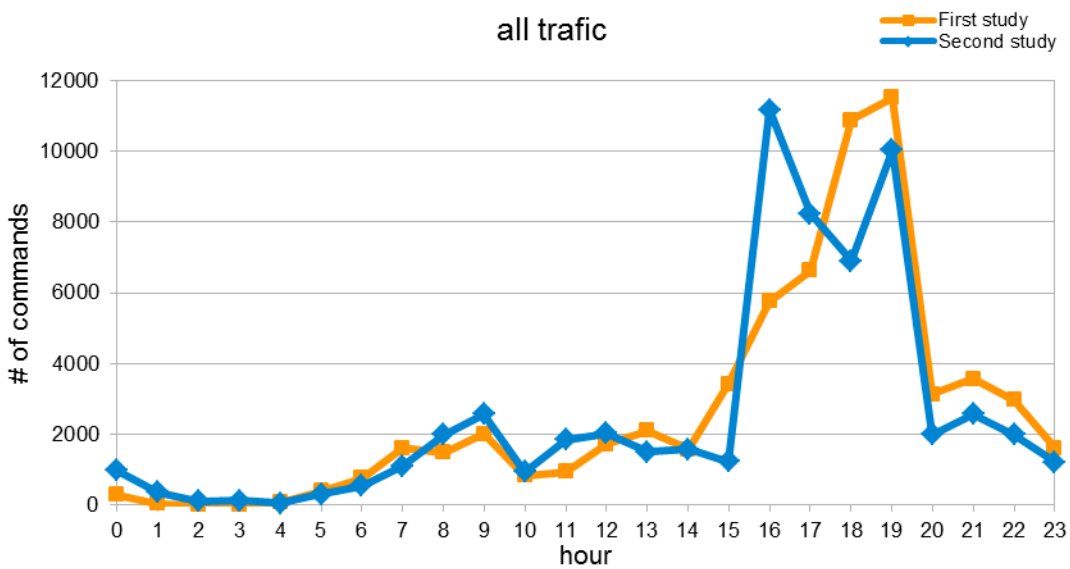



*Figure 1. Total number of sent commands on the days of the experiments.*

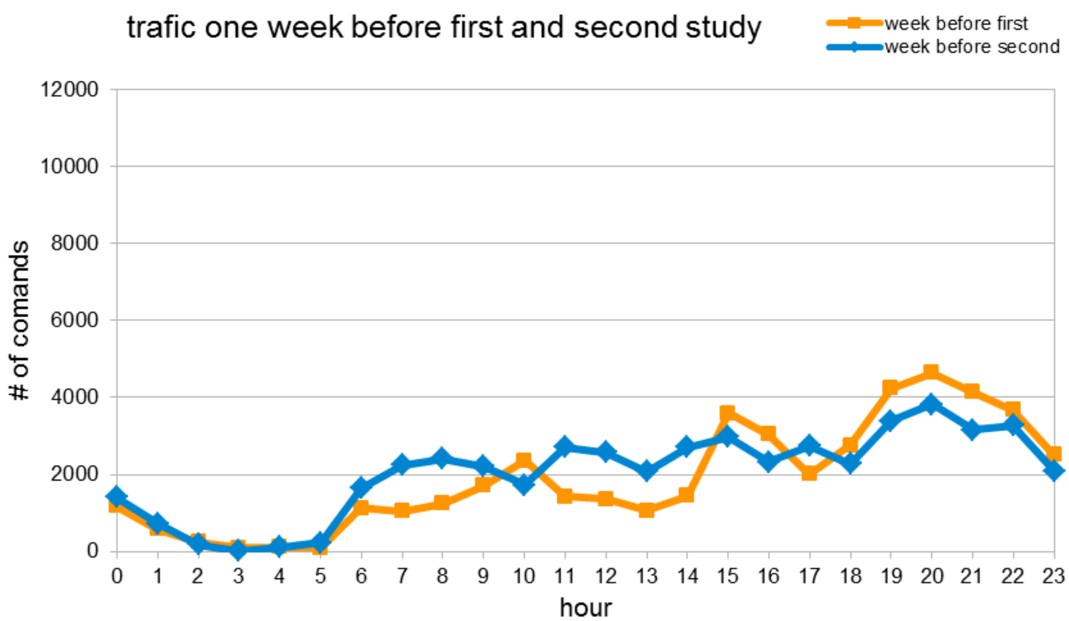



*Figure 2. Almost three times lower activity was recorded a week before each study.*

