Multiple gossip statements and their effect on reputation and trustworthiness

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Empirical and theoretical evidence from various disciplines indicates that reputation, reputation building and trust are important for human cooperation, social behaviour and economic progress. Recently, it has been shown that reputation gained in games of indirect reciprocity can be transmitted by gossip. But it has also been shown that gossiping has a strong manipulative potential. We propose that this manipulative potential is alleviated by the abundance of gossip. Multiple gossip statements give a better picture of the actual behaviour of a person, and thus inaccurate or fake gossip has little power as long as it is in the minority. In addition, we investigate the supposedly strong connection between reciprocity, reputation and trust. The results of this experimental study (with 11 groups of 12 students each) document that gossip quantity helps to direct cooperation towards cooperators. Moreover, reciprocity, trust and reputations transferred via gossip are positively correlated. This interrelation might have helped to reach the high levels of cooperation that can be observed in humans.

Keywords: cooperation; indirect reciprocity; trust; language; rumour

1. INTRODUCTION

Reputation and reputation building is important for the evolution of human cooperative behaviour. It seems to explain the high levels of cooperation between anonymous partners in one-shot interactions in a global market (e.g. modern e-commerce systems such as eBay and Amazon; see Resnick *et al.* 2000) and cooperation between non-relatives in general (Nowak & Sigmund 2005). The function and the effect of reputation building has been studied by several researchers from various disciplines (Alexander 1987; Emler 1990; Krebs 1990; Pollock & Dugatkin 1992; Nowak & Sigmund 1998; Ostrom 1998; Wedekind & Milinski 2000; Leimar & Hammerstein 2001; Milinski *et al.* 2002; Fehr & Fischbacher 2003; Semmann *et al.* 2004; Bolton *et al.* 2005; Seinen & Schram 2006; Röhl *et al.* 2007). The development of a reputation is important for the process of indirect reciprocity (IR; Alexander 1987; Nowak & Sigmund 2005; Ohtsuki & Iwasa 2006; Brandt *et al.* 2007). In principle, IR occurs when people have the possibility to decide whether to help others, and thereby base their decision on (social) information about these people, i.e. their reputation. Here, it is important to distinguish IR from direct reciprocity (Trivers 1971), where the helped individual could directly reciprocate and subsequently help the helper; this situation is excluded in the IR framework (but see Roberts 2008). IR can therefore be summarized by the phrase ‘I help you and somebody else helps me’ (Nowak & Sigmund 2005) if people know my reputation.

In line with the theory (Nowak & Sigmund 1998), such an opportunity to build up reputation has been shown to increase cooperative behaviour in experimental games (Wedekind & Milinski 2000; Milinski *et al.* 2002, 2006;

Semmann *et al.* 2004; Seinen & Schram 2006). However, in these experimental studies, people were always directly informed about other people’s behaviour. This resembles a situation in which people would first directly observe others and then decide whether to help or not. Furthermore, people had access to complete information about their partners—they saw all previous decisions of their partners about helping others or not. Thus, previous studies included direct observation and complete information. Yet, the natural situation is different: we cannot observe everybody all the time, especially not those people we possibly meet and interact with in the future.

To overcome this lack of information, especially in large groups, it has been argued that language and gossip might have evolved as a substitute for direct observation (Enquist & Leimar 1993; Dunbar 1996; Nowak & Sigmund 1998, 2005; Mohtashemi & Mui 2003; Panchanathan & Boyd 2003). As gossip and gossiping is regarded as one of the most important social and cultural phenomena (Gluckman 1963; Paine 1967; Fine & Rosnow 1978; Noon & Delbridge 1993; Emler 2001), it has been investigated for decades (e.g. Cox 1970; Haviland 1977; Suls 1977; Levin & Arluke 1987; Eder & Enke 1991; Ellickson 1991; Goodman & Ben-Ze’ev 1994; Wilson *et al.* 2000; McAndrew & Milenkovic 2002; Baumeister *et al.* 2004; Foster 2004; Bosson *et al.* 2006), but only recently it has been shown that gossip can serve as a substitute for direct observation in the context of IR (Sommerfeld *et al.* 2007).

