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**Cite this article:** Macfarlan SJ, Quinlan R, Remiker M. 2013 Cooperative behaviour and prosocial reputation dynamics in a Dominican village. *Proc R Soc B* 280: 20130557.  
<http://dx.doi.org/10.1098/rspb.2013.0557>

Received: 3 March 2013

Accepted: 10 April 2013

### Subject Areas:

behaviour, cognition, ecology

### Keywords:

cooperation, prosociality, reputations, indirect reciprocity, Dominica

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Electronic supplementary material is available at <http://dx.doi.org/10.1098/rspb.2013.0557> or via <http://rspb.royalsocietypublishing.org>.

# Cooperative behaviour and prosocial reputation dynamics in a Dominican village

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Prosocial reputations play an important role, from the evolution of language to Internet transactions; however, questions remain about their behavioural correlates and dynamics. Formal models assume prosocial reputations correlate with the number of cooperative acts one performs; however, if reputations flow through information networks, then the number of individuals one assists may be a better proxy. Formal models demonstrate indirect experience must track behaviour with the same fidelity as direct experience for reputations to become viable; however, research on corporate reputations suggests performance change does not always affect reputation change. Debate exists over the cognitive mechanisms employed for assessing reputation dynamics. Image scoring suggests reputations fluctuate relative to the number of times one fails to assist others in need, while standing strategy claims reputations fluctuate relative to the number of times one fails to assist others in good standing. This study examines the behavioural correlates of prosocial reputations and their dynamics over a 20-month period in an Afro-Caribbean village. Analyses suggest prosocial reputations: (i) are correlated with the number of individuals one assists in economic production, not the number of cooperative acts; (ii) track cooperative behaviour, but are anchored across time; and (iii) are captured neither by image scoring nor standing strategy-type mechanisms.

## 1. Introduction

Prosocial reputations are a set of beliefs, perceptions and evaluations a community forms about one of its members' tendencies to help others at a cost to the self [1–8]. They are of theoretical and practical importance across a range of contexts, including collective action [3–6,8–14], the evolution of language [4], mental and physical health [15–19], development [17–20], reproduction [21,22], Internet transactions [23] and resource conservation [24]. Prosocial reputations function by reducing transaction costs associated with cooperative partnership formation through increases in trust [5,8,13,25]. Humans become aware of these reputations by age five, and understand that indirect experience contributes to an individual's standing among peers by age six [26]. Not surprisingly, people begin using prosocial reputations to form alliances in middle childhood [19,20] and continue this process throughout adolescence and adulthood [8]. Formal models often assume individuals track the *number of cooperative acts* others perform when assessing prosocial reputations [5,10–14]. However, people could track the *breadth of cooperative behaviour*. If reputations accrue because information flows through social networks [27,28], then individuals who give to greater numbers of alters will have greater broadcast power and therefore, better reputations.

Associations between behavioural change and reputation change are a matter of debate. Formal models suggest reputation-based cooperation can evolve if people modulate behaviour via the mechanism of *phenotypic defection*, a process whereby otherwise cooperative individuals make errors in judgement or lack

the time, energy or ability to assist others [29–31]. Under these conditions, behaviour serves as an indicator of quality or commitment [32] and prosocial reputations become evolutionarily viable, but only if indirect experience tracks behaviour with the same fidelity as direct experience [12]. If people modulate cooperative behaviour, and reputations track behaviour with the same accuracy as direct experience, then the relationship between prosocial reputations in one time period and another should be fully mediated by the amount of cooperative behaviour that occurs within this timeframe. However, research on corporate reputations suggests once firms achieve a reputation, people are hesitant to change their minds, resulting in reputations that are resistant to performance change [33–35]. As a result, reputations may be anchored across time, irrespective of the amount of cooperative behaviour one enacts.

