

Intuition and cooperation reconsidered

ARISING FROM D. G. Rand, J. D. Greene & M. A. Nowak *Nature* **489**, 427–430 (2012)

Rand *et al.*¹ reported increased cooperation in social dilemmas after forcing individuals to decide quickly¹. Time pressure was used to induce intuitive decisions, and they concluded that intuition promotes cooperation. We test the robustness of this finding in a series of five experiments involving about 2,500 subjects in three countries. None of the experiments confirms the Rand *et al.*¹ finding, indicating that their result was an artefact of excluding the about 50% of subjects who failed to respond on time.

There are two major problems in the analysis by Rand *et al.*¹ First, their exclusion of subjects who fail to respond on time cause a selection problem. In their observational studies, Rand *et al.*¹ show that slow responders cooperate less. The exclusion of slow responders therefore automatically increases cooperation in the time-pressure treatment. Second, when including all subjects in the Supplementary Information analyses, they incorrectly control for whether subjects answer on time. Without controlling for this endogenous variable, the time pressure effect is not significant (t value = 1.62, P value = 0.11 in both study 6 and study 7).

We test the robustness of the Rand *et al.*¹ results in experiments 1–4, and experiment 5 is a replication. To minimize missing values we use a binary decision. In experiment 1, two subjects simultaneously decide whether to keep X or give a larger amount to the other individual in a prisoner's dilemma². X is varied in five rounds with new pairs in each round. Subjects (Swedish students, $n = 167$) are randomly allocated to deciding within 10 s or waiting 10 s before deciding. The mean rate of cooperation is about 50% in both groups (t value = 0.33, P value = 0.740) (Fig. 1a).

The maximum time to respond is reduced to 7 s in experiments 2–4, and a four-person public goods game is used². Subjects decide whether to keep a fixed amount or give a larger amount to the group (the amount is varied in four rounds with new groups in each round). Experiment 2 (Swedish students, $n = 199$) and experiment 3 (USA general population sample, $n = 583$) have identical designs. In experiment 4 (Austrian students, $n = 320$), the time subjects have to wait before deciding is increased to 20 s and the wording is changed slightly. The time pressure effect is in the opposite direction of Rand *et al.*¹ in experiments 2–4, but not significant (t value = -0.55 , P value = 0.586 in experiment 2; t value = -0.44 , P value = 0.663 in experiment 3; t value = -1.93 , P value = 0.054 in experiment 4) (Fig. 1a). Pooling experiments 1–4, the rate of cooperation is 44% with time pressure and 47% without time pressure (t value = -1.29 , P value = 0.197). Including only the first round decision, the rate of cooperation is 44% with time pressure and 46% without time pressure (Chi-square = 0.60, P value = 0.432).

In experiments 1–4, subjects knew that they would be making decisions under time pressure before they reached the decision screen. In Rand *et al.*¹, subjects did not know about the time pressure until they reached the decision screen. Rand *et al.*¹ also included an example in the instructions, but the example may also prime decisions (the example ended with “Thus you personally lose money on contributing”). These differences are tested in experiment 5 in a one-shot public goods game with six treatments. Treatments 1 and 2 are a replication of the Rand *et al.*¹ design, but with a binary decision. Treatments 3 and 4 are identical to treatments 1 and 2, but do not include the example. Treatments 5 and 6 replicate treatments 3 and 4, but information about time pressure is given before the decision screen. Design and wording of experiment 5 were done in collaboration with D. Rand. Data are collected on Austrian students ($n = 353$),