In an experimental game in which students could write a short comment, i.e. gossip, about other people’s behaviour, Sommerfeld *et al.* (2007) showed that gossip reflected the people’s cooperative behaviour and transferred this information to other members of the group who, in turn, relied on this information, although only marginally when gossip described extremes. However, in a situation where everybody would totally rely on single

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gossip statements, it would be evolutionarily favourable to cheat and lie about one's own behaviour or the behaviour of close relatives and thus manipulate reputations. Lying defectors would not bear the costs of cooperation, but gain the benefit from those that would otherwise help only cooperators; they would spread in the population and cooperation could not be maintained (Nakamaru & Kawata 2004). Consequently, for the evolution of cooperation by IR, it is important that a partners' reputation is reliably known (Nowak & Sigmund 1998; Roberts 2008) and that cheaters can be effectively detected (Nakamaru & Kawata 2004; see also Hess & Hagen 2006).

We suggest that gossip can help to meet these prerequisites by its quantity. A single gossip statement may only be a poor indicator of a person's reputation. However, in our daily life, we rarely know just one gossip statement about another person. We know plenty of gossip, and it has already been shown that repetition of specific gossip increases its believability (Hess & Hagen 2006). Yet, such a repetition would only give a more reliable picture of a single situation, but not a complete picture of the person concerned. Thus, we propose that multiple gossip statements approximate the complete picture much better than single observations or comments do. In contrast to Hess & Hagen (2006), we investigate this experimentally in the context of human cooperation and focus on gossip's influence on real behaviour. We designed a computer-based game in which participants encounter one or several gossip statements about other people's cooperative behaviour and then have to decide whether to cooperate or not. It has already been shown that a single gossip statement does not lead to the same behaviour as direct observation does (Sommerfeld *et al.* 2007). Our expectation is that the participants' response upon reading several statements is closer to the response they show with complete information (i.e. after direct observation) than the response upon reading a single statement. Furthermore, the game includes predefined situations concerning gossip quantity and valence in order to measure the effect of single statements of opposing valence. Thereby, we intend to simulate situations in which, for instance, a person tells nice stories about a close friend, but in which others report the friend's real behaviour and gossip negatively about him/her. We also include the contrary situation of little negative and plenty of positive gossip.

Last, we extend our experimental design to incorporate another highly connected social phenomenon: trust, a concept that seems to contribute substantially to the success of human societies and their economic progress (Knack & Keefer 1997; Zak & Knack 2001). According to a model proposed by Ostrom (1998), trust, reciprocity and reputation are linked by a positive feedback mechanism, and Dasgupta (1999) pointed out that 'trust is based on reputation, and reputation is acquired on the basis of observed behaviour over time'. Trust has been a topic in economic research for some time (Gambetta 1988; Berg *et al.* 1995; Güth *et al.* 1997; McCabe & Smith 2000; McCabe *et al.* 2003; Krueger *et al.* 2007; Rigdon *et al.* 2007), as well as the connection between trust and reputation (Lahno 1995; Diekmann & Przepiorka 2005; King-Casas *et al.* 2005), but only recently the connection between trust, reputation and reciprocity has

been investigated (Bravo & Tamburino 2008). Using evolutionary modelling, Bravo and Tamburino have shown that trust and reciprocity, and therefore cooperation, are indeed dependent on reputation building and the spread of information about others' reputation in the population.

In order to investigate this connection experimentally, we combine an IR game with the well-established trust game designed by Berg *et al.* (1995). Thereby, we aim to investigate the effect of reputation transferred via gossip in the trust game, as well as the connection between cooperative behaviour, trustworthiness and trustfulness.

2. MATERIAL AND METHODS

We conducted this experiment in November and December 2007 at the Universities of Kiel, Germany, and Vienna, Austria, where we recruited 132 first-semester biology students. The volunteering students were randomly divided into 11 groups of 12 people each. Each participant of a group played the experimental game on an individual computer that was connected to a server. Opaque partitions prevented the participants watching one another. Before each experimental session, the participants were orally informed about how to operate the computers, about their total anonymity concerning their decisions within the game and the payment of their earnings at the end, and that they play with real money (euro) in the game (see also Sommerfeld *et al.* 2007).

