INDIRECT RECIPROCITY AND PROSOCIAL BEHAVIOUR: EVIDENCE FROM A NATURAL FIELD EXPERIMENT*

Short title: Indirect Reciprocity and Prosocial Behaviour

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Some of the greatest human achievements are difficult to imagine without prosociality. This paper employs a natural field experiment to investigate indirect reciprocity in natural social interactions. We find strong evidence of indirect reciprocity in one-shot interactions among drivers. Subjects for whom other drivers stopped were more than twice as likely to extend a similar act to a third party. This result is robust to a number of factors including age, gender, social status, presence of onlookers, and the opportunity cost of time. We provide novel evidence for the power of indirect reciprocity to promote prosocial behaviour in the field.

Daily life is difficult to imagine without prosociality: children who never share toys, partners who never contribute to the household, friends who never buy birthday gifts, professors who never referee, wealthy people who never support the poor, or drivers who never give way. The pervasiveness of prosocial behaviour in such widely different everyday human interactions suggests multiple underlying motivations. Folk theorems (Friedman, 1971) show that such interactions can be explained by self-interest if they are repeated. In addition, models of altruism (Andreoni, 1990), reciprocity (Rabin, 1993; Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006), and social preference (Levine, 1998; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002) provide explanations for prosocial behaviour among strangers where opportunities to reciprocate are limited. A large body of experimental research provides insights into the relative importance of these motivations in different environments (Engelmann and Strobel, 2004; Falk *et al*., 2008; Leibbrandt and Lopez-Perez, 2012).

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This paper studies the relevance of a different explanation for prosocial behaviour: *indirect reciprocity* (Alexander, 1987). In contrast to explanations arguing that social comparisons, warm glow, intentions, or beliefs trigger prosocial behaviour, indirect reciprocity assumes that past encounters affect prosocial behaviour. More precisely, the idea is that you exhibit prosocial behaviour because somebody else has exhibited prosocial behaviour towards you (*upstream* indirect reciprocity) or that you receive prosocial behaviour because you have exhibited prosocial behaviour towards somebody else (*downstream* indirect reciprocity). There is substantial theoretical work on both types of indirect reciprocity, which shows that they can explain prosocial behaviour in large populations that are typical of modern societies (Boyd and Richerson, 1989; Kandori, 1992; Nowak and Sigmund, 1998*a,b*; Leimar and Hammerstein, 2001; Panchanathan and Boyd, 2004; Nowak and Sigmund, 2005; Christakis and Fowler, 2009). However, empirical evidence on the relevance of indirect reciprocity in everyday social interactions is lacking.

Our paper provides initial insights into the role of indirect reciprocity in everyday social interactions using a natural field experiment. The chosen field setting represents a paradigm of modern societies: it affects many members on a frequent basis, interactions mainly take place between strangers, and cooperation is essential to prevent breakdown. We investigate prosocial behaviour in the traffic environment of a large urban car park.[1] More specifically, we study the likelihoods with which drivers give up their right of way and stop to help other drivers in two experimental treatments. In the indirect reciprocity treatment, we observe the likelihood with which drivers give way to an experimenter after another experimenter yields right of way to them. We compare this to our baseline treatment, where we simply observe the likelihood with which drivers voluntarily give way to an experimenter. By comparing these two treatments, we can infer the relative importance of indirect

[1] We are not the first to consider traffic situations as an ideal setting to study reciprocity. For example, Cox (2000) provides anecdotal evidence on indirect reciprocity in traffic situations and refers to Jim Engle-Warnick, who while riding the bus observed that bus drivers frequently extended courtesies to others on the road.

reciprocity as compared to unconditional generosity. At the same time, by capturing the details of the traffic environment, we are also able to say something about the robustness and motivations underlying upstream indirect reciprocity.

We find that subjects are more than twice as likely to act generously and stop after someone else has stopped for them. Thus, we provide causal evidence for indirect reciprocity as a powerful force for motorists to give up their right of way and find it to be more potent than unconditional generosity in our field setting. Moreover, we show the impact of indirect reciprocity on stopping behaviour to be robust to the level of traffic congestion as well as the physical distance travelled since receiving the kind act, and that the stopping rate is not affected by the presence of co-passengers.

Studying indirect reciprocity in everyday situations among strangers is extremely difficult. First, it involves a triadic experimental design where experimenters can manipulate past social interactions and record the impact on future interactions. Second, it involves creating opportunities for indirect reciprocity in a setting where participants can associate the link between past and future social interactions. Finally, to show the relevance of indirect reciprocity in modern societies where social interactions take place among strangers, it involves a design where reputation concerns are limited.

The contribution of the present study is to test the role of indirect reciprocity in such an environment that is typical of everyday life. More generally, we present the first field experiment on indirect reciprocity involving actual person-to-person prosocial encounters. We are aware of only two recent field studies which attempt to measure the effects of indirect reciprocity and other related concepts in the field (Yoeli *et al*., 2013; Van Apeldoorn and Schram, 2016).

Van Apeldoorn and Schram (2016) examine downstream indirect reciprocity in an online platform where participating members can repeatedly ask for and offer services (namely, travel tips and guidance) to each other free of monetary charge. The presence of downstream reciprocity is measured by estimating the probability of receiving help (as a fellow traveller) after help has been offered by oneself. The authors find that a service request is more likely to be granted to member profiles with a positive history of service provision. Thus, the accumulated reputation of participants plays a key role in this online community.

