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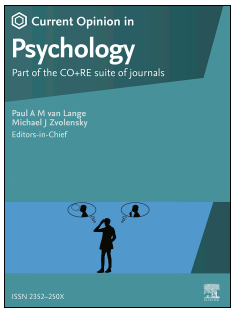

Extortion – a voracious prosocial strategy

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Extortion – a voracious prosocial strategy

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Abstract

Recently Press and Dyson have dramatically changed our view on the Prisoner's Dilemma by proposing new class of strategies that enforce a linear relationship between the two players' scores. Players adopting 'Extortion' respond with cooperation to cooperation in the majority of cases, defect in other rounds, but respond to defection with defection. In this way Extortion enforces full cooperation of the partner who accedes to it because he profits from doing so. This unbeatable strategy is nevertheless prosocial because it is mostly cooperative and induces cooperation even though it gains most itself. Experiments show that about 40% of humans choose to use extortion in competitive situations or when they have the power to exchange co-players. Upon being punished in egalitarian situations they use a generous strategy.

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Cooperation, Prisoner's Dilemma, ZD strategy, Extortion, Competition, Punishment, Asymmetric power

Abbreviations
ZD strategy, Zero Determinant strategy

1. Introduction

Reciprocity is the basis of human cooperation despite the risk of impending defection [1-3].

The experimental paradigm for studying cooperation through reciprocation is the Prisoner's Dilemma game [1-3]. Each of two players can either cooperate (C) or defect (D). If both cooperate, each player earns more than if they both defect. However, if one defects and the other cooperates, the defector has the highest gain and the cooperator the lowest. Irrespective of what the other does, you gain more by defection if the game is played only once, hence the dilemma. When the same subjects meet repeatedly, numerous sequences by each player of, e.g., C, D, D, C, C and so on, are possible. Axelrod's [3] computer tournament simulating evolution among strategies that had been proposed by theorists found 'Tit-for-Tat' as the winner, followed by 'Generous Tit-for-Tat' [4],'Win-stay, lose-shift'[5], i.e., all cooperative strategies [6]. This is in contrast to the daily newscasts reporting widespread uncooperative human behaviour. The strategy describing reality has been missing.

In 2012 Press and Dyson [7**] challenged the current expectation for nice strategies. They found a special class of strategies, called Zero Determinant (ZD) strategies, which enforce a linear relationship between the two players' scores – the more one gains the more gains the other though at a different level. If the ZD player X chooses to extort Y, Y simply seeks to maximise his own score in response to whatever X is doing. Extortionate strategies, predicted by Press and Dyson [7], grant a disproportionate number of high payoffs to X at Y's expense. It is, however, in Y's best interest to cooperate with X because only by doing so is Y able to increase his own score. He will accede to X's extortion because it pays him to do so [8*]. Extortioners use a conditional cooperative strategy with a bias to their own advantage: they respond to each D with D, and to C in slightly more than 50% of the cases with C, otherwise with D. The partner can maximise his gain only by C-C interactions, thus playing finally 100% C. Y learns that his D is always answered by a D, but a C is most often answered by a C. Only by playing C, Y can earn from C-C. Y can earn the maximum by always playing C, in order to meet all of X's about 60% answers to C with C; cooperative answers may be just above 50%, i.e. strong extortion, or much larger than 50%, i.e. mild extortion (see Table 1 in [11*]. Extortion earns voraciously from its about 40% D-C interactions. This unbeatable strategy is nevertheless prosocial because it is mostly cooperative and induces cooperation in other players, even though it gains most itself. Extortion intends to benefit the co-player: extortion gains from the co-player's acceding by which she earns the more she accedes.

If, however, Y sabotages both his own and X's score by defecting, he might aim to discipline X, as in an ultimatum game [9] with X proposing an unfair ultimatum and Y declining the offer thereby sabotaging the payoffs for both players [7]. In a one-shot ultimatum game, e.g. [10], disciplining has no future, because it is one-shot, whereas in an iterated PD it may have.