The experimental game consisted of 17 rounds in which the participants encountered different game situations. Each new game situation was introduced by a series of text pages explaining details and rules. In addition, the first introduction pages informed the participants about the following details: (i) each participant was endowed with starting money of 10 euro each, (ii) each participant was provided with a pseudonym in order to preserve their anonymity during the final payment of their earnings, and (iii) they must neither talk during the game nor draw attention towards themselves in any way.

Three major game situations were encountered during the game: IR rounds; gossip rounds; and a single trust game at the end. In IR rounds, the participants acted as potential donors and were asked whether they wanted to give 1.25 euro to another player, their receiver. Upon clicking YES, the donor paid 1.25 euro from his/her account and the other player received 2.00 euro (the additional 0.75 euro were paid by the experimenters). If the answer was NO, no money was exchanged. During the game, IR rounds varied in the information provided about the potential receiver. In the first round, the potential donors had no additional information about their potential receiver; in rounds 2–6, the donors were informed about all previous decisions of their receivers. These type of rounds are called observer IR rounds (figure 1). Further types of IR rounds were encountered later in the game and are explained below.

The second major game situation was encountered in rounds 7–9: gossip rounds (figure 1). Here, each participant was provided with all previous decisions of another participant and was asked to write a short (50 characters) comment about that person.

After these three gossip rounds, the participants again played IR rounds (rounds 10–12; figure 1), with the following information about their potential receiver: either (i) all previous YES/NO decisions of this player from rounds 1 to 6, (ii) a single gossip statement about this player written by another

Figure 1. A flow diagram of the game. 'IR' refers to indirect reciprocity. The numbers on the left-hand side indicate the number of rounds of each particular type played. Ratings of gossip valence took place between the trust game and the pay-off. A detailed description of single rounds is found in the text.

participant, or (iii) a set of three gossip statements about this player written by three different participants. To control for sequence effects, each participant played these three different situations in rounds 10–12 in a random sequence. Furthermore, without them knowing, the participants were paired with the same receiver throughout these three rounds.

Rounds 13–15 consisted again of IR rounds providing preset gossip information about the potential receiver—supposedly written by another participant (figure 1). In these rounds, each participant encountered three out of five possible combinations of preset gossip statements: (i) three negative and one positive statement (hereafter referred to as nnp), (ii) two negative and one positive statement (nnp), (iii) one negative and one positive statement (np), (iv) one negative and two positive statements (npp), or (v) one negative and three positive statements (nppp). The sequence of the three combinations encountered by a single participant was randomized, as was the sequence of the individual gossip statements displayed in each round. The preset gossip statements were based on original student gossip from a previous study (Sommerfeld *et al.* 2007) and randomly selected by the computer program (see the electronic supplementary material for further details).

In the last two rounds (rounds 16 and 17; figure 1), the participants played a trust game (Berg *et al.* 1995). In our version of this game, a sender is endowed with 6.00 euro and is asked how much (if any) he/she wants to give to a recipient. The money sent in this way is tripled before it reaches the recipient. Subsequently, the recipient is asked how much (if any) he/she wants to return to the sender; the rest he/she keeps for himself/herself. The returned amount of money reaches the sender unchanged. Because the recipient can only lose money by returning something to the sender, he/she is rationally expected to return nothing. Consequently, by anticipating this choice, a rational sender is expected to send nothing to the recipient (Berg *et al.* 1995).

In our experimental game, the participants played the trust game first in the role of a recipient (round 16). Here, they were asked to answer the question of how much they would return for each possible sender decision (i.e. if the sender gives 0, 1, 2, 3, 4, 5 or 6 euro and the recipient would receive 0, 3, 6, 9, 12, 15 or 18 euro, respectively). In the following

round (round 17), each participant was endowed with 6.00 euro and acted as a sender; he/she was asked how much of the 6.00 euro he/she wanted to give to his/her recipient. To facilitate this decision, each sender was provided with gossip information about their recipient. Of the five aforementioned possible combinations of positive and negative preset statements, one combination was displayed per sender. Prior to the trust game, the participants were informed that their decisions as both the sender and the recipient will not be disclosed to anyone later in the game. After the sender decisions, the participants were paired and the computer calculated and displayed the pay-off for each participant individually.