Similarly, Yoeli *et al*. (2013) test the role of publicity and reputational concerns in promoting large-scale prosocial behaviour. In their study, individual residents participate in a real-world public goods game by deciding whether or not to support their local energy demand response program that is designed to prevent blackouts. The authors implement two experimental treatments by varying if local residents can identify which person from their building complex signed up for the program. They find that participation rates are three times higher in the observable treatment, a finding that is similar to other studies showing that making people's contributions to public goods observable increases overall contribution levels (Alpizar *et al*., 2008; Lacetera and Macis, 2010).

Our study contrasts with these two studies as we investigate upstream indirect reciprocity where individuals help others not because of their reputation but because they were helped before. Upstream indirect reciprocity is based on a recent positive experience and does not require the decision maker to have any information about the prosocial preferences of the person whom she may help. To the best of our knowledge, the employed design is the first to capture indirect reciprocity in a natural social interaction between strangers who are able to explicitly, and always in real time, experience the kind actions of others and then immediately have the opportunity to reciprocate the same act of kindness for someone else. We believe that our experimental design studies one of the most common and simple examples of indirect reciprocity.

The observed indirect reciprocity in our setting is consistent with gratitude (Emmons and McCullough, 2004; Bartlett and DeSteno, 2006; Grant and Gino, 2010); a 'sentiment which most immediately and directly prompts us to reward'. (Smith, 1976, p.68) Moreover, from an evolutionary perspective, the decision to reciprocate can also be reconciled with self-interest in the form of misdirected acts of gratitude based on group or societal fitness. In our indirect reciprocity treatment, the subject helps others because she has been helped, and keeps helping as long as she receives help, leading to increased levels of cooperation. Since the anonymous one-shot interactions that we study involve strangers who do not have repeated encounters and no effective ways to communicate information about others (i.e., the probability of knowing someone's reputation is close to zero), Rand and Nowak (2013) argue that such patterns of upstream reciprocity cannot explain the evolution of cooperation, but rather that the concept itself is a by-product of natural selection for reciprocal cooperation. That is, since cooperation via direct or indirect reciprocity can be beneficial to human groups over time, we may have emotionally internalised such behaviours and may even act in a reciprocal manner when the future rewards are unclear.

The present study also complements field experiments on the role of direct reciprocity in bilateral interactions (Gneezy and List, 2006; List 2006; Falk, 2007; Bellemare and Shearer, 2009) and laboratory experiments on indirect reciprocity (Dufwenberg *et al*., 2001; Bolton *et al*., 2005; Greiner and Levati, 2005; Seinen and Schram, 2006; Engelmann and Fischbacher, 2009; Servátka, 2009), as well as conditional cooperation (Keser and Van Winden, 2000; Fischbacher *et al*., 2001; Croson *et al*., 2005; Kocher *et al*., 2008; Martinsson *et al*., 2013).[2] Our work is furthermore closely related to experimental studies on indirect punishment (Rockenbach and Milinski, 2006; Ule *et al*., 2009; Carpenter and Matthews, 2012; Balafoutas *et al*., 2014).

Overall, the paper has at least two important implications. First, it shows that indirect reciprocity can reduce waiting times and affect traffic flow and thus social welfare. Second, it

[2] See Charness *et al*. (2011) for an excellent summary of the experimental literature on indirect reciprocity. For laboratory evidence of direct reciprocity, where agents engage in repeated bilateral interactions, see, for example, Roth *et al*. (1991), Andreoni and Miller (1993), Fehr *et al*. (1993), Berg *et al*. (1995), Cooper *et al*. (1996), and Dufwenberg *et al*. (2001). Alpizar *et al*. (2008) and Shang and Croson (2009) are recent examples of field experiments on conditional cooperation.

suggests that indirect reciprocity can account for a large share of prosocial behaviour that may have otherwise been imprecisely labelled as unconditional generosity.

1. Experimental Design

We conducted a field experiment in a large metropolitan city in Australia. Figure 1 illustrates the field setting: a shopping village car park area with more than 350 parking spaces that consists of a main road connected to eight side-paths forming seven t-intersections. The selected shopping village is visited by several thousand individuals each weekend from different parts of the city, resulting in a very high turnover of temporary car park space occupants. Data was collected on weekends, i.e. Saturdays and Sundays, and during the busiest period of the day (between 11am and 3pm) between September 2013 and February 2014.

To measure the presence and relative importance of indirect reciprocity in this environment, we used two experimental treatments (*baseline* and *indirect reciprocity*), which we conducted with the help of experimenters. The baseline treatment captured the average baseline level of generosity. The indirect reciprocity treatment captured the baseline level of generosity and the additional level of generosity triggered after the subjects experienced a generous act. Thus, the difference in generosity across treatments can be attributed to indirect reciprocity. We next describe the two experimental treatments in more detail.

1.1. Baseline Treatment

Figure 2a illustrates the two-person interaction in the baseline treatment. The observed interaction consists of the waiting individual (Experimenter A) and the decision maker (Subject). The aim of the baseline treatment was to measure the average level of generosity, or prosocial behaviour, by observing the rate at which random passers-by stopped and helped by giving way to our waiting experimenter. Experimenter A was waiting at the first t-intersection (Lane 1) when a subject approached (see Figure 1). A binary observation was recorded after a subject approached Experimenter A and either 'stopped' or 'did not stop'. Observations in the baseline treatment were only counted when the path in front of the subject was strictly clear of any other interactions. That is, the subject was not stopped for by another driver prior to approaching Experimenter A, and he/she did not stop, or was even close to stopping, for someone else from the previous (higher numbered) lanes. This was ensured by the waiting Experimenter A and associated research assistants who video recorded the interactions.