Lastly, debate exists within the indirect reciprocity literature over the cognitive mechanisms employed for assessing reputation dynamics [5,9–12]. *Image scoring* [5,9] assumes when individuals fail to help another, reputations decrease, even if the person they failed to help has a bad reputation. *Standing strategy* [3,10–12] assumes it is justifiable to withhold assistance from another if the person for whom they withhold assistance has a bad reputation. In the latter case, individuals lose status if they refuse to assist another in good standing and remain static if the person they did not help was in bad standing. Researchers employing different paradigms come to different conclusions on the plausibility of each mechanism. Formal models [10–12] demonstrate only a standing strategy is evolvable, while laboratory experiments suggest image scoring is most parsimonious with human decision-making [9].

We test the following questions about the behavioural correlates of prosocial reputations and their dynamics using 20 months of economic behaviour and reputation data from a rural Dominican village: (i) do reputations track the number of cooperative acts or the number of individuals with whom one cooperates; (ii) do reputations track behavioural change with high fidelity or are reputations anchored across time; and (iii) does the mechanism of image scoring or standing strategy better capture reputation dynamics? We find prosocial reputations: (i) are based on the number of unique individuals one assists in economic production, not the number of cooperative acts performed; (ii) track cooperative behaviour in economic production, but also are anchored across time; and (iii) are based on neither the mechanism of image scoring nor standing strategy; however, change in the number of alters an ego assists in economic production explains some variance in reputation dynamics.

## 2. Study site

The village of Bwa Mawego (pseudonym) [36,37] is located on the southeast coast of the independent Caribbean nation of Dominica [38]. It is a matrifocal community [39,40] comprises 400 residents [41] derived of Indigenous Carib, European and African ancestry. Village economy combines subsistence horticulture, fishing and cash cropping. The primary cash crop cultivated is the Caribbean Bay tree (*Pimenta racemosa* (Miller) J. W. Moore) [42], the leaves of which are steam distilled to produce essential bay oil [43]. Unrefined bay oil is sold to the nation's essential oil cooperative, whereby it is refined and traded on the international commodities market.

Corporate patrilineal kin groups own all land in the village; however, individuals manage plots of bay trees on a usufruct basis. Although no institutionalized sexual division of labour exists, production largely is a male task. Land managers, referred to as a 'chief-for-a-day' (CFAD) when they distil bay oil [8], harvest plots of bay every 10 months; however, access to multiple plots of land and staggered growth causes CFADs to labour year round. Bay oil distillation is gruelling work and impossible to perform alone. When individuals distil bay oil they do not ask others for assistance, instead they start work alone. A village wide norm dictates that individuals should provide assistance to CFADs if they have received labour in the past from that individual. Because the village is small and the activity is highly conspicuous, people realize when they are obligated to assist. Individuals who do not owe labour may assist a CFAD if they seek to create a new reciprocal labour partnership. The more assistance one has the easier the process; as such, an economy of scale is present, with median group sizes equal to three individuals [8,43]. Villagers state two helpers are ideal, as this number manages the tradeoff between sufficient labour to complete the task, while minimizing reciprocal labour obligations. CFADs own all oil generated from distillation events. Helpers have no stake in the oil that is distilled, but are incentivized to work as they will require labour from others when they distil bay oil in the future. As such, labour exchange in bay oil distillation represents a multi-player, iterated, sequential Prisoner's Dilemma—all individuals are better off in the long-term by reciprocally cooperating with labour partners; however, the temptation to free-ride is ever present as individuals have a short-term incentive to receive labour without providing it back reciprocally. Males tolerate mild defections in reciprocity; however, individuals who consistently fail to reciprocate labour gain reputations as non-cooperators and are punished through labour supply reduction as people simply stop assisting them [8,43]. Previous analyses reveal variation in cooperative behaviour in bay oil distillation leads to variation in prosocial reputations, with individuals providing more labour in better reputation [8]. Individuals with better reputations are more desirable labour partners and receive a greater volume of assistance when they distil bay oil. These high-quality individuals are selective with whom to reciprocate labour, providing it back to those who live in close proximity or signal partnership commitment through displays of labour [8,43]. Individuals who have laboured together reciprocally are more likely to assist one another in times of need and because high-quality individuals achieve more reciprocal partnerships, they have the greatest social capital for mitigating risk [43].