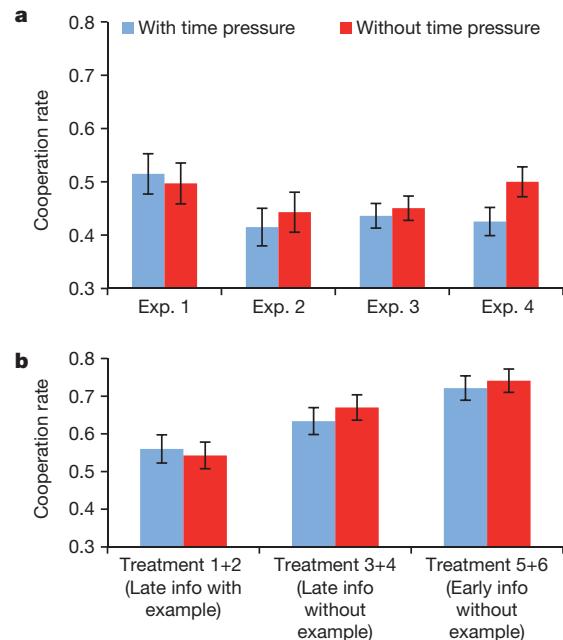


Figure 1 | Time pressure does not increase cooperation in social dilemmas. **a**, Mean (\pm s.e.) rate of cooperation with and without time pressure in a repeated prisoner's dilemma game with stranger matching (experiment 1, Exp. 1) and a repeated public goods game with stranger matching (experiments 2–4). The result in Rand *et al.*¹ of time pressure increasing cooperation is not confirmed in any of the experiments. **b**, Mean (\pm s.e.) rate of cooperation in treatments 1–6 in a one-shot public goods game (experiment 5). The result in Rand *et al.*¹ of time pressure increasing cooperation is not confirmed in any of the comparisons. Treatments 1 and 2 replicate the Rand *et al.*¹ design (with late information that the decision will be made under time pressure), but with a binary decision. Treatments 3 and 4 are the same as treatments 1 and 2, but without the example used by Rand *et al.*¹ Treatments 5 and 6 replicate treatments 3 and 4, but provide early information that the decision will be made under time pressure (as in experiments 1–4). The rate of contribution is lowest in treatments 1 and 2 consistent with a priming effect of the example.

and two USA general population samples (Decision Research sample, $n = 251$; Qualtrics Panels sample, $n = 600$).

No significant effect of time pressure for any of the comparisons is found (Fig. 1b). The rate of cooperation is 56% with time pressure and 54% without time pressure in the replication of Rand *et al.*¹ (Chi-square = 0.11, P value = 0.737). The most striking result is that including the example reduces cooperation, consistent with a priming effect (Chi-square = 8.16, P value = 0.004).

We conclude that forcing individuals to decide quickly in social dilemmas does not in general increase the rate of cooperation, casting doubt on the Rand *et al.*¹ interpretation of humans as intuitively cooperative.

METHODS

In the five rounds of experiment 1, the subjects decide between giving SEK150 to the other player and keeping between SEK40 and SEK90. In the four rounds of experiment 2/3/4, the subjects decide between keeping SEK50/€5/\$2.5 and giving between SEK75–150/€7.5–15/\$3.75–7.5 to the group. In experiment 5, the subjects decide between keeping an amount (\$2 in the Decision Research sample, \$4 in the Qualtrics Panels sample, and €4 in the Austrian sample) and giving twice

as much to the group. An Appendix with more detailed descriptions of the methods and results are available from the authors.

Gustav Tinghög^{1,2}, David Andersson¹, Caroline Bonn³, Harald Böttiger⁴, Camilla Josephson¹, Gustaf Lundgren⁵, Daniel Västfjäll^{6,7}, Michael Kirchler^{3,8} & Magnus Johannesson^{1,5}

¹Division of Economics, Department for Management and Engineering, Linköping University, SE-581 83 Linköping, Sweden.

²The National Center for Priority Setting in Health Care, Department of Medical and Health Sciences, Linköping University, SE-581 83 Linköping, Sweden.

³Department of Banking and Finance, University of Innsbruck, Universitätsstrasse 15, 6020 Innsbruck, Austria.

⁴Klarna AB, Norra Stationsgatan 61, SE-113 43 Stockholm, Sweden.

⁵Department of Economics, Stockholm School of Economics, Box 6501, SE-113 83 Stockholm, Sweden.

e-mail: magnus.johannesson@hhs.se

⁶Department of Behavioural Sciences and Learning, Linköping University, SE-581 83 Linköping, Sweden.

⁷Decision Research, 1201 Oak Street, Suite 200, Eugene, Oregon 97401, USA.

⁸Centre for Finance, Department of Economics, University of Gothenburg, Box 600, SE-40530 Göteborg, Sweden.

Received 6 February; accepted 16 April 2013.

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Author Contributions G.T. and M.J. designed research; all authors performed research; D.A. analysed data; G.T., M.K. and M.J. wrote the paper.

Competing Financial Interests: Declared none.

doi:10.1038/nature12194

Rand *et al.* reply

REPLYING TO G. Tinghög *et al.* *Nature* **498**, <http://dx.doi.org/10.1038/nature12194> (2013)

Tinghög *et al.*¹ take issue with two of the ten experiments in our paper² (studies 6 and 7). Here we reanalyse the data from these experiments as suggested by Tinghög *et al.*¹, and demonstrate that our reported positive effect of time pressure on cooperation is not an artefact. Furthermore, an aggregate analysis based on fifteen studies and 6,910 decisions also replicates this effect³.