1.2. Indirect Reciprocity Treatment

Figure 2b illustrates the three-person interaction in the indirect reciprocity treatment. Experimenter A was again positioned inside the waiting vehicle in Lane 1. The second experimenter (Experimenter B) repeatedly entered the main connecting path through the last lane (Lane 8) and slowly approached each of the remaining six t-intersections, casually observing whether there was a subject waiting to enter the main road. The speed of travel undertaken by Experimenter B was 15-30 km/h, as determined by the local car park traffic rules and traffic on the main path. The initial interaction between Experimenter B and the subject could take place at any of the six available t-intersections (Lanes 2 to 7 in Figure 1). This range and natural variation in initial interactions was possible because Experimenter A was always positioned and waiting in Lane 1. In each instance, when Experimenter B approached a waiting subject, the former was instructed to stop and allow the subject to enter the main path. The subject then had the opportunity to reciprocate the same act of generosity for Experimenter A, and again we recorded each observation using the binary indicator: 'stopped' or 'did not stop'. Similar to that in the baseline treatment, observations in the indirect reciprocity treatment were only counted when the subject had no interaction with any other drivers, other than Experimenter B, prior to approaching the waiting Experimenter A.

Experimenters A and B both drove middle-class vehicles throughout the experiment.[3] There were two experimenters, one middle-aged woman and one middle-aged man, and we varied the gender of the experimenters by switching their roles. There were no other individuals inside the experimenter vehicles. Subject decisions and the surrounding environment were recorded by a video camera concealed inside Experimenter B's vehicle.[4] Experimenters A and B also communicated via mobile phones on speaker to voice record each observation. This renders the data collection process transparent and easy to verify when viewing the recorded footage and classifying each observation.

We were able to observe each subject's decision, gender, approximate age, and social class, as well as the weather conditions. In addition, we recorded whether any co-passengers were present in the subject's automobile, as their presence may have influenced the subject's generosity if she expected that her reputation would be affected by her choice. Lastly, we also recorded the level of traffic congestion ('speed of movement'), which was categorised depending on the presence of two or more other vehicles being naturally positioned at the end of the main path, forcing subjects to slow down as they approached the waiting experimenter. This variable also captured the subject's opportunity costs, as the given field infrastructure allowed the subject to quickly go past Lane 1 and simply ignore the waiting experimenter if the road was free, and thus save more time than when the road was busy.

Specifically related to the indirect reciprocity treatment, we also collected information on the physical distance between the subject's initial interaction with Experimenter B and the

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[3] This classification is based on automobile values taken from RedBook.com.au (a vehicle valuation and information source in Australia, which is equivalent to the Kelley Blue Book publically available from the United States: www.kbb.com). The vehicles driven by our experimenters (2009 VW Polo and 2010 Toyota Corolla) were approximately valued between AUD$15,000 and AUD$20,000. We used the same online valuation source to confirm the recorded social class/status classifications of the vehicles occupied by subjects.

[4] During the baseline treatment, the interaction between the subject and Experimenter A was video recorded from a vehicle parked close by in the same lane (Lane 1 in Figure 1).

waiting Experimenter A (by recording the lane number from which the subject was allowed onto the main path). There were six different distances available, in increments of roughly 17 metres, resulting in measured lengths between 17 metres (if the subject was let in from Lane 2) and 102 metres (if the subject was let in from Lane 7). This information enabled us to study whether the propensity to reciprocate a generous act was dependent on physical distance, a proxy for the time elapsed since receiving the favour.

Even though each subject-experimenter pairing was naturally random (i.e., once a subject left the parking area, they were very unlikely to come back and encounter our experimenter again), we avoided any potential suspicion raised by anyone monitoring the area (for prolonged periods of time) by instructing the experimenters to regularly take short breaks between interactions (e.g., by parking the vehicle for some time before entering the lanes again). Also, in the case when Experimenter A was denied the kind act and had no new subjects approaching, the experimenter would move along and not stay stationary at the t-intersection for any noticeable amount of time. This procedure was also followed because there could have been other visiting commuters waiting to exit Lane 1 behind Experimenter A. In any case, given the very large number and turnover of visitors to the chosen area, repeated encounters with an experimenter were never an issue.

2. Experimental Findings

2.1. Descriptive Overview

Table 1 presents a summary of subject and field characteristics by experimental treatment. In total, there were 316 individuals in our sample. Of our subjects, 71% were men and 39% were estimated to be mature (>40 years old). A co-passenger was present with a 47% probability. The weather was clear 77% of the time, and the speed of movement was slow during 20% of the interactions. We observed no significant treatment differences in gender, age, presence of co-passengers, weather conditions or speed of movement, suggesting that treatment randomisation was successful. Social class, however, was lower in the baseline than in the indirect reciprocity treatment ($p = 0.013$). We control for social class in all of our formal regressions.

2.2. The Role of Demographic and Field Variables

Table 2 provides a detailed look at the generosity rates conditional on subject and field characteristics. In the baseline treatment, we observed that speed of movement was an important determinant for stopping behaviour. If the road was clear only 4% stopped, whereas 56% stopped if the road was busy ($p < 0.001$, Fisher's exact test, two-sided). In addition, we observed that men were statistically as likely to stop as women (18% *versus* 7%; $p = 0.130$), and that drivers in better automobiles (higher social class) tended to stop more often than drivers in less valuable automobiles (20% *versus* 10%; $p = 0.072$). We found no evidence that the presence of a co-passenger affected stopping. Drivers with co-passengers were not more likely to stop than drivers without co-passengers (14% *versus* 15%; $p = 0.825$). Similarly, age and weather conditions did not seem to matter for stopping behaviour ($p > 0.290$).