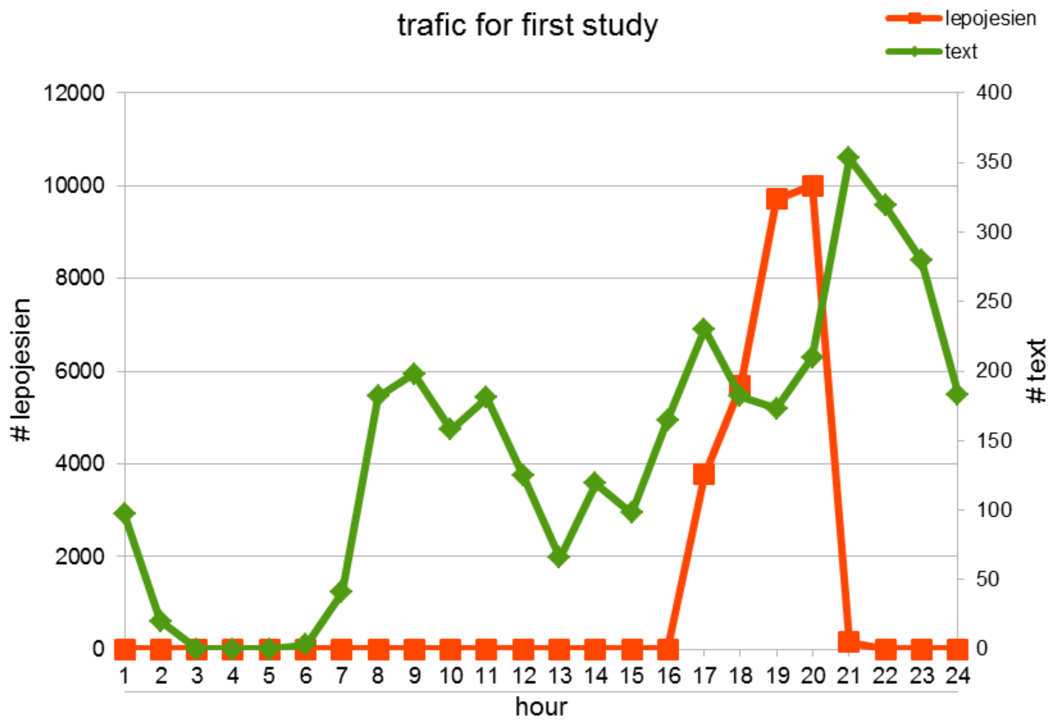



*Figure 3. The command in the first study ('lepojesien') elicited a peak activity shortly after its introduction. However, a correspondingly high activity of text messages follows shortly thereafter. Presumably, after using the command, players discuss it via texting.*

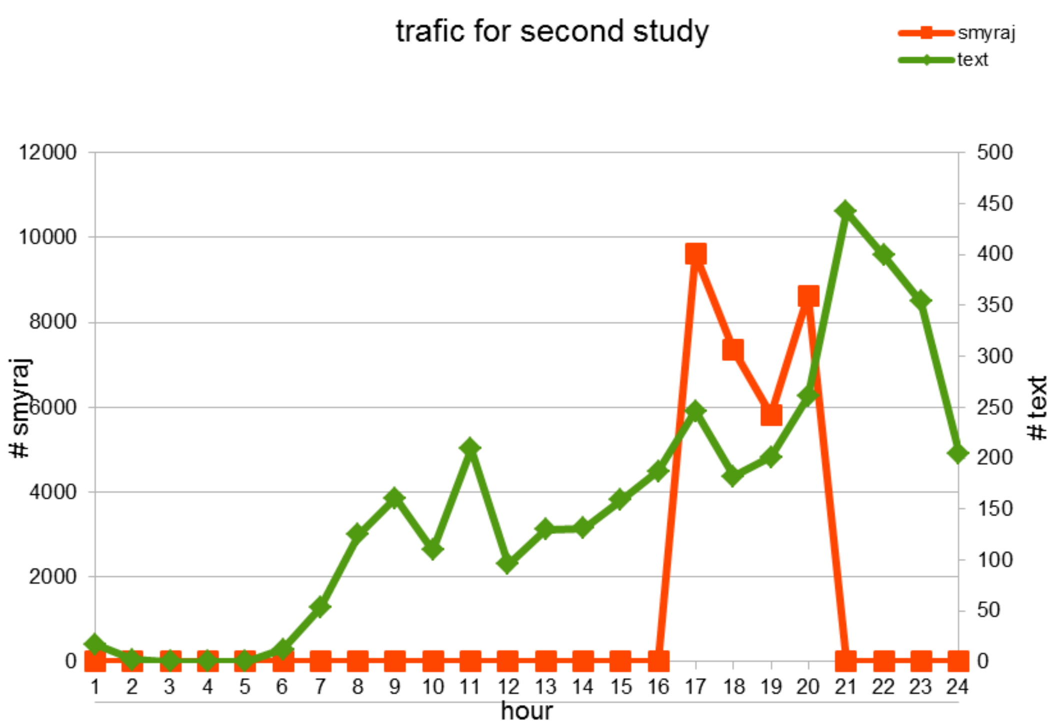



*Figure 4. A similar temporal pattern may be observed in the second study with the command 'smyraj'. Texting drops within the peak usage of the new command but skyrockets shortly after.*

Additionally, the usage of most popular command in the game ('sru') drops for the peak usage of new commands (fig. 5 & 6).