1.1 Extortion subdues human players but is finally punished in symmetric games

An obvious first experimental step to study the extortion strategy would be to explore the performance of such strategies against humans. We have designed an economic experiment where participants were matched with an extortioner not knowing that they play against a computer program [11*]. Extortioners succeeded against each of their human opponents always with a higher payoff. Figure 1 c,d shows that the payoff of the human subject increases with her cooperation. However, at each percentage of human cooperation the extortioner's payoff is much higher (Figure 1 a,b). A similar follow-up study found similar results, when the computerized nature of the opponent was known by human subjects [12].

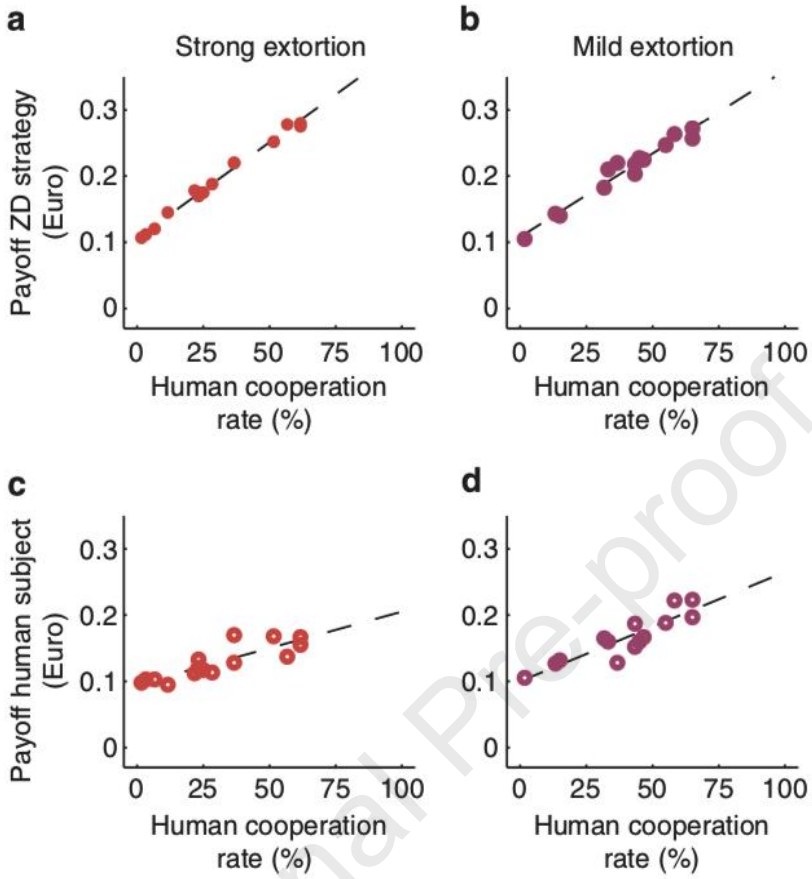

Figure 1 *The graph shows the effects of human cooperation on the payoff of the extortionate ZD strategy* (Figures 1a,b) and on the human subjects' payoffs (Figures 1c,d). In mild extortion the extortionate strategy responds with a higher probability of C to the human player's C than in strong extortion. The horizontal axis shows the fraction of rounds in which the human players cooperated. Coloured dots represent the outcome of the experiment, whereas the dashed line depicts the linear regression curve based on a least squares analysis. Human cooperation had a strongly positive impact on the extortioner's payoff, and a weakly positive impact on the own payoff. Thus, withholding cooperation would be a form of costly punishment [11].