## 3. Material and methods

### (a) Labour

One village resident and S.J.M. performed daily instantaneous scan samples of the village's eight distilleries over a 20-month period, in two 10-month intervals (Time 1, 1 July 2008–30 April 2009; Time 2, 1 May 2009–1 March 2010). During distillery scans, we recorded the number of people present, the CFAD, all individuals providing assistance, their sex and age. Time 1 (T1) revealed 193 distillation events, involving 92 males who worked either as a CFAD or as a labour assistant. Time 2 (T2) revealed 101 males participating in 272 distillation events. A total of 129 men worked across the entire 20-month period. A subset of 53

**Table 1.** Descriptive statistics for bay oil labour and prosocial reputations.

	<i>n</i>	mean (s.d.)	median	min.	max.
T1					
age	53	46 (13.5)	43	19	81
CFADs assisted	53	2.8 (3.4)	2	0	15
log-10 CFADs assisted	53	0.43 (0.36)	0.48	0	1.2
days assisting	53	4.7 (6.6)	3	0	33
log-10 days assisting	53	0.53 (0.44)	0.6	0	1.5
prosocial reputation	53	0.7 (0.3)	0.8	0	1
T2					
CFADs assisted	53	3.6 (3.8)	3	0	16
log-10 CFADs assisted	53	0.52 (0.36)	0.6	0	1.2
days assisting	53	7.3 (9.3)	4	0	45
log-10 days assisting	53	0.68 (0.48)	0.7	0	1.7
prosocial reputation	53	0.6 (0.3)	0.8	0	1

males had their reputations assessed in both time periods and descriptive statistics of the amount of labour they provided is contained in table 1. Independent samples *t*-test reveals there is no statistical difference in the mean age of individuals in the subset when compared with those not in the analysis ( $t = -1.7$ ; d.f. = 103;  $p = 0.09$ ); however, a Mann–Whitney *U*-test reveals the subset worked significantly more days when compared with those not used in the analysis ( $U = 3100$ ;  $N = 129$ ;  $p < 0.001$ ).

### (b) Reputations

Prosocial reputations were assessed using a peer-rated pile sort task approximately three months following their associated labour period. In July 2009, M.R. asked five community members (two males and three females) to rate the 53 men on their prosocial tendencies using the French patois term 'koudmen' (the word is a derivative of the French phrase *coup de main*). Koudmen is a tradition widely acknowledged by Dominicans [44] and refers to one who gives labour to others in need. The task required raters to read 53 cards containing the name of an individual male who laboured in bay oil and place it into one of two categories: (i) ego would not provide labour to an alter in need; or (ii) ego would provide labour to an alter in need. Raters were selected on the basis that they had participated in bay oil distillation at some point during the labour period and could read. Interviews were performed alone in private locations and raters were given opportunities to elaborate why individuals had particular reputations. One female reviewer was dropped from analyses as she failed to provide reputation assessments for several egos. In May 2010, S.J.M. employed the identical task for the same 53 males using three of the original four reviewers. Another female who fit the selection criterion was substituted for the missing rater. Applying benchmarks associated with inter-rater reliability for nominal-level data and multiple reviewers [45], peer assessments had moderate inter-rater reliability in T1 (Gwet's  $AC_1 = 0.6$ ;  $p < 0.0001$ ;  $n = 53$ ) and fair inter-rater reliability in T2 (Gwet's  $AC_1 = 0.24$ ;  $p = 0.003$ ;  $n = 53$ ) and were averaged within each time period (T1 mean =  $0.7 \pm 0.3$ ; T2 mean =  $0.6 \pm 0.3$ ). The three raters who assessed reputations in both time periods had moderate to substantial within-individual reliability scores (Gwet's  $AC_1$  range: 0.44–0.67) suggesting raters generally maintained their opinion about people across time. When raters changed their mind about men's prosocial tendencies, they did so for different individuals, suggesting raters have different