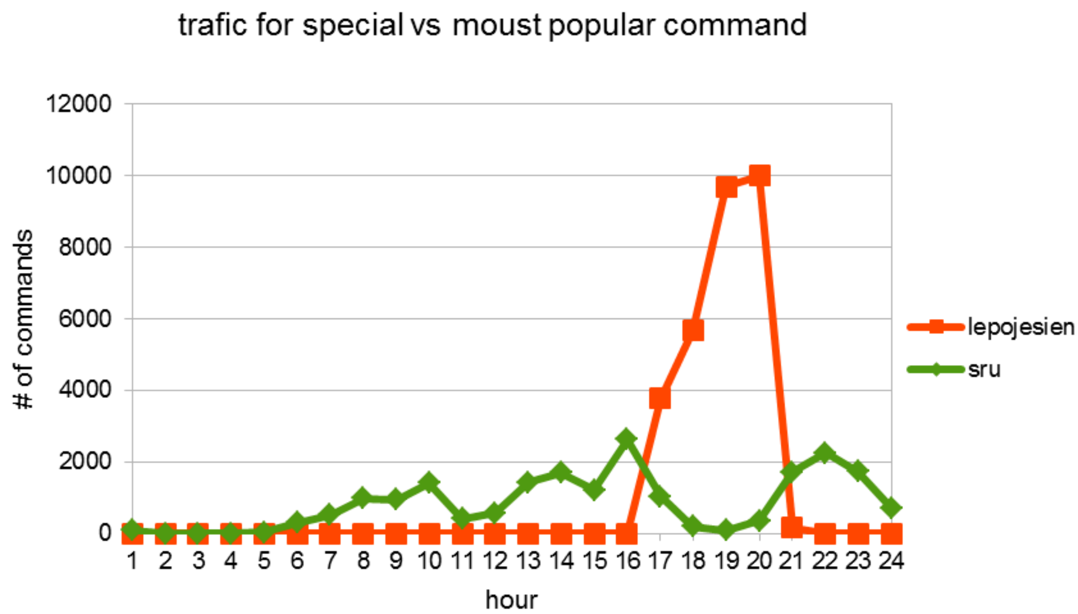



*Figure 5. The usage of the most popular command 'sru' decreases during the first experiment.*

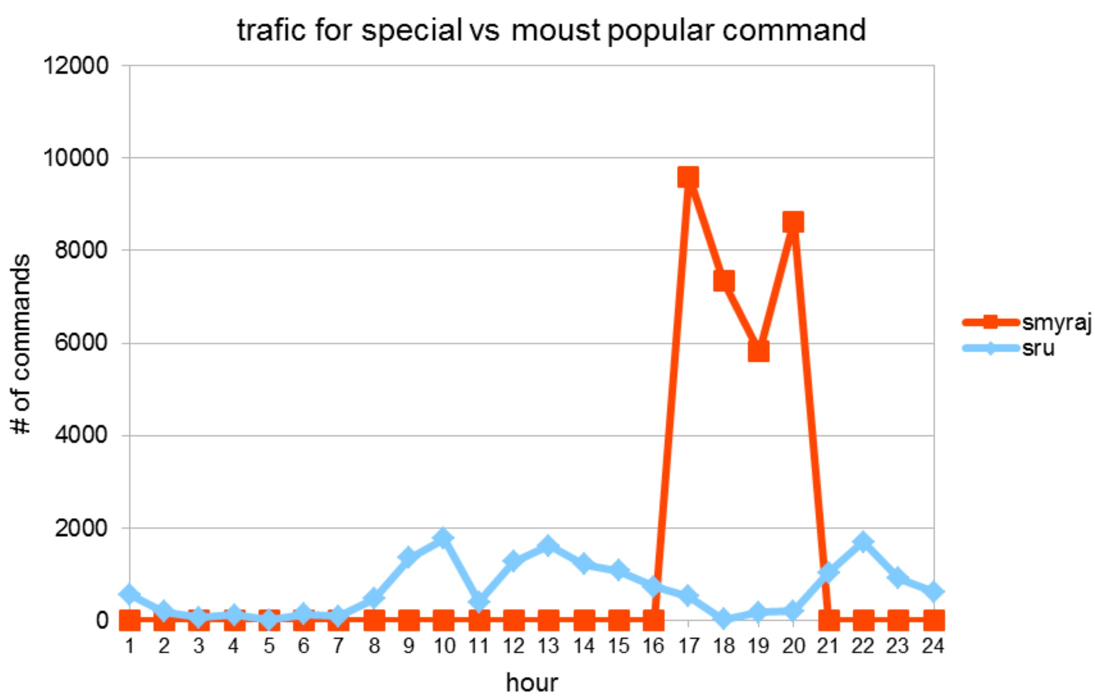



*Figure 6. Similarly, the 'sru' command usage drops also for the second experiment.*

The activity in the day preceding the experiment is a good predictor both for the total activity on the next day as well as for the usage of the new commands (Table 1 & 2.)