After acceding to extortion in the first half of 60 rounds, the human players showed a strong

concern for fairness [13,14]. By withholding contributions before reaching 75% C (Figure 1) they applied an implicit form of costly punishment. They punished extortion by refusing to fully cooperate, thereby reducing their own, and even more so, the extortioner's gains. Of course, a computer program will not react to disciplining; real human beings might have, as is shown later. Thus, the prospects of extorting others in social relationships seem limited. In the long run, a generous strategy might be more profitable, but not always as will be shown.

1.2 Extortion strategies resist disciplining when higher competitiveness is rewarded

Human players accede to a computer playing extortion [11,12] for some time until they 'punish' the extortioner by playing D, sacrificing their small gain for tearing down the extortioner's larger gain, which could not coerce the computer. Theorists studied the new ZD world with evolutionary simulations and predicted extortioners to switch to more cooperative, generous strategies. We thus expect again to see nice and cooperative strategies prevailing [8,15-18].

Stewart and Plotkin [15**] identified a different subset of ZD strategies, called 'generous ZD' strategies that forgive defecting opponents. Contrary to extortionate behaviour a generous ZD player always cooperates after mutual cooperation and only mildly punishes defection. The regression of the co-player's payoff on the generous player's payoff yields a line above the diagonal, hence generous players have always a lower payoff than their co-player, they let their co-players succeed until both reach mutual cooperation (Figure. 2a). However, the regression of the co-player's payoff on an extortioner's payoff yields a line below the diagonal, hence extortioners have always a higher payoff than their co-player, they outcompete their co-players (Figure 2b). In both cases the regression has a positive slope as a ZD strategy defines a linear relationship between the players' payoffs. The best response to both extortion and generous strategies is to cooperate.