In studies 6 and 7, we examined the relationship between intuition and cooperation by manipulating decision time: in one condition, subjects playing a public goods game were asked to decide in less than 10 s; in the other condition subjects were asked to think for at least 10 s before deciding. Tinghög *et al.*¹ make an excellent point regarding potential issues related to excluding subjects who did not respond in time (or including a dummy variable controlling for failure to obey the time constraints).

Here we reanalyse our data following the suggestions of Tinghög *et al.*¹. We do not exclude subjects who failed to obey the time constraint, and we do not control for such failure. As in our original analyses, we find a significant positive effect of time pressure on cooperation ($N = 891$; rank-sum, $P = 0.014$; Tobit regression with demographic controls, $P = 0.022$; we combine studies 6 and 7 because of a non-significant interaction between time pressure and study, $P = 0.62$). Thus the time-pressure effect reported in our previous paper is not an artefact of exclusion, as Tinghög *et al.*¹ have suggested.

Furthermore, our original paper presented data from ten studies using three distinct methods to test whether people's automatic, intuitive responses are more or less cooperative than responses generated through reflection and deliberation. All of these studies supported the conclusion that, on average, intuition favours cooperation. The concerns of Tinghög *et al.*¹ apply to two of these ten experiments, which used only one of our three methods. They do not challenge the convergent evidence presented by the other eight studies. On the contrary, their criticism of our studies 6 and 7 is based on their acceptance of the correlational results we reported in studies 1–5.

Tinghög *et al.*¹ report five experiments in which there is no significant effect of time pressure on cooperation. However, four of these experiments involve design changes that are likely to eliminate the time-pressure effect. First, in these experiments subjects played the

cooperation games after having made a series of other economic decisions. Thus they had been given an opportunity to adjust to the laboratory setting, reducing the spillover of intuitions from outside the lab. As demonstrated in our study 9, previous experience eliminates the positive effect of intuition². Second, subjects were under time pressure not only when deciding, but also when acquiring information about the payoff structure. As noted in our Supplementary Information², faster acquisition of payoff information is associated with decreased cooperation⁴. This is because cooperative decisions require information about the payoffs to others, rather than just one's own payoff. Thus, the confounding of these opposite effects of time pressure on information acquisition and prosociality would be expected to result in a null effect.

In the fifth experiment of Tinghög *et al.*¹, these problems are eliminated. This study's null result is disappointing. However, it fits within the pattern of results observed in an aggregate analysis examining every experiment our group has ever run applying time pressure to social dilemmas (thus eliminating potential "file drawer" effects)³.

Across 15 studies and 6,910 decisions, there is a highly significant positive effect of time pressure on cooperation. This effect persists when including subjects who did not obey the time constraint. Furthermore, there is substantial study-to-study variation, with some studies showing significant positive effects of time pressure and others showing no effect. Critically, no study shows a significant negative effect of time pressure on cooperation, consistent with the null (but non-negative) results of Tinghög *et al.*¹. We also find that, over the last 2 years, the size of the time-pressure cooperation effect has steadily decreased in the subset of studies run on Amazon Mechanical Turk (AMT⁵). Given the marked increase in the popularity of AMT as a platform for behavioural experiments, this is consistent with our previous finding that experience undermines the intuitive cooperation effect.

In sum, our findings are supported by (1) a reanalysis of studies 6 and 7, (2) the remaining eight studies reported in our original paper, and (3) an aggregate analysis of data from over a dozen other time-manipulation studies. Thus, there is clear convergent evidence that intuition promotes cooperation on average, but not in all cases, nor

BRIEF COMMUNICATIONS ARISING

for all people. Deepening our understanding of the factors that moderate the effect of intuition on cooperation is an important direction for future research, one that we hope Tinghög and collaborators will join us in pursuing.

David G. Rand^{1,2,3}, Joshua D. Greene² & Martin A. Nowak^{1,4,5}

¹Program for Evolutionary Dynamics, Harvard University, Cambridge, Massachusetts 02138, USA.

e-mail: drand@fas.harvard.edu

²Department of Psychology, Harvard University, Cambridge, Massachusetts 02138, USA.

³Department of Psychology, Yale University, New Haven, Connecticut 06520, USA.

⁴Department of Mathematics, Harvard University, Cambridge, Massachusetts 02138, USA.

⁵Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, Massachusetts 02138, USA.