*Table 1. Correlations between activity on the day before the first experiment and various indicators of the study day activity*

**Correlations (N=150)**

| | | preceding day command out | study day command out | study day special out | study day special in | study day special out degree |
|---|---|---|---|---|---|---|
| preceding day command out | Pearson Correlation | 1 | ,727** | ,551** | ,574** | ,268** |
| | Sig. (2-tailed) | | ,000 | ,000 | ,000 | ,001 |
| study day command out | Pearson Correlation | ,727** | 1 | ,883** | ,674** | ,311** |
| | Sig. (2-tailed) | ,000 | | ,000 | ,000 | ,000 |
| study day special out | Pearson Correlation | ,551** | ,883** | 1 | ,634** | ,299** |
| | Sig. (2-tailed) | ,000 | ,000 | | ,000 | ,000 |
| study day special in | Pearson Correlation | ,574** | ,674** | ,634** | 1 | ,203* |
| | Sig. (2-tailed) | ,000 | ,000 | ,000 | | ,013 |
| study day special out degree | Pearson Correlation | ,268** | ,311** | ,299** | ,203* | 1 |
| | Sig. (2-tailed) | ,001 | ,000 | ,000 | ,013 | |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

*Table 2. Correlations between activity on the day before the second experiment and various indicators of the study day activity*

**Correlations (N=135)**

| | | preceding day command out | study day command out | study day special in | study day special out | study day special out degree |
|---|---|---|---|---|---|---|
| preceding day command out | Pearson Correlation | 1 | ,641** | ,523** | ,467** | ,152 |
| | Sig. (2-tailed) | | ,000 | ,000 | ,000 | ,078 |
| study day command out | Pearson Correlation | ,641** | 1 | ,760** | ,888** | ,302** |
| | Sig. (2-tailed) | ,000 | | ,000 | ,000 | ,000 |
| study day special in | Pearson Correlation | ,523** | ,760** | 1 | ,761** | ,153 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Sig. (2-tailed) | ,000 | ,000 | | ,000 | ,077 |
| study day special out | Pearson Correlation | ,467** | ,888** | ,761** | 1 | ,250** |
| | Sig. (2-tailed) | ,000 | ,000 | ,000 | | ,003 |
| study day special out degree | Pearson Correlation | ,152 | ,302** | ,153 | ,250** | 1 |
| | Sig. (2-tailed) | ,078 | ,000 | ,077 | ,003 | |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The within subject (the day before and the day of the experiment) as well as across subject comparisons were conducted using repeated measures design.

**Command out**

In the first experiment, the high degree nodes send significantly more commands than both the low degree users and the control group (main effect F=26.18, p<0.01). Moreover, there were more commands sent on the day of the experiment than before (F=13.07, p<0.01). The interaction of group and day was not significant (Fig. 7)

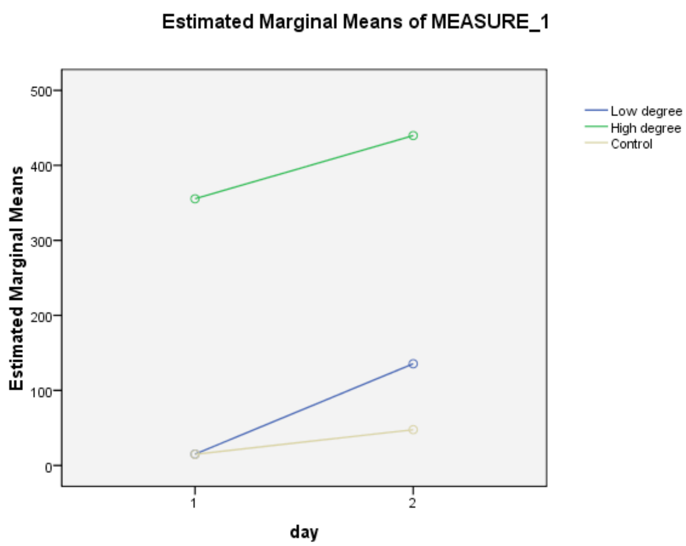



*Figure 7. Commands sent in the first experiment by the experimental and control groups – on the preceding day (1) and study day (2).*

Similar results were obtained for the command out indicator in the second experiment (main effect of day F=4.94, p<0.05 and of group F=46.12, p<0.01) – Fig 8.