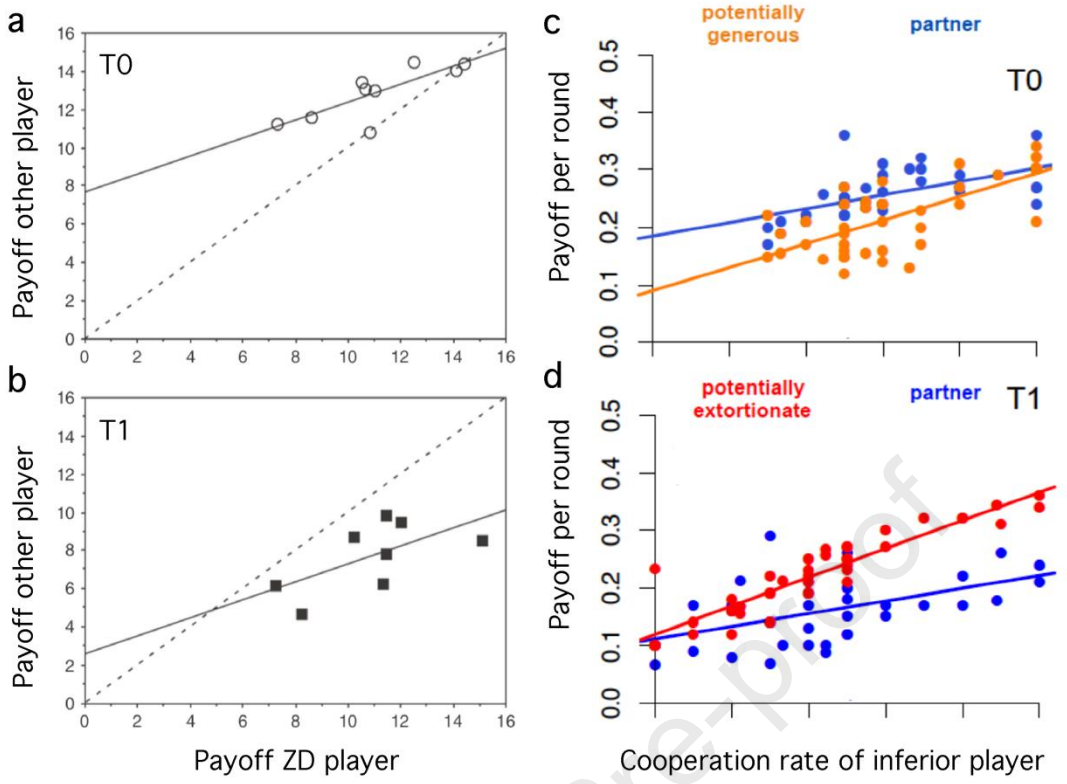

Figure 2. *Correlation between payoff of ZD player and the payoff of the partner in the treatments,* (Figure 2a) "ZD generous" (T0), (Figure 2b) "ZD extortion" (T1); c,d payoffs of each player dependent on cooperation of inferior player. Correlation between cooperation rate of the inferior player and payoff per round for the inferior player and the other player in the treatments (Figure 2c) without incentive (T0), the potentially generous player (orange) being inferior; (Figure 2d) with asymmetric incentive (T1), the partner (blue) being inferior. Individual points represent average payoff and the average cooperation of 10 rounds per individual [19].

An experiment [19] tested with students whether extortioners can be found in reality and whether these are, as predicted, quickly disciplined, and whether 'generous ZD strategies' emerge thereafter. Participants were not informed about neither extortionate nor generous ZD strategies. Furthermore, the hypothesis was tested whether extortion can be favoured by offering one player an incentive to gain extra money if she manages to become competitively superior over her partner, using an extortion strategy. Under completely symmetric power conditions an iterated Prisoner's Dilemma (T0) was compared with the same game where an incentive was assigned in public only to one player chosen randomly (T1). The first hypothesis assumes that the incentive to earn an extra bonus is strong enough that the designated player adopts extortion to be competitively superior at the expense of some losses due to the partner's occasional sabotaging both his own and X's score by defecting. The second hypothesis is that in comparison to T1, T0 being egalitarian might pave the way for

generous ZD strategies because there is no bonus to gain that renders potential extortion profitable and an extorting player may become disciplined after some time. Thus, in T0 generous ZD strategies are predicted.

In egalitarian iterated Prisoner's Dilemmas with no incentive (T0) generous ZD strategies prevailed: generous players let their co-players succeed until both reach mutual cooperation (Figure 3a). When one player was assigned an additional monetary incentive (bonus) (T1), he/she often adopts the extortion strategy: extortioners outcompete their co-players (Figure 3b). Surprisingly, extortioners refused to become disciplined, thus forcing partners to accede: Their proportion of C after partner's C would increase during the game if they are disciplined. They did, however, not increase to respond with C after their partners' C during the Prisoner's Dilemma game, instead in all but one group extortioners even decreased cooperation.

These findings elucidate the relevance of extortion strategies to human behaviour and the role of incentive structures in inducing such behaviours. In reality various kinds of incentives to try to gain more than an equal share exist, e. g. colleagues competing for a higher better paid position.

1.3 Asymmetric power boosts extortion

Most economic studies require that the strategic scenario in which individuals are involved is symmetric—all subjects have comparable strategic options, and they expect similar economic consequences. However, most social interactions contain at least some degree of asymmetry. If some individuals have more influence than others, individuals in a superior strategic position may be able to help themselves to a higher share of the group payoff, although they know that this comes at the expense of their cooperating peers.

An economic experiment simulated a company with an employer and two employees [20]. If the employer is not satisfied with an employee's achievements, she can decide to fire the person and find replacement from the labour market. In the first of two treatments, a repeated game between two types of players was designed, the so-called double player and two single players. In each round, the double player interacts simultaneously though separately with

each single player in a Prisoner's Dilemma. Each single player interacts only with the double player. The double player can choose different actions for each single player. The second treatment is similar except that there are three single players, with one of the single players randomly being determined to start as being inactive. Inactive players neither participate in the game, nor do they receive any payoff. After each round, all subjects including the inactive player are informed about the decisions of all group members including those of the double player. Every ten rounds, double players can decide whether they want to continue to play with the two currently active single players, or whether they want to choose one of the single players to be replaced by the inactive player (the replaced player would then become the inactive player for the next ten rounds). There is the treatment 'without replacement' and the treatment 'with replacement', respectively. Because the double player can avoid being disciplined by exchanging a 'disciplining' single player, he/she is free to adopt extortion. Using the replacement option double players had an effective mechanism to enforce cooperation.