**Table 2.** HLM model explaining the relationship between cooperative behaviour and age on prosocial reputations.

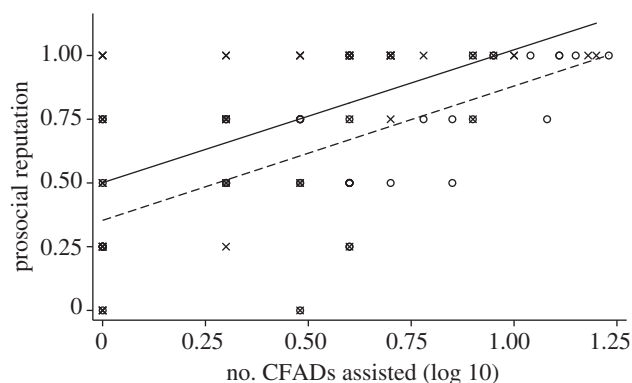
	<i>B</i> ( $\pm$ s.e.)	<i>z</i>	<i>p</i> -value
constant	0.9 (0.1)	8.0	<0.001
age	-0.008 (0.002)	-4.0	<0.001
log-10 CFADs assisted	0.5 (0.2)	2.5	0.01
log-10 days assisting	-0.1 (0.2)	-0.6	0.5

access to information, social information flows at different rates to raters or raters discount information in different ways.

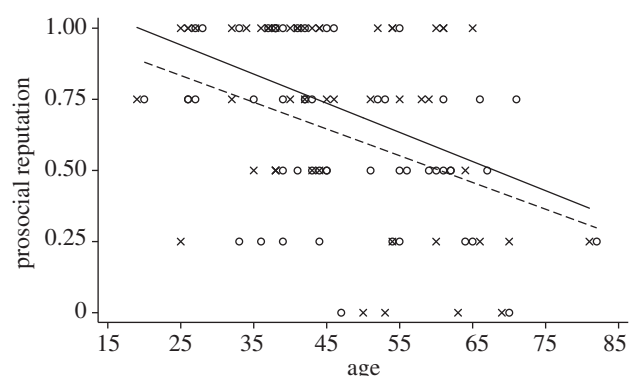
## 3. Results

*Question 1.* Does the number of acts or the breadth of cooperation predict reputations? Formal models assume people track the number of cooperative acts an individual performs for assessing reputations. However, if indirect experience flows through information networks, individuals who give labour to a greater number of alters should have better reputations. The number of cooperative acts and the number of people one assists are count events and were transformed using a base-10 logarithm (after a constant of one was added to the data). The data also have a panel structure (see the electronic supplementary material, M1), necessitating hierarchical linear modelling (HLM), implemented with STATA v. 10 [46]. When the cross-nested effects of the individual and year of analysis are controlled, HLM analysis reveals the number of unique individuals one assists, not the number of prosocial acts one performs, predicts prosocial reputations in both time periods (log likelihood = -8.9;  $N = 106$ ; Wald  $\chi^2 = 58.6$ ;  $p < 0.001$ ; table 2 and figure 1). Additionally, age has a significant negative relationship with prosocial reputations (figure 2).

*Question 2.* Are reputations resistant to behavioural modification? Formal models suggest for reputation-based cooperation to evolve, indirect experience must track behaviour with sufficient fidelity to approximate direct experience. If



**Figure 1.** Relationship between number of CFADs assisted and prosocial reputation. Crosses, T1; circles, T2; solid and dashed lines, best-fit line.



**Figure 2.** Relationship between age and prosocial reputation. Crosses, T1; circles, T2; solid and dashed lines, best-fit line.

people track behaviour in this manner, then the relationship between reputations in T1 and T2 should be mediated by prosocial behaviour in T2. However, if reputations are anchored across time because people are hesitant to change their mind, then reputations in T1 will be correlated with reputations in T2, irrespective of prosocial behaviour in T2. To assess these propositions, we regressed prosocial reputations in T1, the number of CFADs assisted in T2 (which was transformed using a base-10 logarithm after a constant of one was applied the data), and age on prosocial reputations in T2 (see electronic supplementary material, M2). Multiple linear regression analysis reveals all three variables predict prosocial reputations in T2 ( $R^2 = 0.54$ ;  $n = 53$ ; Wald  $\chi^2 = 71.4$ ;  $p < 0.001$ ; table 3).