The impact of our subject and field characteristic variables was qualitatively similar in the indirect reciprocity treatment. In particular, we observed that stopping was much less likely if the road was clear than if the road was busy ($p < 0.001$, Fisher's exact test, two-sided). Men were more likely to stop than women, but again this gender difference was not statistically significant (34% *versus* 26%; $p > 0.270$). There were very small differences in the likelihood of stopping conditional on social class (2 percentage points; $p > 0.860$), while age and weather conditions were also unimportant. Interestingly, as in the baseline treatment, the presence of a co-passenger had no impact on generosity in the indirect reciprocity treatment ($p = 0.495$). The insignificant impact of the co-passenger variable in both treatments suggests that reputational concerns towards co-passengers are unimportant in these environments.[5]

Table 3 presents three probit models to further shed light on the role of demographic and field-specific variables in the baseline (model 1) and indirect reciprocity treatments (models 2 and 3). The most important covariate was again the level of congestion ($p < 0.001$). In addition, we found that the gender difference was more pronounced and robust in these models after controlling for the full set of collected variables. Men were much more likely to stop both in the baseline ($p = 0.012$, model 1) and indirect reciprocity treatments ($p < 0.010$, models 2 and 3). Perceived social class had a statistically significant impact on helping behaviour only in the baseline treatment, with lower-status individuals being 14 percentage points less likely to give way than higher-status individuals ($p = 0.005$, model 1). Such a status effect was not apparent in the indirect reciprocity treatment, with a statistically insignificant estimated coefficient ($p > 0.150$, models 2 and 3). None of the other variables were significantly related to stopping behaviour. Model 3 accounted for potential non-linear effects of distances travelled on reciprocal behaviour in the indirect reciprocity treatment. We did not find that the propensity to reciprocate depended on the physical distance, as none of the included distance dummies were statistically significant at conventional levels ($p > 0.170$ for each indicator, model 3).

2.3. Overview of Treatment Differences

Figure 3 illustrates the likelihood of stopping in both experimental treatments and visualises the strength of indirect reciprocity. Of the subjects, 14.6% (n = 157) stopped in the baseline treatment. In the indirect reciprocity treatment, however, 32.1% stopped (n = 159),

[5] One might also argue that reputational concerns are higher in the indirect reciprocity treatment because a car (with Experimenter B) was always following the subject. However, in Table 3 (model 1) we find that the presence of a car behind the subject (variable *Commuter Behind*) had no significant impact on the generosity rate in the two-person baseline treatment. This provides evidence that the presence of a car behind the subject does not explain the treatment difference.

and thus the generosity rate increased by 119%, a highly significant treatment difference ($p < 0.001$, Fisher's exact test, two-sided). That is, individuals demonstrated a significantly higher propensity to act in a prosocial manner after receiving the same positive act.

2.4. Robustness and Drivers of Treatment Differences

Figure 4 illustrates the robustness of the treatment differences. More precisely, the subfigures illustrate the findings with regard to distance travelled in the indirect reciprocity treatment (4a), the presence of a co-passenger (4b), speed of movement (4c), and the gender of the driver (4d). Figure 4a provides evidence that indirect reciprocity was robust to the physical distance travelled, or time elapsed, since being helped. No matter whether the physical distance was short (no lane in between, $n = 46$), medium (one or two lanes in between, $n = 72$), or long (at least three lanes in between, $n = 41$), the observed act of giving was always at a rate over 30% and thus more than twice as likely than in the baseline treatment ($p < 0.015$ for each of the three comparisons).

Figure 4b shows that the large treatment difference existed regardless of the presence of co-passengers. Figure 4c shows that the treatment difference was robust to the level of congestion (4% *versus* 20% stopping if the speed of movement was fast; $p < 0.001$, $n = 253$; and 56% *versus* 81% stopping if the speed of movement was slow; $p = 0.058$, $n = 63$, Fisher's exact tests). Finally, Figure 4d shows that the treatment difference was significant both for men and women ($p < 0.025$ for each comparison).

To further test the robustness of the treatment difference, we estimated probit regression models in which we regressed the subject's decision (whether or not to act generously) on a dummy variable for treatment, the set of observed characteristics, and their interactions. Table 4 corroborates the previous findings and shows that our results are robust to the inclusion of demographic and field variables. The estimated marginal effects in Table 4 indicate that subjects were on average around 17 percentage points more likely to act in a prosocial manner in the indirect reciprocity (IR) treatment compared to the baseline treatment ($p < 0.001$, models 1 and 2). The above estimate is robust to the inclusion of important field-specific controls, in particular, the speed of movement or busy period dummy, which attracts quite a large and statistically significant coefficient. Men were estimated to be 16 percentage points more likely to stop than women ($p < 0.001$, model 2). In the same regression, subjects occupying low-status automobiles were predicted to be around 12 percentage points less likely to provide the favour than those in higher-status automobiles ($p = 0.004$, model 2). In the final column of Table 4, we included a series of interaction terms between the indirect reciprocity treatment dummy and each control variable in order to test for heterogeneity in reciprocal behaviour. The insignificant coefficient estimates indicate a lack of between-group differences in generosity across the two experimental treatments.

3. Concluding Remarks

Theoretical work on indirect reciprocity has received considerable attention in the social sciences as it offers an explanation for prosocial behaviour even when interactions mainly take place between strangers. Our study provides new field experimental evidence on the role and robustness of indirect reciprocity in everyday social interactions. The findings suggest that upstream indirect reciprocity plays a crucial role for prosocial behaviour among random drivers, as subjects are more than twice as likely to stop for others if someone else has stopped for them.