At the end of the game, the participants were asked to rate the valence of each gossip statement they encountered or wrote during the game on a scale from 1 (very negative) to 7 (very positive) with four representing neutral valence. Each experimental session ended with the anonymous payment of the individual earnings to the participants (mean pay-off = 26.22 euro) as described by Semmann *et al.* (2005).

The design of the entire game did not allow for any direct reciprocity (Trivers 1971), or permit any standing strategy (Sugden 1986). Furthermore, the participants composed gossip only about players they encountered in neither IR nor trust game rounds; they were always third-party observers.

All data were analysed using the R statistical package (v. 2.6.2) for Windows XP. To verify the normality of residuals, we used the Shapiro–Wilk test procedure. If not stated otherwise, the data were analysed on the group level. Furthermore, all r^2 -values refer to adjusted r^2 and p -values are corrected for multiple testing if applicable.

3. RESULTS

In the observer IR rounds at the beginning of the experiment (rounds 1–6; figure 1), the participants reached a mean cooperation level of 59 per cent (s.d. 12.2%). Thereby, individual behaviour varied from 0 to 100 per cent cooperation with only 10 participants (7.6%) who cooperated never or just once and 39 participants (29.5%) who cooperated five or six times (out of six).

To analyse the gossip rounds (figure 1), we used gossip ratings provided by each participant as a measure of the individual gossip's valence. Furthermore, we grouped the participants according to the number of YES decisions they saw on their individual screen when asked to write gossip about their game partner. This yielded a total of seven groups (0, 1, 2, ..., or 6 out of six YES decisions displayed) of which we calculated the cooperation level as the number of YES responses divided by the total number of people in the respective group. As in a previous study (Sommerfeld *et al.* 2007), the more YES decisions the participants saw, the more positive the gossip they wrote ($y = 0.69x + 2.01$, $r^2 = 0.92$, $F_{1,5} = 55.35$, $p < 0.001$). Furthermore, subsequent ratings of gossip were positively correlated with the original rating of the same gossip by its author ($y = 0.45x + 2.11$, $r^2 = 0.20$, $F_{1,394} = 102.3$, $p < 0.001$). The same was found for gossip triplets where we compared the average original ratings by the gossip authors with the average rating of these statements by the participant encountering them ($y = 0.66x + 1.16$, $r^2 = 0.39$, $F_{1,130} = 81.74$, $p < 0.001$). This analysis was performed on an individual level, justified by the explicit statement

not to give ratings strategically because they will not be used later in the game.

Two different situations encountered in the game allowed for the analysis of the response on the gossip written by the participants. First, the participants encountered only a single gossip statement as a basis for their YES/NO decision. For this situation, we grouped the participants according to their subjective rating of the provided gossip (subsequent rating as opposed to the author's rating) and calculated the cooperation level in per cent for each of these seven groups (i.e. gossip rating is 1, 2, 3, 4, 5, 6 or 7). We found that the more positive the participants rated the provided gossip, the higher their cooperation ($y = 9.54x + 8.23$, $r^2 = 0.68$, $F_{1,5} = 10.66$, $p = 0.022$). In a second situation, the participants encountered three different gossip statements. In order to calculate a cooperation level from binary YES/NO decisions, we grouped the participants according to their average rating of the three statements in the following groups: average rating is (i) lower than 2, (ii) between 2 and 3, (iii) between 3 and 4, (iv) between 4 and 5, (v) between 5 and 6, or (vi) higher than 6. Note that the integer numbers belong to the higher interval (e.g. an average rating of 3 would fall in interval (iii)). As before, a higher average gossip rating led to increased cooperation ($y = 12.54x - 7.79$, $r^2 = 0.95$, $F_{1,4} = 71.03$, $p = 0.001$). For both situations (single gossip and three gossip statements), we used the R function 'anova()' to estimate the best model, and for reasons of parsimony kept the simplest, i.e. in both the cases a linear model.