*Question 3.* Does the mechanism of image scoring or standing strategy better capture reputation dynamics? Image scoring suggests people lose reputations anytime they fail to help another who needs assistance, while standing strategy assumes reputations decline relative to the number of times a person fails to assist a person in good standing. To assess these propositions, we calculated the change in reputation for each male, as well as a cooperative behaviour score via image scoring and standing strategy (table 4). Image scores were derived by adding the number of times an ego reciprocally assisted an alter who provided labour to ego, subtracted from the number of times ego failed to reciprocate labour to an alter who provided labour, plus the number of times ego provided labour to an alter who never assisted ego. To derive standing scores an assessment of ‘good’ and ‘bad’ standing was required. Individuals were placed into ‘good’ standing if three or more reviewers in T1 suggested the ego would provide *koudme*. We then added the number of times an ego

**Table 3.** Linear regression model explaining the relationship between prosocial reputation in T1, cooperative behaviour in T2, and age on prosocial reputations in T2.

	$B (\pm \text{s.e.})$	$z$	$p$ -value
constant	0.5 (0.2)	3.0	0.003
log-10 CFADs assisted T2	0.4 (0.07)	5.4	<0.001
prosocial reputation T1	0.2 (0.09)	2.7	0.008
age	-0.005 (0.002)	-1.9	0.052

reciprocally assisted an alter who provided labour to ego, subtracted from the number of times ego failed to reciprocate labour to an alter who provided labour and was in good standing, plus the number of times ego provided labour to an alter who never assisted ego. Because image and standing scores were almost perfectly correlated (Spearman’s  $\rho = 0.98$ ;  $n = 53$ ;  $p < 0.0001$ ), we assess the efficacy of each mechanism by comparing the correlation of each to the change in reputation. Neither the image (Spearman’s  $\rho = -0.14$ ;  $p = 0.31$ ) nor the standing score (Spearman’s  $\rho = -0.09$ ;  $p = 0.5$ ) variable predicted prosocial reputation change. A post-hoc analysis revealed change in number of CFADs assisted between T1 and T2, but not change in the number of days assisting, explained a small percentage of the variance in reputation dynamics (model  $R^2 = 0.04$ ;  $p = 0.07$ ;  $N = 53$ ;  $\Delta$  CFADs  $\beta = 0.3$ ;  $t = 2.3$ ;  $p = 0.03$ ;  $\Delta$  Days  $\beta = -0.15$ ;  $t = -1.3$ ;  $p = 0.2$ ).

## 4. Discussion and conclusion

We performed this analysis to assess the behavioural correlates of prosocial reputations and the nature of their dynamics. Our results suggest prosocial reputations are related to the number of unique individuals one assists, not the number of cooperative acts. This finding supports the commonsense notion that reputations flow through information networks [27]. Age was a significant predictor of prosocial reputation in both time periods, with younger individuals in higher prestige compared with older individuals, even after controlling for behaviour. It is possible people assume the best of new bay oil workers and change their opinions relative to the number of community members they assist in economic production. Alternatively, the energetic demands of bay oil distillation may impede older individuals from volunteering labour, which can lead to lower reputation scores. Whatever the cause, this finding conflicts with the assumption that individuals start off with neutral reputations [5]. Additionally, we find that reputations are correlated across time even after controlling for behaviour and age. That reputations are ‘sticky’ across time suggests the presence of an anchoring effect [47]; once an individual achieves a reputation, it has a lasting effect on how others view him, irrespective of the number of good deeds performed. If reputations are considered to be the value of a person in a society, then reputation stickiness may be the social analogue to price stickiness found in commodity markets [48,49]. Neither the image score nor the standing strategy variables were significant predictors of reputation change. However, change in the number of people assisted explained a small proportion of the variance in reputation change,