Our study also provides some insights into the ultimate mechanisms behind indirect reciprocity. Most theoretical work assumes that indirect reciprocity is a strategy to build reputations and thus driven by self-interest. However, there is also theoretical (Nowak and Roch, 2007) and experimental laboratory evidence (Engelmann and Fischbacher, 2009) showing that indirect reciprocity is complemented and driven by non-selfish motivations. Moreover, while many theoretical models are able to explain downstream reciprocity quite well, the same is not true for acts of upstream reciprocity where a person who has just received help feels the need to help someone else (see Boyd and Richerson, 1989; Brandt and Sigmund 2006).

Our findings suggest that self-interest plays an important role for prosocial behaviour in the given field setting, but that it is unlikely that self-interest is the sole driver for indirect reciprocity. In particular, we find that the estimated treatment difference is robust to our measures of opportunity costs and reputation concerns. However, we cannot rule out that indirect reciprocity is a result of trigger strategies that prescribe stopping for others as long as others stop for me (Nowak and Sigmund, 2005). Such trigger strategies may also be supported by a social norm of stopping, where seeing someone stop and help creates awareness of this norm.

Importantly, our findings are consistent with the idea that received acts of generosity affect emotions, which in turn increase the likelihood of generosity (Smith, 1976). Such observed acts of misdirected generosity in one-shot anonymous field interactions, where unrelated participants gain no future benefits, can be reconciled from an evolutionary perspective as a consequence of natural selection for reciprocal cooperation which has over time left a mark on human emotions (Rand and Nowak, 2013). Thus, while interacting individuals sometimes only witness each other once and have no strong concerns about their reputation, they still feel indebted, and are arguably shaped, to pass on such prosocial acts received from others to the next person.

The study reveals some of the first natural field evidence that humans behave in an upstream reciprocal manner. Moreover, the general findings confirm much of the existing laboratory literature on the presence of indirect reciprocity (e.g., Dufwenberg *et al*., 2001; Greiner and Levati, 2005). While it is difficult to directly compare our field findings with those from the laboratory, our observed indirect reciprocity treatment effect of 119% broadly suggests the power of indirect reciprocity for promoting prosocial behaviour in the field to be just as high as, and even higher than, inside the lab.

In terms of collective welfare, we provide evidence that indirect reciprocity can lead to higher levels of prosocial behaviour among drivers and hence reduce waiting times. Such welfare enhancing effects are perhaps most apparent for agents interacting during busy periods when potential idle times can be very long. While the same profound effect sizes may not hold in non-busy periods, it still remains a possibility that undisrupted chains of upstream indirect reciprocity, beyond our physically-confined experimental ground, would similarly lead to reduced downtimes and overall gains in social welfare. That is, while the average level of cooperation in the indirect reciprocity treatment is found to be much lower during non-busy than busy periods (20% *versus* 81%), our findings still demonstrate that indirect reciprocity boosts prosocial behaviour substantially more during non-busy times (a change in the stopping rate from 0.04 to 0.20 for non-busy periods, and from 0.56 to 0.81 for busy periods). Indirect reciprocity then leads to as much as a fivefold increase in the level of prosociality even at times when the opportunity cost of stopping and helping others is relatively high.

We end with some ideas for future research on indirect reciprocity. First, it would be interesting to directly test the role of emotions for indirect reciprocity. Second, it seems of crucial importance to know how robust indirect reciprocity is over longer time spans. While our finding that indirect reciprocity is robust over a short period of time suggests that indirect reciprocity is not simply driven by a reflex to mimic the behaviour of others, we still do not know whether indirect reciprocity remains a driving force for prosocial behaviour if, for example, meanwhile one has experienced other unrelated kind or unkind acts. Third, it seems important to explore potential covariates of indirect reciprocity in the studied and other similar environments. For example, the social status of each interacting agent may determine the propensity to reciprocate such natural acts of kindness.

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Additional Supporting Information may be found in the online version of this article:
Data S1.

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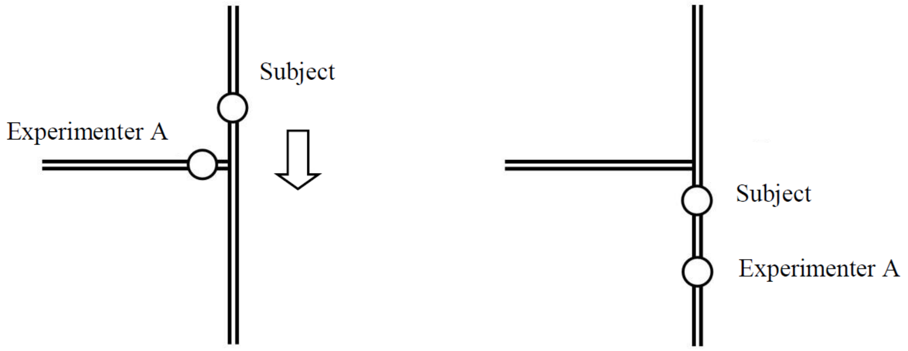
Fig. 1. *Field Setting*

Notes. The field experiment was conducted in a large shopping village car park area in the city of Brisbane, Australia. The area consisted of a main lane or path that was connected to eight perpendicular lanes (numbered from ‘1’ to ‘8’) forming seven separate t-intersections. Experimenter B (top right) would enter the main path from Lane 8 and approach each sequential t-intersection, stopping for a potential subject (as identified in Lanes 3 and 6, for example) travelling towards the Exit/Destination (marked in the top-left corner). Experimenter A was positioned at the end of Lane 1 (top left), waiting to be allowed onto the main path by approaching subjects.