Double players were classified as extortioners [7] if (i) their cooperation rate was at least 10% lower than the cooperation rate of their single players, and (ii) they incentivized their co-players to cooperate. Not all double players made use of their potential to enforce unilateral cooperation. In the treatment without replacement, only one participant, in the treatment with replacement, almost half of the double players satisfied both criteria. Thus, the replacement option triggered extortionate behaviours among about half the double players.

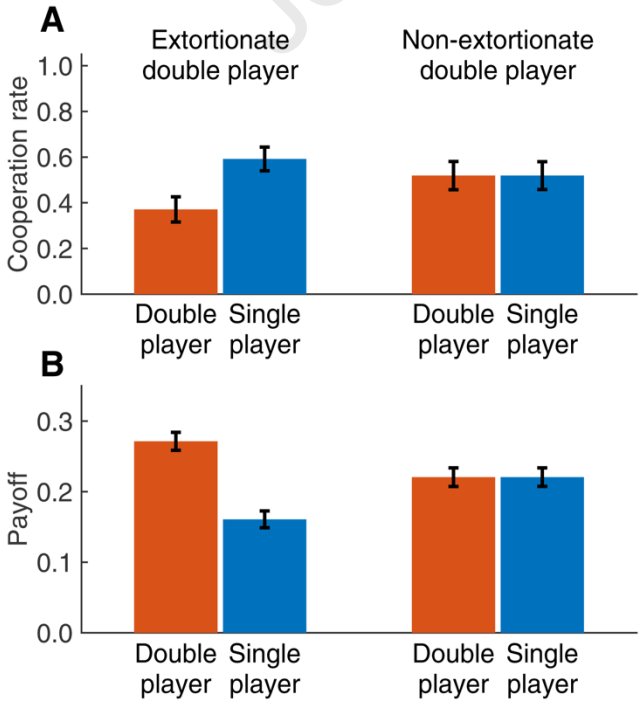

Figure 3. *In the treatment with replacement, double players benefit from being extortionate.* The graph shows cooperation rates (Figure 3A) and payoffs (Figure 3B) in the treatment with replacement, depending on whether the double player was classified as extortionate or not. Error bars represent standard errors. Extortionate players were less cooperative than non-extortionate players; nevertheless, they received more cooperation from their respective co-players. As a result, extortionate double players outperformed both their direct co-players and non-extortionate double players. Adapted from [20].

Extortionate behaviours paid off, as can be shown in the treatment with replacement by comparing the extortioners with the non-extortioners (Figure 4): double players had a distinct payoff advantage from being extortionate. In contrast, single players had a clear disadvantage from being matched with an extortioner. Single players were more likely to be replaced when they cooperated only half of the time or less. Similarly, single players were more likely to be replaced when they cooperated less than the other active single player. Extortioners incentivize their co-players to cooperate, and they obtain an excessive share of the resulting payoffs (Figure 4). Against an extortioner, single players could only gain by increasing their own cooperation rate, from which the extortioner would gain even more, as predicted by ZD theory [7].