To measure the effect of gossip compared with direct observation, we grouped the participants again according to the number of YES decisions (0, 1, 2, ..., 6 out of six decisions) they were provided with in our control observer IR round (round 10, 11 or 12, depending on the individual random sequence; see §2), and calculated the cooperation levels for these seven groups according to the information regime (i.e. direct observation, single gossip statement or multiple gossip statements; figure 2). To keep our results conservative, we decided to exclude the group of participants who encountered zero YES decisions from the following analysis; the low sample size in this group ($n = 2$; figure 2) would result in a weak representation of the population mean and potentially lead to unjustified conclusions. We then performed a MANOVA with the actual cooperation of a participant's partner as an independent variable and with the cooperation levels according to the information regime as three dependent variables. The reaction of the participants according to the actual cooperation of their partners differed significantly between the information regimes (MANOVA, Wilk's lambda < 0.0005 , $F_{3,2} = 2047.8$, $p < 0.001$). The individual linear responses within each information regime are as follows (figure 2): (i) direct observation ($y = 8.58x + 28.78$, $r^2 = 0.46$, $F_{1,4} = 5.33$, $p = 0.082$), (ii) single gossip statement ($y = 9.80x + 16.09$, $r^2 = 0.61$, $F_{1,4} = 8.85$, $p = 0.041$), and (iii) multiple gossip statements ($y = 13.53x + 2.69$, $r^2 = 0.98$, $F_{1,4} = 207.6$, $p < 0.001$).

Preset gossip rounds (cf. figure 1) were analysed by grouping the participants according to the number and valence (positive, p, or negative, n) of gossip statements they encountered: nnp; np; pp; and ppp (see §2). The analysis of how preset gossip was rated by the participants (using the average rating for several statements

Figure 2. Elicited cooperation based on the observed cooperation or gossip information. Open circles show the percentage of the participants cooperating dependent on the observed cooperation (as the number of YES decisions out of six decisions) of their game partner. Regression line (dotted line): $y = 8.58x + 28.78$, $r^2 = 0.46$, $F_{1,4} = 5.33$, $p = 0.082$. Grey circles represent the resulting cooperation after the original information (x-axis) was transmitted via a single gossip statement (grey line: $y = 9.80x + 16.09$, $r^2 = 0.61$, $F_{1,4} = 8.85$, $p = 0.041$). Black circles represent the resulting cooperation after transmission via three gossip statements (black line: $y = 13.53x + 2.69$, $r^2 = 0.98$, $F_{1,4} = 207.6$, $p < 0.001$). The numbers in brackets indicate sample size for each group. Note that data points are displayed side by side for clarity if they superimposed exactly.

of the same valence) documents a significant difference between designed positive and designed negative statements for each of the five groups (paired t -test, $t_{10} > 9.6$, $p < 0.001$ for each group). Owing to the violation of parametrical test assumptions, non-parametrical tests were used for the between-group analysis of mean gossip ratings. A general test showed significant differences (Kruskal–Wallis chi-squared = 41.77, d.f. = 4, $p < 0.001$) that were further examined using a multiple comparison test (R function 'kruskalmc()'). The following pairs of groups showed significant differences ($n = 22$ for each comparison): nnp-nppp ($p < 0.001$); nnp-npp ($p < 0.001$); np-nppp ($p < 0.001$); and np-npp ($p = 0.002$). For the analysis of the corresponding cooperation levels, a parametrical test was applied and showed a similar picture (overall: $F_{4,50} = 10.890$, $p < 0.001$; significant pairs with each $n = 22$: nnp-nppp, $p = 0.002$; nnp-npp, $p < 0.001$; np-nppp, $p = 0.009$; np-npp, $p < 0.001$); pairs that showed significant differences in mean gossip ratings also showed significant differences in the cooperation level and vice versa. In order to analyse the effect of a change of a single gossip statement's valence, we examined rounds in which triplets of gossip statements were encountered. We compared the following situations: nnn; nnp; np; and ppp. For the extremes (nnn and ppp), we included those participants who rated all three gossips encountered in a gossip IR round (either round 10, 11 or 12; see §2) as either negative (i.e. each rating below 4 for the nnn group) or positive (i.e. each rating above 4 for the ppp group). Between these groups, mean gossip ratings were significantly different (Kruskal–Wallis chi-squared = 35.99, d.f. = 3, $p < 0.001$; with the following significant group differences: nnn-npp, $n = 20$, $p < 0.001$; nnp-ppp, $n = 20$, $p < 0.001$; nnn-ppp, $n = 18$, $p < 0.001$; figure 3). However, although the overall analysis of the corresponding cooperation levels was significant (Kruskal–Wallis