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Author Contributions D.G.R., J.D.G. and M.A.N. performed the analysis and wrote the paper.

doi:10.1038/nature12195

Regression tables for Rand et al. Reply

Here we present the regression tables for the analysis described in Rand et al. Reply (2013) *Nature*. We reanalyze the data from Study 6 and 7 of Rand et al. (2012) *Nature* “Spontaneous giving and calculated greed.” As suggested by Tinghog et al. in their Brief Communication Arising, we include all subjects regardless of whether or not they obeyed the time constraint. We continue to demonstrate a significant positive effect of time pressure on cooperation, with or without controls. Thus the results reported in our 2012 paper are not an artifact.

We present results using linear regression (Table 1), tobit regression (Table 2), and ANOVA (Tables 3 and 4). In all cases, the dependent variable is the fraction of subjects’ endowment contributed to the Public Good.

Table 1. Linear regression with robust standard errors

	(1)	(2)	(3)	(4)	(5)
Time pressure	0.0601** (0.0251)	0.0551** (0.0249)	0.0549** (0.0246)	0.0455 (0.0282)	0.0462* (0.0279)
Physical Lab (0=Study 6, 1=Study 7)		-0.109*** (0.0300)	-0.123*** (0.0387)	-0.129*** (0.0429)	-0.142*** (0.0492)
Failed Comprehension			0.0107 (0.0277)		0.0109 (0.0277)
Age			0.00384** (0.00153)		0.00382** (0.00154)
Female			0.0402 (0.0262)		0.0404 (0.0263)
US Resident			0.0772** (0.0340)		0.0776** (0.0340)
Time pressure X Physical Lab				0.0403 (0.0600)	0.0362 (0.0597)
Education dummies	No	No	Yes	No	Yes
Constant	0.504*** (0.0184)	0.532*** (0.0195)	0.321*** (0.0588)	0.537*** (0.0208)	0.327*** (0.0595)
Observations	891	891	891	891	891
R-squared	0.006	0.022	0.057	0.022	0.057
Robust standard errors in parentheses					
*** p<0.01, ** p<0.05, * p<0.1					

Table 2. Tobit regression with robust standard errors

	1	2	3	4	5
Time pressure	0.102** (0.0432)	0.0943** (0.0427)	0.0957** (0.0419)	0.0801* (0.0482)	0.0835* (0.0473)
Physical Lab (0=Study 6, 1=Study 7)		-0.206*** (0.0521)	-0.232*** (0.0679)	-0.236*** (0.0763)	-0.258*** (0.0868)
Failed Comprehension			0.0305 (0.0474)		0.0308 (0.0474)
Age			0.00726 (0)		0.00724 (0)
Female			0.0512 (0.0453)		0.0515 (0.0453)
US Resident			0.150** (0.0605)		0.150** (0.0605)
Time pressure X Physical Lab				0.0597 (0.104)	0.0508 (0.102)
Education dummies	No	No	Yes	No	Yes
Constant	0.534*** (0.0317)	0.586*** (0.0334)	0.196* (0.106)	0.594*** (0.0354)	0.203* (0.107)
Observations	891	891	891	891	891
Robust standard errors in parentheses					
*** p<0.01, ** p<0.05, * p<0.1					

Table 3. ANOVA without controls

Number of obs = 891 R-squared = 0.0222
 Root MSE = .370325 Adj R-squared = 0.0189

Source	Partial SS	df	MS	F	p-value
Model	2.759727	3	0.919909	6.71	0.0002
Time pressure	0.692133	1	0.692133	5.05	0.0249
Physical Lab (0=Study 6, 1=Study 7)	1.890764	1	1.890764	13.79	0.0002
Time pressure X Physical Lab	0.065324	1	0.065324	0.48	0.4903
Residual	121.644	887	0.137141		
Total	124.4038	890	0.13978		

Table 4. ANOVA with controls

Number of obs = 891 R-squared = 0.0570
 Root MSE = .365733 Adj R-squared = 0.0431

Source	Partial SS	df	MS	F	p-value
Model	7.095514	13	0.545809	4.08	0
Time pressure	0.659466	1	0.659466	4.93	0.0266
Physical Lab (0=Study 6, 1=Study 7)	1.471503	1	1.471503	11	0.0009
Time pressure X Physical Lab	0.052417	1	0.052417	0.39	0.5315
Failed Comprehension	0.020221	1	0.020221	0.15	0.6975
Age	0.811037	1	0.811037	6.06	0.014
Female	0.317884	1	0.317884	2.38	0.1235
US Resident	0.702664	1	0.702664	5.25	0.0221
Education	1.688085	6	0.281347	2.1	0.0506
Residual	117.3082	877	0.133761		
Total	124.4038	890	0.13978		