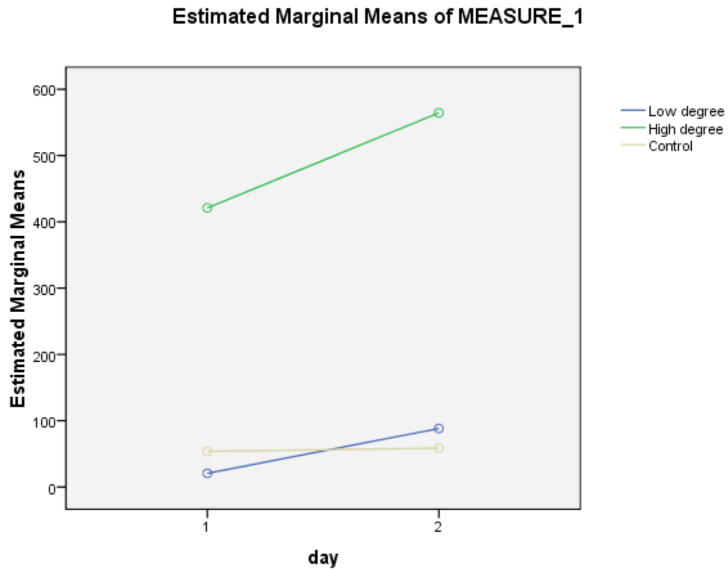



*Figure 8. Commands sent in the second experiment by the experimental and control groups – on the preceding day (1) and study day (2).*

**Command in**

In both experiments, the received commands differ both with respect to the group ($F=16.05$, $p<0.01$ in the first experiment, $F=40.81$, $p<0.01$ in the second) and the day ($F=10.56$, $p<0.01$ in the first experiment, $F= 17.18$, $p<0.01$ in the second). The interaction of the factors is also significant ($F=4.17$, $p<0.05$ in the first experiment, $F=14.25$, $p<0.01$ in the second). In both experiments, the high degree nodes receive more commands than both low degree and control players, as revealed by post hoc analysis with Bonferroni correction. In the first experiment both the high and low degree nodes receive more commands on the experiment day that the day before, while the control group receives not a significantly different number (Fig. 9). In the second however, only the hubs receive more commands on the day of the experiments then the day before – low degree nodes and control group receive similar number of commands on both days (Fig. 10).

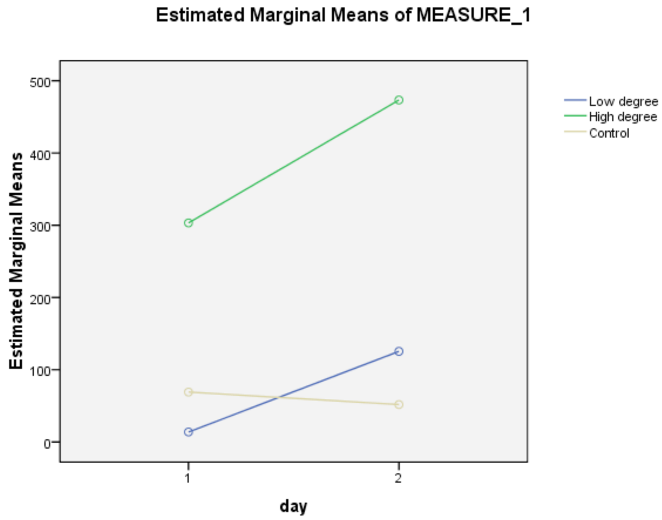



*Figure 9. Commands received in the first experiment by the experimental and control groups – on the preceding day (1) and study day (2).*

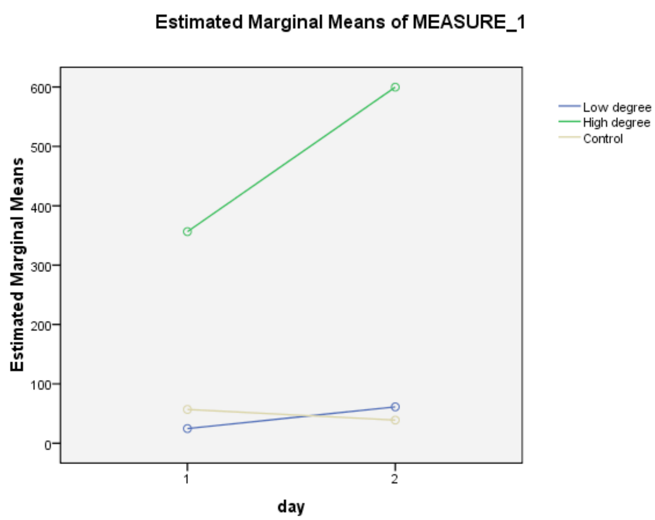



*Figure 10. Commands received in the second experiment by the experimental and control groups – on the preceding day (1) and study day (2).*

## Special command usage

To verify the effects of command target group on its usage we conducted ANOVA analysis for the special command indicators. In the first experiments all indicators differed with respect to the group ($F=9.43$, $p<0.01$ for special in, $F=11.55$, $p<0.01$ for special out and $F=22.88$, $p<0.01$ for special out degree). Post hoc analysis with Bonferroni correction showed that the main effects come from the fact that hubs send more, receive more and interact with more partners using the special command than both controls and low degree users.