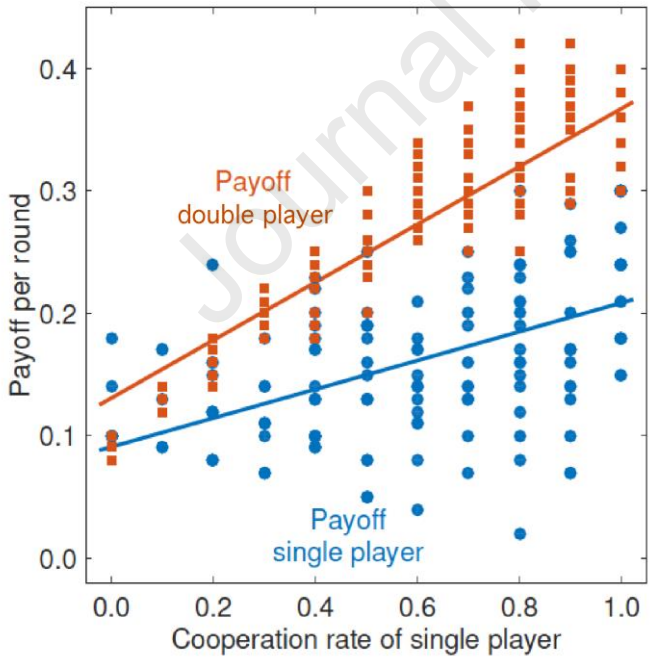

Figure 4. *Extortioners incentivize their co-players to cooperate*. For groups with an extortionate double player in the treatment with replacement, the graph shows how both the single and the double players' payoffs depend on the single player's cooperation rate. Each dot corresponds to an outcome of a 10-round block, across the 13 extortionate groups; the two lines represent linear regression curves. Extortioners adopt a strategy such that single players benefit from increasing their cooperation rate within each 10-round block (as the blue line has a positive slope). The more cooperative single players are, the higher is the share of

total payoffs that goes to the extortioner (as the distance between the two lines becomes maximal when the single players' cooperation rate approaches 100%). Adapted from [20].

As the results show, power asymmetries can easily pervert mutually beneficial interactions, and thereby favour the emergence of extortionate relationships. The existence of such extortionate strategies has been discovered only recently [7], only few empirical tests exist. Herein, it is shown that asymmetry can pave the way for these new ZD extortion strategies.

2. Conclusion

The long-standing belief that evolved social strategies can be only nice and cooperative [2-5] has been challenged by Press and Dyson's finding of the new Zero Determinant strategies for the Prisoner's Dilemma, e.g., the unbeatable extortion strategy enforcing cooperation up to 100% just by responding with C to C slightly more often than 50%. To increase their own payoff co-players need to accede to extortion providing the extortioner with a much higher payoff. Co-players can resist only by giving up their own payoff by in this way costly punishing the extortioner by refusing to cooperate. In symmetric games extortion can thus be disciplined. In usually asymmetric situations, where either one player has the option to gain an extra payoff by being more competitive or has the power to replace uncooperative co-players, i. e., a common practice in companies, extortion wins the game. The specific design of the 'double player' experiment mimics certain aspects of labour markets, but most likely extortionate practices can emerge in many other asymmetric social interactions, e. g., big companies may play extortion against their suppliers. If suppliers do not cooperate enough, they will be substituted. Chains of supermarkets seem to extort farmers to sell their products for minimal prices. Both tennis and racing stars need not extort their home country for a tax reduction, they move to a low tax country. A review of potential examples of extortion being used in real life where it works or does not work would be desirable.

Extortion can win in negotiation scenarios where representatives risk losing their whole endowment if groups fail to reach a well-specified target sum as in the climate change game [21]. Also learning can boost extortion [22]. Extortioners cannot increase their frequency to 100 percent in evolving populations [15] because they end up with mutual defection when they meet each other. The more frequent extortioners become, the more often they lose from

meeting their own kind. Thus, there is a limit frequency of extortion beyond which more cooperative generous strategies have a higher overall payoff and can spread [15]. Experiments [19-21] found potential extortioners at a frequency of about 40% implying the limit frequency of extortion. Hence, about 40% of the people in the real world might be potential extortioners disguised as nice folks.

Credit author statement

Manfred Milinski: Conceptualization, writing – review and editing.

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Conflict of interest statement

The author has no conflict of interest.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: