Division of Economics, EGC
School of Humanities and Social Sciences
Nanyang Technological University
14 Nanyang Drive
Singapore 637332

Clash of The Temperaments: Why Vendettas Perpetuate

Friedel BOLLE and Jonathan H.W. TAN

2017

EGC Report No: 2017/08

HSS-04-90A
Tel: +65 6790-6073
Email: D-EGC@ntu.edu.sg

Clash of the Temperaments: Why Vendettas Perpetuate†

Friedel Bolle
European University Viadrina, Germany

Jonathan H.W. Tan
University of Nottingham, UK

Version: September 15, 2017

Abstract

The Vendetta Game dynamically models conflict resolution processes in which players can take turns to steal from one another probabilities of winning a prize. Vendettas are far more prevalent in the laboratory than predicted in equilibrium, assuming self-interest or even spite. To make sense of this, we identify four behavioral types each with their temperaments: melancholic *Gamesmen* (27%) who play equilibrium, antisocially sanguine *Sharks* (53%) who optimistically demand more than their equilibrium share, choleric *Educators* (17%) who punish greedy co-players or otherwise play equilibrium, and phlegmatic *Meeks* (3%) who demand less than their equilibrium share. Within games, i.e. through the course of stealing and counter-stealing, non-Sharks become greedier. Across games, the characteristic profiles of subject types sharpen with experience. Sharks earn least and Meeks earn most. The clash of temperaments perpetuates feuds. We compare our four types with the types of players observed in the related Repeated Prisoner's Dilemma game.

Keywords: conflict; vendetta game; experiment; temperaments; types

JEL classifications: C72, D74

PsychInfo classifications: 3020, 3120

† We are grateful to Fabio Galeotti, Marta Sernec, Kei Tsutsui, Eliza Tan, and Axel Sonntag for the research assistance. Many thanks to Shaun Hargreaves Heap, Nikos Nikiforakis, Ernesto Reuben, and participants to presentations in Ascona, Bari, Berlin, East Anglia (Norwich), Innsbruck, Jena, LUISS (Rome), Magdeburg, Southampton, and Turin for advice and encouragement. The financial support of the European University Viadrina, the University of Nottingham, and the University of East Anglia is gratefully acknowledged. Part of this paper was written when Jonathan Tan was Visiting Scholar at the Economic Growth Centre, Nanyang Technological University, Singapore.

1. Introduction

Peace is fragile.[1] The United Nations Peacekeeping effort is presently supported by a $7.9 billion budget and 111,512 personnel, 90,905 of whom are uniformed Blue Berets out in the field. This is not enough. Figure 1 shows the prevalence of bloodshed in conflicts worldwide. Conflict also prevails in organizations between people who strive towards individual goals at the expense of morality and other colleagues. As caricatured by Erika Sheffer's play "The Fundamentals" that premiered at Steppenwolf Theatre (Vitello, 2016), the conflict of individual ambitions at the workplace is truly a human resource management challenge (Bolle et al. 2010) and one that undermines firm performance (Bae and Lawler, 2000). Another important example is domestic violence, which finds its origins in marital conflicts on various issues of disagreement including trivial ones (Johnson, 2010). Conflicts escalate and fly out of control, as do tempers. In all these cases, the pursuit of conflicting interests fuels feuds that ultimately leave no one better off. Emotions determine economic behavior (Elster, 1998; Loewenstein, 2000).

<Insert Figure 1 about here.>

In this paper, we attribute the fragility of peace to the diverse temperaments that people have. We define temperaments as the affective disposition to strategic interactions that manifest as actions in anticipation or response to others' behavior. Temperaments determine the speed and magnitude of reactions and whether they are driven by emotions and strong and instinctive reciprocity or by rational analysis. The four temperaments was initially discussed as a proto-psychological theory of four fundamental types: the *sanguine* who are optimistic, manic, mobile, expressive, and changeable; the *choleric* who are hot-tempered, fast to react, and irritable; the *melancholic* who are analytical, wise, and quiet; and the *phlegmatic* who are relaxed and peaceful (Steiner, 1944). Temperaments have also been used in personality psychology to describe approach and avoidance dispositions to goals (Tellegen, 1985; Clark; 1993). We identify patterns of strategic behavior and emotions that are associated with various temperaments in a conflict setting where these differences are highly visible.