Exactly the same results were obtained for the second experiment ($F=25.38$, $p<0.01$ for special in, $F=16.42$, $p<0.01$ for special out, $F=8.21$, $p<0.01$ for special out degree). Again, the hubs have higher values on each of the indicators than both controls and low degree nodes.

**Other indicators**

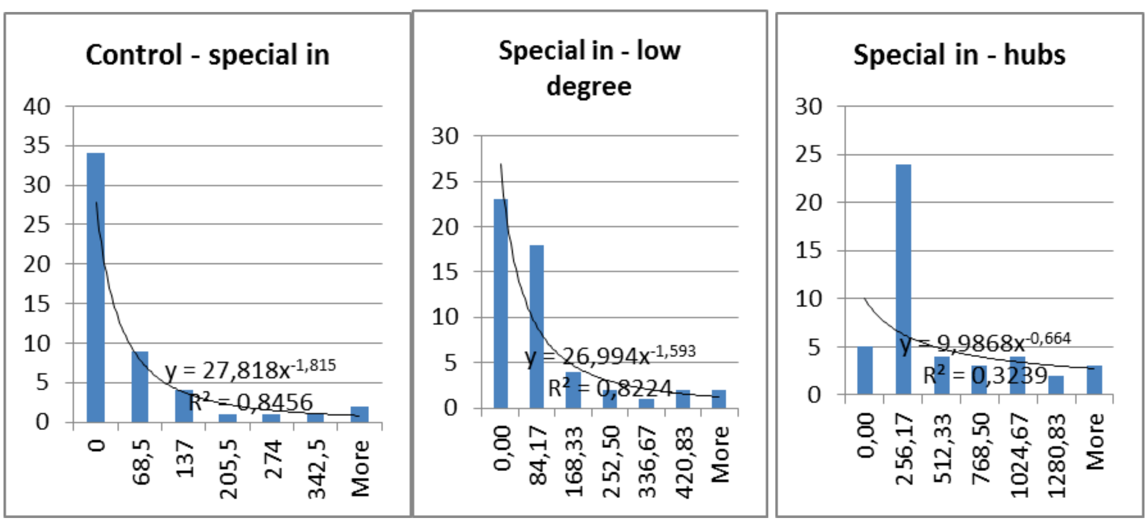
Other activity indicators on the day before and the day of the study were also compared across groups for both experiments. A summary of the effects is presented in table 3.

*Table 3. Activity indicators compared across groups and days*

| Indicator | Main effect of group | | Main effect of day | | Interaction effect | |
|---|---|---|---|---|---|---|
| | 1st Study | 2nd Study | 1st Study | 2nd Study | 1st Study | 2nd Study |
| *Degree* | F=50.52, p<0.01 | F=21.77, p<0.01 | F=0.02, p>0.05 | F=3.69, p=0.057 | F=0.2, p>0.05 | F=0.39, p>0.05 |
| *Out degree* | F=39.1, P<0.01 | F=23.52, p<0.01 | F=0.37, p>0.05 | F=3.8, p=0.053 | F=0.52, p>0.05 | F=0.52, p>0.05 |
| *In degree* | F=46.62, p<0.01 | F=22.15, p<0.01 | F=0.0, p>0.5 | F=3.1, p=0.08 | F=0.25, p>0.05 | F=0.79, p>0.05 |
| *Sms in* | F=15.76, p<0.01 | F=8.43, p<0.01 | F=4.74, p<0.05 | F=0.43, p>0.05 | F=1.39, p>0.05 | F=0.01, p>0.05 |
| *Sms out* | F=21.48, p<0.01 | F=8.06, p<0.01 | F=3.03, p=0.08 | F=0.01, p>0.05 | F=0.52, p>0.05 | F=0.2, p>0.05 |

The groups differed significantly in all measures of activity; generally, activity had also a tendency to increase on the day of the experiment, especially in the second study. The interaction of these factors was however not significant.

**Special command usage distributions (Figure 11)**



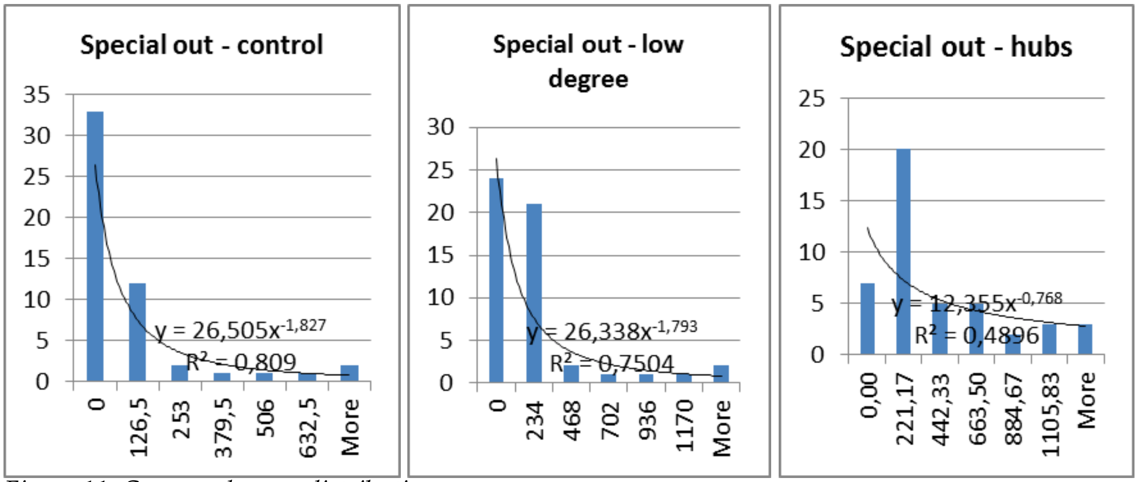



*Figure 11. Command usage distributions*

**Summary**

The experiment showed differences in activity among groups of users defined by their activity: hubs, low degree nodes and controls. The introduction of a novelty into the social network in the game community resulted in a general increase of traffic. However, the change in activity did not vary across groups with the sole exception of incoming game commands, which increased more for the hubs than the other groups.

The design of the game and the experiment did not allow measuring the spread of novel behavior in the network. In order to be able to verify if targeting high degree users results in a wider spread in the network we conducted an additional experiment – this time in an instant messaging system. This allowed us to study a vastly larger community (15mln total users) and to define target, experimental groups (hubs, low degree) in a more reliable way using normal communication rather than fictional commands.

## Experiment in an instant messaging community

A free gift „pass the smile" (Figure 12) was distributed among 3000 users of GaduGadu (GG) communicator network.

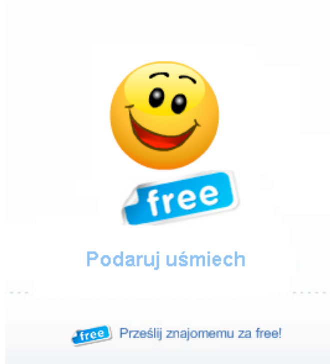



*Figure 12. The gift that was initially sent to 3000 communicator users. They could set it as a decoration on their avatar and send it further to any person on their contact list. The picture used in all experimental groups was the same.*

The gift could be given away by a person to one of the friends from his/her contact list. The sample of users was divided into 3 groups of equal size (1000) based on the connectivity level of users. The three groups were dubbed "hubs" – people with the highest connectivity, "tails" - people with the lowest connectivity and "random" - a sample of average users. The connectivity was assessed according to active connections count for the preceding month. A connection was considered "active" if during this time it was used at least 4 times with 3 or more messages being exchanged. The content, length or order of the messages has not been analyzed, only the number. The degree distribution is shown in the Figure 13.