Figure 3. Mean gossip rating and resulting cooperation in rounds in which three gossip statements were encountered. This graph shows the mean (+s.e.) gossip rating (white bars, left y-axis) and the cooperation level (black bars, right y-axis) according to the number and valence (positive, p, and negative, n) of gossip statements encountered. Note that the extreme groups (nnn and ppp) refer to the gossip written by the participants, whereas the intermediate groups (nnp and npp) refer to preset gossip. Different letters show significant differences (each $p < 0.001$) for gossip ratings (white bars), whereas the asterisk marks the significant difference for the cooperation levels (black bars, asterisk indicates $p = 0.005$).

chi-squared = 13.19, d.f. = 3, $p = 0.004$; figure 3), a more detailed analysis did not reveal the same effects (significant group differences: nnp-ppp, $n = 20$, $p = 0.005$). This was due to an unexpectedly high cooperation in the group in which the participants encountered three negative statements (nnn: $50 \pm \text{s.e. } 16.7\%$ cooperation). Furthermore, we found a much higher variance in the extreme groups (mean/variance; nnn: 44/25%, nnp: 32/1%, npp: 71/3%, ppp: 81/12%; Levene's test, $F_{3,36} = 6.70$, $p = 0.001$).

All analyses of the trust game are based on the individual level, justified by the explicit statement that the participants' decisions as a sender and as a recipient will not be used or disclosed in any way later in the game. Overall, the average sender decision was 2.60 euro (s.e. 0.17 euro), which is approximately 44 per cent of the 6.00 euro the senders were endowed with. Note that this result is not biased by the gossip they encountered, because the different gossip conditions (nnnp, nnp, np, npp and nppp) are balanced among all participants. Furthermore, the mean gossip rating across all conditions was close to neutral ($3.9 \pm \text{s.e. } 0.1$).

A detailed analysis showed that the participants' sender decision was positively correlated with mean gossip ratings of the encountered gossip statements ($y = 0.47x + 0.81$, $r^2 = 0.06$, $F_{1,130} = 9.926$, $p = 0.002$; figure 4). Using the grouping according to the gossip condition, as mentioned above, showed an overall effect (Kruskal-Wallis chi-squared = 21.12, d.f. = 4, $p < 0.001$) and the following significant multiple comparison results: nnnp-npp, $n = 55$, $p < 0.001$; nnnp-nppp, $n = 44$, $p = 0.003$. The amount of money sent by a participant in the sender role was positively correlated with the initial cooperation of the participant at the beginning of the game ($t = 3.08$, d.f. = 130, $p = 0.003$). The more cooperative a participant is in IR rounds, the more money he/she sent in the trust game. Note that the correlation between mean gossip ratings and sender decision remains significant after correcting for the senders' cooperation in IR rounds ($y = 0.46x - 1.80$, $r^2 = 0.07$, $F_{1,120} = 10.42$, $p = 0.002$).

Figure 4. Sender decision according to the average rating of encountered gossip. Circle area represents the number of participants who decided accordingly (see the key in the graph). Regression line: $y = 0.47x + 0.81$, $r^2 = 0.06$, $F_{1,130} = 9.926$, $p = 0.002$.

For the analysis of the recipients' decisions, note that the recipients' decisions were not influenced by any gossip. First, we focused on the general return behaviour of the recipients. As a measure for the general return behaviour, we calculated the average return for each possible sender decision as a percentage of the respective tripled sender decision. In this way, a recipient who returns 0, 1, 2, 3, 4, 5 and 6 euro of the possible 0, 3, 6, 9, 12, 15 or 18 euro has a general return behaviour of 33 per cent. A recipient who always returns the total amount received from the sender has a general return behaviour of 100 per cent. The mean general return behaviour of the participants in our study was 29 per cent (s.e. 1.3%). Analysing the recipients' return behaviour according to the amount of money the recipients potentially will receive from the sender, but independent of the actual sender decisions, we found a significant effect (Friedman's chi-squared = 126.23, d.f. = 5, $p < 0.001$). The more money they potentially receive, the higher the fraction they would send back to the sender. Note that the situation where the sender sends 0.00 euro is omitted from the analysis, because the recipients had no choice in this situation. A *post hoc* multiple comparison revealed the following significant differences according to the potential amount sent by the sender (using the R function 'friedmanmc()'; for each difference $n = 44$, 55 or 66 and $p < 0.002$): 1-3; 1-4; 1-5; 1-6; 2-4; 2-5; 2-6; and 3-6. Furthermore, we found the general return behaviour to be positively correlated with the initial cooperation ($t = 3.33$, d.f. = 130, $p = 0.001$) as was the sender decision (see above). Looking at the actual money exchange in the game, the average relative return was 28 per cent (s.e. 1.8%), with 31 per cent of the participants returning more money than the sender originally sent.

4. DISCUSSION

The results of this experimental study support earlier findings about people's behaviour in games of IR and the use of gossip therein: people cooperate more often with cooperators than with defectors (Wedekind & Milinski 2000); people write more positive gossip about cooperators than about defectors (Sommerfeld *et al.* 2007); and people cooperate more with people about whom they read positive gossip than with people about whom they read negative gossip (Sommerfeld *et al.* 2007). This corroborates the hypothesis that gossip is a vector for socially relevant

further information (Nowak & Sigmund 1998, 2005; Mohtashemi & Mui 2003; Panchanathan & Boyd 2003).

Against this background, the present study investigates the effect of multiple gossip statements and the reaction of people encountering them. Our results document that the original cooperation was a significantly better predictor of the participants' responses when they had access to multiple gossip statements, when compared with single statements or direct observation. Whereas in the direct observation regime the original cooperation of the partner accounts for 46 per cent of the variation in the participants' responses, the percentage increases in the single gossip statement regime (61%) and reaches the highest value in the multiple gossip statement regime, where it accounts for 98 per cent of the variation. Thus, the more the gossip was provided, the better it represented the behaviour of the person concerned. Furthermore, gossip even represented this behaviour better than direct observation did. This finding might be connected to an earlier finding that people are influenced by gossip even if they knew hard facts about the other person (Sommerfeld *et al.* 2007). In both the cases, a distinct behaviour has already been judged by other people. Humans might adjust their own behaviour in order not to depart from the public opinion of their local group; they do not want to stand out. Following other people's judgement is potentially easier than making one's own, and might be rooted in a fundamental need to belong (Baumeister & Leary 1995).

In the preset gossip scenarios of this study, where people could base their decision on several preset judgements, we could investigate the effect of a single contrasting gossip statement. In the balanced situation (one positive and one negative statement, i.e. the np group), the participants acted neutrally (average gossip rating of both the statements/s.e. 4.0/0.2; mean cooperation/s.e. 47%/8.4%). In unbalanced situations, people reacted in accordance with the majority of statements: they were more likely to cooperate if the majority of statements were positive, and were more likely to defect if the majority of statements were negative. This indicates that a single gossip statement does not have a strong impact on the donor's decision. Thus, if the valence of most of the gathered gossip is in line with a person's real behaviour, the power of single inaccurate statements is very limited. In this way, cooperators seem to be able to detect defectors reliably by the use of gossip.

However, the present results also indicate that people have more difficulties reacting on an actually clear-cut situation: the variance in responses was higher in situations where the participants had to react on three similar either positive or negative statements than in situations where they encountered a mixture of positive and negative gossip. The highest variance in responses was observed in the all-negative group; it was more than twice as high as in the all-positive group. Somehow, people seem to be reluctant to believe in absolute cooperation or defection. Especially, people facing purely negative gossip showed an unexpectedly high cooperation. They might have told themselves 'he/she can't be that bad'. This finding is in line with a previous finding by Hess & Hagen (2006) who found that people preferred benign alternatives to negative gossip. Furthermore, it is consistent with a previously found dampening effect of gossip (Sommerfeld *et al.* 2007). This dampening effect refers to a discrepancy between

the response upon gossip about a person and the response upon directly observing the same person. Reading gossip, the students cooperated less often with cooperators and more often with defectors than in the situation involving direct observation (Sommerfeld *et al.* 2007). Although the present study does not document a dampening effect in a situation similar to that of the previous study (cf. figure 2), the higher variation in extreme situations (figure 3) and the highly cooperative response towards the all-NO participants (figure 2) still indicate its presence.

The absence of a dampening effect in the data of figure 2 is potentially due to a difference in the design. In our previous study, the participants encountered situations in which they had to write gossip based on only a fraction (i.e. two out of six) of all previous decisions of their partners (in addition to the complete information situation, i.e. facing six out of six decisions). Thus, the participants could not be sure that the gossip they encountered was based on complete information. To adjust for this shortcoming, they might have dampened their response. By contrast, in the present study, the students played only gossip rounds where they knew all of the previous six decisions; they always had complete information and knew that all gossip was based on such. In summary, the following results are known: single gossip statements based on complete information lead to no dampening effect (this study); multiple gossip statements based on complete information lead to no dampening effect (this study); and single gossip statements based on potentially incomplete information lead to a dampening effect (Sommerfeld *et al.* 2007). The missing piece is a situation in which multiple gossip statements are based on potentially incomplete information. This last condition might also approximate the natural situation best. In our everyday life, we are aware that gossip is not fully reliable, owing to our limited possibility for observation. Here, a dampened response does make sense, and obtaining a more precise picture of another person by gathering plenty of gossip might alleviate this dampening effect. Thereby, in situations with only little information, the dampening might be a mechanism to avoid a high cooperation with defectors who seem to be nice and, at the same time, to avoid risking one's own good reputation by defecting against potentially nice people who seem to be bad.

In the trust game of the present study, the participants behaved, in general, similarly as in previous studies implementing the trust game and rewarded trust (Berg *et al.* 1995; Cox 2004; Sutter & Kocher 2007). In addition, our results document that reputation gained via reciprocating also helps in the trust game; the sender decisions were strongly influenced by the gossip that was based on reciprocating behaviour (figure 4). This shows the strong relationship between reciprocity, trust and reputation as described by Ostrom (1998). People who reciprocate often gain a high reputation that results in high perceived trustworthiness, which is, in turn, more likely to be honoured by these people. These positively reinforcing interrelations may have fostered the evolution of cooperation (Bravo & Tamburino 2008).

Surprisingly, the sender decision was positively correlated with the basic cooperative behaviour of individuals; the cooperative participants sent more money to their recipients and were thus more trustful. This finding might be connected to a general attitude towards investing/

handling money, affecting both IR and trust game situations. In addition, it might be connected to an inner assumption about the recipient's behaviour (Dawes et al. 1977). As Orbell & Dawes (1991) pointed out, cooperators generally expect a higher cooperation in their environment (in this case the recipient) than defectors do (see also Croson 2007).

In conclusion, our results document that multiple gossip statements optimize human responses in a way that cooperation can be more accurately directed towards cooperators. Furthermore, we showed that single inaccurate statements have only limited power to influence people's responses. Given this and the fact that people react on other's reputation transferred via gossip, important prerequisites allowing for the high levels of cooperation are met (Bravo & Tamburino 2008). Furthermore, as proposed by Ostrom (1998), reputation seems to be universal, at least in our experimental settings, and tightly connects trust and reciprocity. This connection might have led to an upward spiral increasing cooperative behaviour to the level we experience it today, in modern societies.

Nonetheless, our design represents a benign world without any incentive for gossip authors to cheat. Apparently, the real world is different, and future research needs to investigate the power of gossip in situations where cheaters might profit from lying.

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