(a) Baseline Treatment



(b) Indirect Reciprocity Treatment

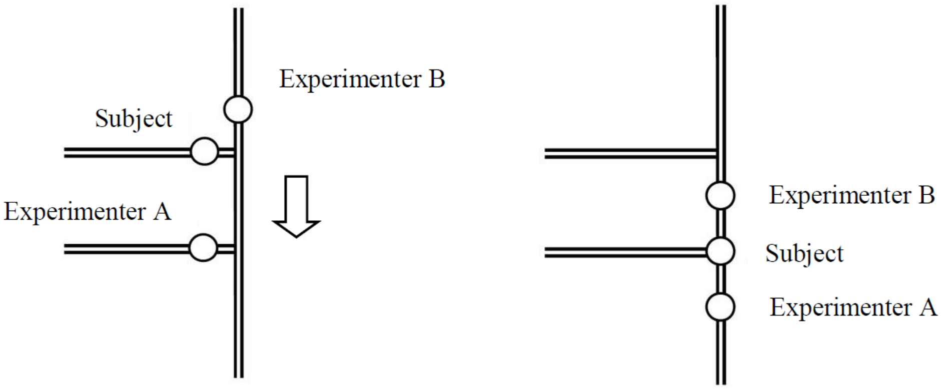


Fig. 2. *Baseline Generosity and Indirect Reciprocity Treatments*

Notes. Baseline treatment (two-person interaction) is illustrated in the top panel (a). Here, the left-hand side subfigure illustrates the initial interaction between the Subject and Experimenter A. The right-hand side subfigure illustrates the outcome following prosocial behaviour, in which the Subject stops and helps by giving way to Experimenter A. Indirect reciprocity treatment (three-person interaction) is illustrated in the bottom panel (b). Here, the left-hand side subfigure illustrates the initial interaction between Experimenter B, the Subject, and Experimenter A. The right-hand side subfigure illustrates the outcome following *upstream* indirect reciprocity, in which Experimenter B first stops and gives way to the Subject, and then the Subject (recipient of the kind act) stops and helps by giving way to Experimenter A (a third party not involved in the initial interaction).

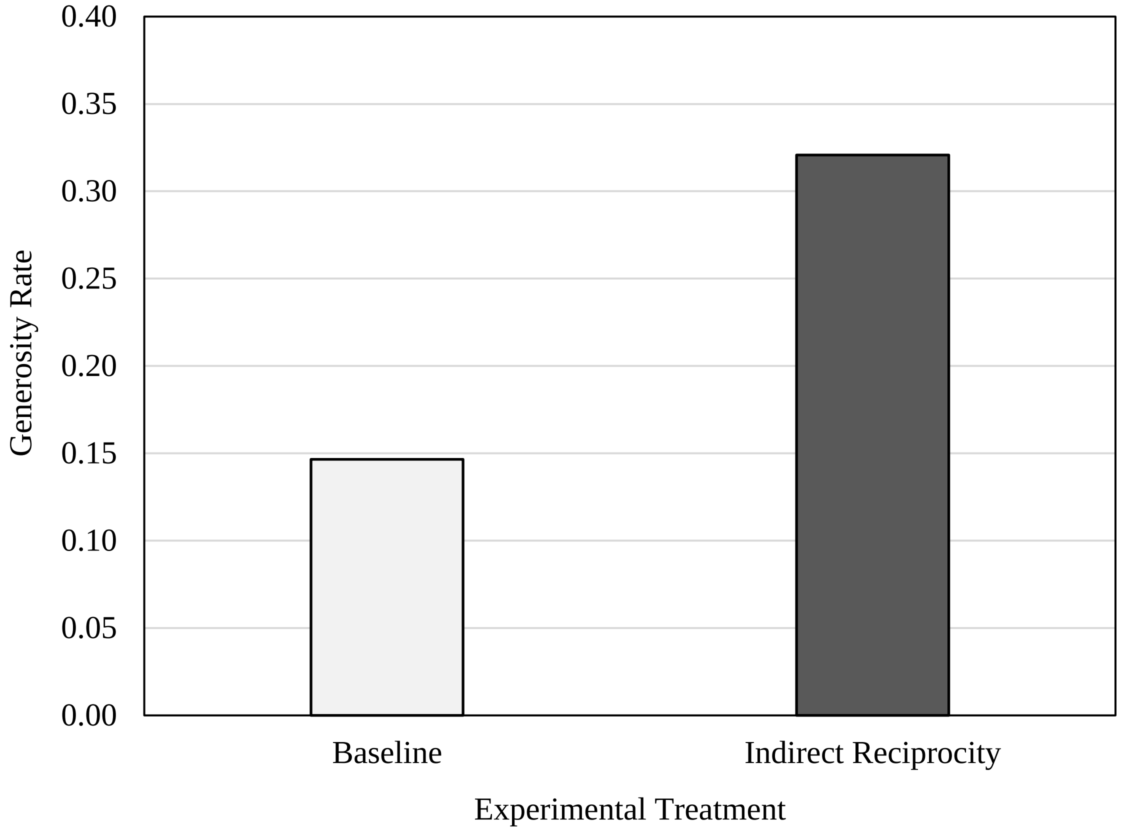


Fig. 3. *Generosity Rate, by Experimental Treatment*

Notes. The light (white) bar shows the generosity rate (vertical axis) in the two-person interaction (Baseline treatment). The dark (grey) bar shows the generosity rate in the three-person interaction (Indirect Reciprocity treatment). The observed treatment difference of 119% is statistically significant at the 1% level (Fisher's exact test).

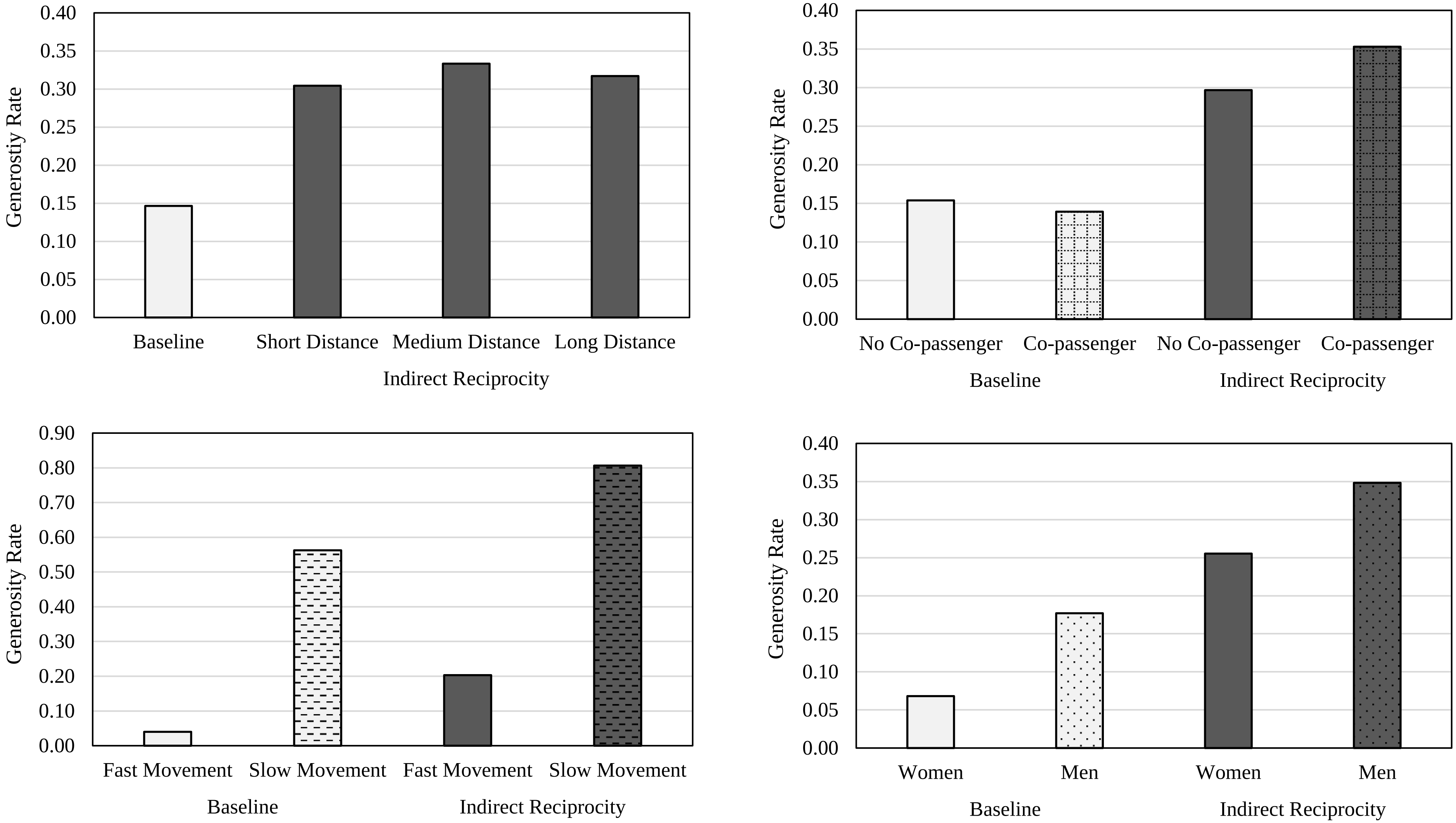


Fig. 4. *Robustness of Indirect Reciprocity, by Subject and Field Characteristics*

Notes. Proportion of subjects who decided to stop for the waiting experimenter: (a) by treatment and physical distance from initial interaction, (b) by treatment and co-passenger presence, (c) by treatment and speed of movement, (d) by treatment and gender. The light (white) bars show the generosity rate (vertical axis) in the Baseline treatment. The dark (grey) bars show the generosity rate in the Indirect Reciprocity treatment.

Table 1

Subject and Field Characteristics, by Experimental Treatment

Variable	Description	Baseline		Indirect Reciprocity	
		Mean	SD	Mean	SD
Gender	= 1 if Male	0.72	(0.45)	0.70	(0.46)
Perceived age	= 1 if Mature (> 40 years old)	0.40	(0.49)	0.38	(0.49)
Perceived social class	= 1 if Low	0.53	(0.50)	0.38	(0.49)
Co-passengers present	= 1 if Yes	0.50	(0.50)	0.43	(0.50)
Weather conditions	= 1 if Clear	0.78	(0.42)	0.77	(0.42)
Speed of movement	= 1 if Slow (busy period)	0.20	(0.40)	0.19	(0.40)
Distance travelled after receiving generous act	= 1 (shortest) to 6 (longest)	-	-	2.50	(1.36)
n		157		159	

Notes. *Perceived social class* was defined by the type, oldness and quality of automobile driven by the subject. Initial coding and recorded video footage was reviewed and verified by research assistants, as well as by using public information available at the online automobile valuation authority (RedBook.com.au). *Speed of movement* (or *busy period)* = 1 if two or more other vehicles were positioned at the end of the main road; forcing the subject to slow down as he/she approached the waiting experimenter. *Distance travelled* is the (scaled) physical distance between the subject's initial interaction with Experimenter B (where the latter provided the generous act to the former) and consequent interaction with the waiting Experimenter A. Relative frequency of distances travelled by subjects since receiving the generous act (for *Indirect Reciprocity* treatment only): Distance 1 (29%), Distance 2 (29%), Distance 3 (16%), Distance 4 (17%), Distance 5 (6%), Distance 6 (3%).

Table 2

Generosity Rate, by Subject Group and Experimental Treatment

	Baseline				Indirect Reciprocity			
	n	Mean	SD	Test of difference	n	Mean	SD	Test of difference
Overall	157	0.15	(0.35)		159	0.32	(0.47)	
Males	113	0.18	(0.38)		112	0.34	(0.48)	
Females	44	0.07	(0.25)	0.13	47	0.26	(0.44)	0.27
Young	94	0.14	(0.35)		99	0.32	(0.47)	
Mature	63	0.16	(0.37)	0.82	60	0.32	(0.47)	0.99
Low social class	83	0.10	(0.30)		61	0.31	(0.47)	
High social class	74	0.20	(0.40)	0.07	98	0.33	(0.47)	0.86
Co-passengers present	79	0.14	(0.35)		68	0.35	(0.48)	
Co-passengers not present	78	0.15	(0.36)	0.83	91	0.30	(0.46)	0.50
Normal speed of movement	125	0.04	(0.20)		128	0.21	(0.40)	
Slow speed of movement	32	0.56	(0.50)	0.00	31	0.81	(0.40)	0.00
Clear weather	122	0.16	(0.37)		122	0.32	(0.47)	
Cloudy or rainy weather	35	0.09	(0.28)	0.29	37	0.32	(0.48)	0.99

Notes. Test of difference between sample proportions is based on the two-sided Fisher's exact test. Resulting *p*-values are reported in the last column for each treatment.

Table 3

Regression Analysis of Generosity in the Baseline and Indirect Reciprocity Treatments

	(1)	(2)	(3)
Male	0.128**	0.185***	0.185***
	(0.051)	(0.071)	(0.070)
Mature	-0.028	-0.027	-0.043
	(0.039)	(0.063)	(0.062)
Low social class	-0.140***	-0.086	-0.087
	(0.050)	(0.065)	(0.063)
Co-passengers present	0.022	-0.002	0.009
	(0.037)	(0.063)	(0.063)
Busy period	0.296***	0.526***	0.537***
	(0.036)	(0.055)	(0.060)
Clear weather	-0.007	-0.029	-0.028
	(0.049)	(0.068)	(0.070)
Commuter behind	0.051		
	(0.041)		
Distance 2 dummy			0.035
			(0.078)
Distance 3 dummy			-0.034
			(0.104)
Distance 4 dummy			0.028
			(0.095)
Distance 5 dummy			0.117
			(0.113)
Distance 6 dummy			-0.293
			(0.216)
n	157	159	159

Notes. ***p<0.01, **p<0.05, *p<0.10. Probit model. Dependent variable is *acted generously*. The coefficients represent average marginal effects. Robust SEs in parentheses. Model (1) corresponds to the baseline treatment, n=157. Models (2) and (3) correspond to the indirect reciprocity treatment, n=159. *Acted generously* = 1 if the subject stopped and gave way to the waiting individual (Experimenter A), 0 otherwise. *Male* =1 if subject was male, 0 otherwise. *Mature* = 1 if perceived age of subject was >40 years, 0 otherwise. *Low social class* = 1 if subject drove low-valued vehicle, 0 otherwise. *Co-passengers present* = 1 if other individuals were present inside the subject's vehicle, 0 otherwise. *Busy period* = 1 if two or more other vehicles were positioned at the end of the main road; forcing the subject to slow down as he/she approached the waiting experimenter, 0 otherwise. *Clear weather* = 1 if weather conditions were clear/sunny, 0 otherwise. *Commuter behind* = 1 if another commuter was present behind and following the subject (in the baseline treatment), 0 otherwise. *Distance travelled* is the (scaled) physical distance between the subject's initial interaction with Experimenter B (where the latter provided the generous act to the former) and consequent interaction with the waiting Experimenter A. The shortest possible distance (Distance 1) is the omitted reference category.

Table 4

Regression Analysis of Observed Generosity

	(1)	(2)	(3)
IR treatment	0.172*** (0.045)	0.172*** (0.038)	0.200* (0.114)
Male		0.157*** (0.043)	0.190** (0.074)
Male * IR treatment			-0.054 (0.090)
Mature		-0.019 (0.038)	-0.040 (0.065)
Mature * IR treatment			0.020 (0.080)
Low social class		-0.117*** (0.040)	-0.225** (0.080)
Low social class * IR treatment			0.161 (0.104)
Co-passengers present		0.007 (0.037)	0.044 (0.058)
Co-passengers present * IR treatment			-0.046 (0.075)
Busy period		0.419*** (0.029)	0.488*** (0.077)
Busy period * IR treatment			-0.102 (0.111)
Clear weather			-0.014 (0.041)
N	316	316	316

Notes. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$. Probit model. Dependent variable is *acted generously*. The coefficients represent average marginal effects. Robust SEs are given in the parentheses. *Acted generously* = 1 if the subject stopped and gave way to the waiting individual (Experimenter A), 0 otherwise. *Indirect reciprocity (IR) treatment* = 1 if subject decision was observed under the three-person interaction (indirect reciprocity treatment), 0 if otherwise. *Male* =1 if subject was male, 0 otherwise. *Mature* = 1 if perceived age of subject was > 40 years, 0 otherwise. *Low social class* = 1 if subject drove low-valued vehicle, 0 otherwise. *Co-passengers present* = 1 if other individuals were present inside the subject's vehicle, 0 otherwise. *Busy period* = 1 if two or more other vehicles were positioned at the end of the main road; forcing the subject to slow down as he/she approached the waiting experimenter, 0 otherwise. *Clear weather* = 1 if weather conditions were clear/sunny, 0 otherwise.