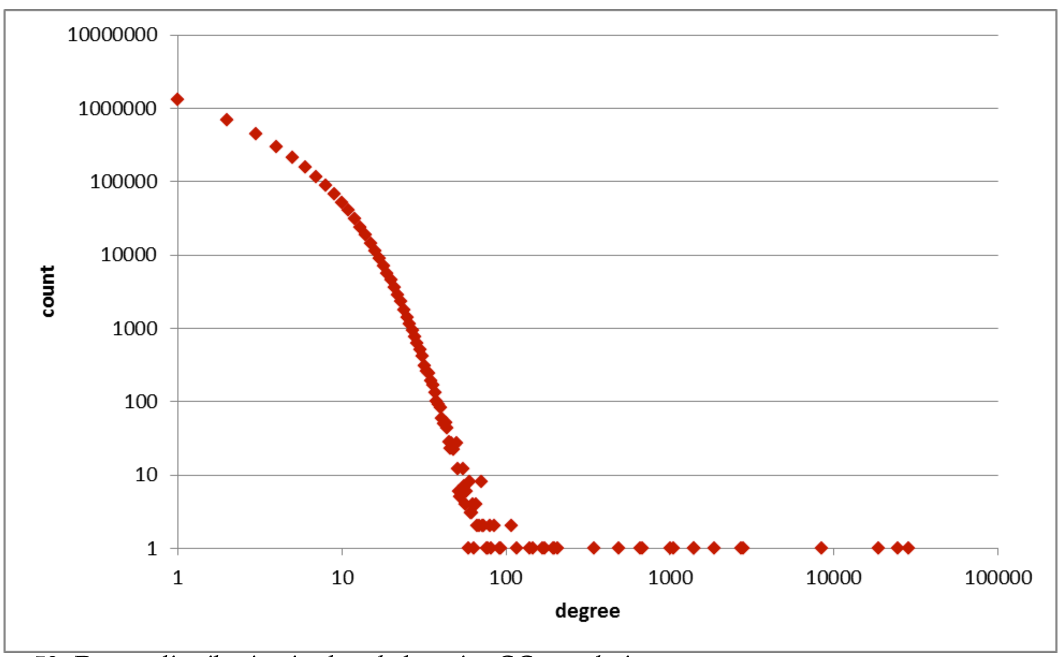



*Figure 53. Degree distribution in the whole active GG population*

The responsiveness (i.e the percent of users who took any action on the first day of the experiment – in the first 7 hours) of the two groups was rather low. The initial 1000 gifts there were passed further 94 times in the hubs group and 69 times in the tails group. The structure of interactions during the first day in two groups is shown in the figure 14.

*Figure 14. The structure of connections in the first day of experiment in the group of hubs (right) and tails (left)*

The comparison between hubs and tails revealed the difference in the temporal pattern of gift spread. The group of highly connected users passed the smile to many more users in the first 15-19 hours of the experiment than the group of low connected users. Up till the 19th hour the hubs transferred the gift to a total of 22652 users as compared to 13757 in the tails group (1.8 times less). However, within the duration of the experiment the difference between hubs and tails spread reached a plateau (around 16000 more gifts from the hubs group than from the tails group) and started to diminish at the end (Figure 15) – in the last three hours the tails' gift spread to more users than the hubs' gift (4679 as compared to 4194).

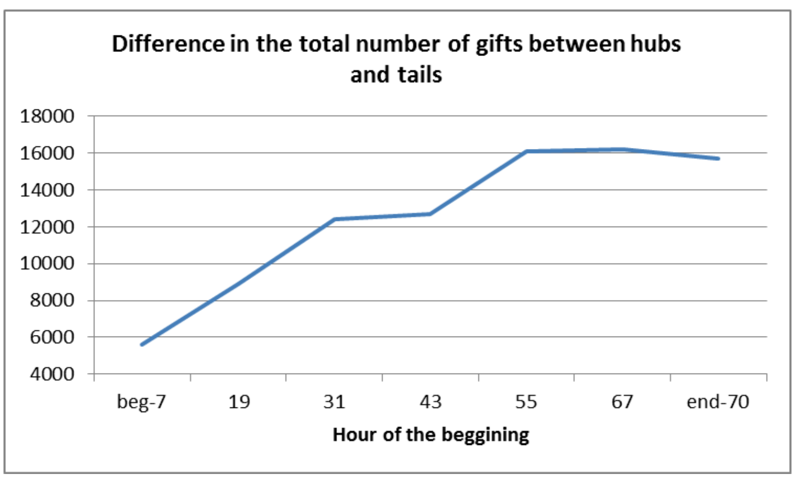



*Figure 15. Difference between the cumulative spread of gifts between the hubs and tails group initially grows but then reaches a plateau and starts to diminish.*

The dropping difference is even more visible in the proportion of total hubs' gifts to tails' gifts (Figure 16), which starts from 1.8 more gifts in the hubs group than drops to stabilizes around 1.2 more and slowly drops thereafter.

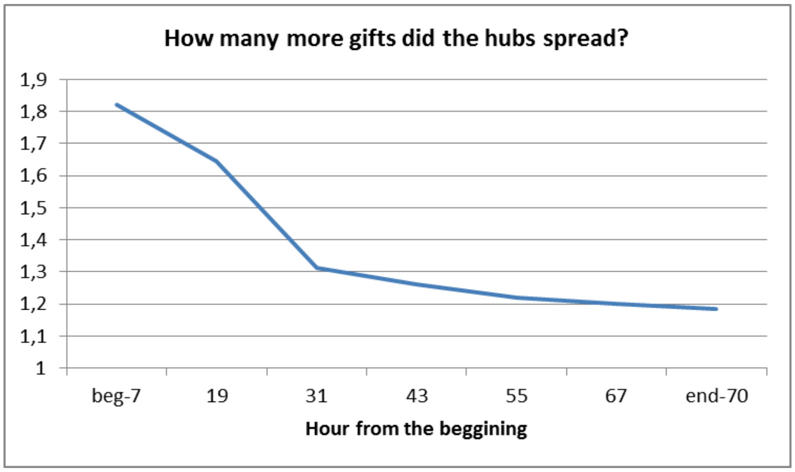



*Figure 16. Gift transmission during the 3 days of experiment as proportion of hubs to tails cumulative spread*

In summary, the analysis of spread shows that targeting hubs only yields a difference in the first hours of manipulation. After that – presumably when the interest in the novelty saturates – the spread in the hubs group slows down. Simultaneously, around that time the initial spread in the tails group possibly reaches a hub and from there on the differences between the groups start to diminish.