**Table 4.** Descriptive statistics for prosocial reputation change and cooperative behavioural scores.

	<i>n</i>	mean (s.d.)	median	min.	max.
Δ prosocial reputation	53	−0.1 (0.3)	0	−0.75	0.5
image score	53	3.8 (9.5)	2	−14	38
standing score	53	4.2 (9.2)	2	−12	38
Δ days assisting	53	2.6 (5.0)	1	−5	23
Δ CFADs assisted	53	0.8 (2.6)	0	−4	9

suggesting that network structure and social position may be important determinants of reputation dynamics. Why do image and standing fail to explain reputation dynamics? First, image scoring and standing strategy assume that reputations are correlated to the number of cooperative acts one performs, not the breadth of cooperation. However, as our analyses demonstrate, this assumption is not justified. Second, both mechanisms assume random assortment; however, previous analyses have revealed spatial proximity and competitive altruism structure cooperation in bay oil distillation [8]. People living in close proximity prefer one another as labour partners as this facilitates trust and allows individuals to more easily coordinate behaviour. Furthermore, a marketplace for labour exchange relationships exists in this community and individuals compete through cooperative acts to navigate reciprocal partnership formation [8]. Highly cooperative individuals are the most desirable labour exchange partners and receive labour from a greater number of individuals compared with the less cooperative. Because it is costly to maintain every possible reciprocal relationship and CFADs require only a small number of individuals to distil bay oil, highly cooperative individuals do not reciprocate with everyone who helps them. As such, when reputations dynamics are calculated via image scoring and standing strategy, behaviourally cooperative individuals may be calculated as uncooperative.

Every study has limitations and this is no different. A small number of raters assessed reputations across the two time periods. A larger number of raters would improve reputation estimates, model fit and regression coefficient estimates. However, the number of raters employed was consistent with studies examining cooperative behaviour via parental or teacher evaluations [50,51]. Additionally, reviewers displayed greater disagreement on male reputations in the second time period. Social psychologists demonstrate people do not value all second-hand information equally [7]; as a result, peoples' evaluation of others may diverge. Furthermore, throughout the time frame of the study, the community continued the process of modernization, with wage labour opportunities and the Internet identified as vectors responsible for reducing community social cohesion [52]. Social cohesion modulates

knowledge transfer [53]; when it erodes, social information transmission can be impeded. Additionally, males in Bwa Mawego act cooperatively and accrue prosocial reputations via a variety of domains, including food and alcohol sharing, community labour projects, gardening, fishing and fathering. Inclusion of such data may explain the divergence of reputation assessments in the second time period as community members may have different access to particular domains of social life. For analytic tractability, we did not analyse the role of gender in prosocial reputations. Developmental and social psychologists have long reported that a gender bias exists in prosocial reputations, with females considered more prosocial than males, despite performing similar tasks [50,54]. Future research will hopefully shed light on the role gender plays in prosocial reputation dynamics in naturalistic settings.

Reputations are fundamental to the human condition. Uncovering their behavioural correlates and the nature of their dynamics through quantitative ethnographic analysis clarifies assumptions employed by formal modellers. Properly specified models may reveal novel properties about the evolution of cooperation via reputations. Furthermore, assessing prosocial reputation dynamics in small-scale societies where reputations are maximally important for navigating daily life overcomes problems of construct and external validity associated with analysis of WEIRD (western, educated, industrialized, rich and democratic) societies [55] in laboratory settings. Although our analysis suggests a particular relationship between behaviour and reputation dynamics, effect size estimates generated from other naturalistic contexts would allow more meaningful generalizations about the universality of these mechanisms. We hope this research prompts other researchers to move in similar directions.

The authors thank Karthik Panchanathan and two anonymous reviewers for their comments on the manuscript; Ed Hagen, Barry Hewlett and Mike Alvard for comments during the initial phases of the project; Juranie Durand for his assistance and knowledge with bay oil distillation; the people of Bwa Mawego for their hospitality and participation in the study; and the Dominican Central Statistical Office for permitting this research.

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