From an economic perspective, conflicts are often resolved through dynamic processes that are tedious and costly. Imagine two employees competing for promotion. By sabotaging the competitor, one can decrease the other's chance of promotion and increase his or her own chance. Thus, the act of sabotage amounts to stealing. One gains, however, less chance than the competitor loses for instance if mudslinging increases a third party's chance. The game of stealing and counter-stealing ends when both players stop stealing or when both winning probabilities hit rock bottom. Contests as such entail acts of "deliberate sabotage" (Chowdhury and Gürtler, 2015). Bolle et al. (2014) present further examples of mutual sabotage, and model them as a Vendetta Game (VG). In this game, two players can take turns to steal from one another probabilities of winning a prize. In the unique equilibrium at most one act of stealing should be observed. The same applies for all subgames that might be reached after non-equilibrium play. In the experiment by Bolle et al. (2014), however, stealing was abundant

[1] "Peace Is Fragile" was even printed on a porcelain grenade featured on a UN advertisement by Saatchi and Saatchi Australia (MacLeod, 2007).

and more than 2/3 of the games ended with both players having minimal winning probabilities. This state of doom was reached after many iterations of stealing and counter-stealing.

The VG has a similar structure as a repeated prisoner's dilemma (PD), and so it generates a similar range of outcomes in this very important class of cooperation games. However, there are some differences between the games. First, players in repeated PD receive a sequence of payments while in VG payment depends only on the terminal state. Second, because of its move structure, VG should essentially compare with a repeated *sequential* PD, but there do not seem to be many experiments with this game. Third, as finitely repeated PD games VG has a unique equilibrium, but this equilibrium is cooperative under not too extreme social preferences while in the repeated PD it is uncooperative. Contrary to theory, however, Vendetta games normally result in conflict while sequential PD games, whether finely or infinitely repeated, show a good amount of cooperation. Fourth, in most stages of the game, VG allows players more than a binary choice: Players can steal less than the equilibrium amount, they can steal the equilibrium amount, or they can steal more. While a defective choice in a PD game can be motivated by fear or greed, under normal preferences stealing more than the equilibrium amount is always greedy.

Players in VG move through the intermediate states spanning across the polar extremes of cooperation and conflict. Because of its non-binary choices, VG allows for the escalation of conflict in a gradual manner. Starting from a default of mutual cooperation, players can take from each other, thereby reducing the cooperation step-by-step as they apocalyptically move towards mutual destruction. Thus we can observe the dark side of human nature, which other experiments do not reveal as clearly as the VG. Although we have highlighted the differences between VG and repeated PD, we should note that, more importantly, both explore the tension between cooperation and exploitation. So it is not too surprising that experimental investigations of repeated PD regularly identify similar types of players as we did in VG (Dal Bo and Frechette, 2017, in a survey of mostly infinitely repeated PD experiments): Total deviators, comparable with our sharks; total cooperators, comparable with our meeks; two species of tit-for-tat players, comparable with our Gamesmen who also play tit-for-tat; Grim players who start with cooperation and keep it unless the co-player deviates, then they play always defective; and WSLS (Win-Stay-Lose-Shift) players whose strategy allows to re-establish cooperation. The last two strategies are both comparable with our Educators, a statement that will be discussed later.

The VG also shares similarities with the Dollar Auction (Shubik, 1971) where two players alternately bid for a dollar. The highest bidder gets the dollar and both players pay their highest bid. Dollar auctions and wars of attrition describe patent races or trying to get a promotion by ever increasing one's effort.[2] VGs also describe competition, but by means of defamation and sabotage: Harbring et al. (2007) analyzed how many prizes minimize sabotage. The act of stealing is akin to making a proposal in favor of the self in a Rubinstein (1992) bargaining game with increasing costs

[2] Hörisch and Kirchkamp (2010) find overbidding in all-pay auctions but not in wars of attrition experiments.

for subsequent proposals. However, experimental subjects in Rubinstein bargaining experiments are far less aggressive than in the VG (see e.g. Binmore et al., 1991; Anbarci and Feltovich, 2013). A possible reason is that in Rubinstein bargaining players exchange proposals, whereas in VG they are (seemingly) endowed with property rights that are violated by each new “proposal”. Another difference between the VG and other bargaining games is that, in the former, negotiations concern winning probabilities while, in the latter, they are about monetary payoffs.

In the VG, under assumptions of self-interest or social preferences including spite, peace is paradoxically the game theoretic equilibrium. However, experimental subjects feud to the bitter end. Thus, we analyze the heterogeneity of behavioral types responsible for the perpetuation of vendettas, a phenomenon that was left unexplained in previous analysis focusing on aggregate behavior (Bolle et al., 2014). Our approach acknowledges that people are different, and that temperaments are more crucial in determining social conflict than social preferences are. The findings prompt fresh new attempts of modeling dynamic social behavior. This study sits along the lines of Fischbacher et al. (2001), who showed the importance of understanding heterogeneity in experimental games, and described different behavioral types in public good experiments. Half of their subjects were typed as “conditional cooperators” who match the average contributions of co-players, one third of the subjects were “free-riders” who contribute nothing, and the rest displayed less regular behavioral patterns. This pure description is extremely valuable because it provides an explanation for the gradual decrease of contributions in public good experiments, and because it directs the search for explanation of behavior with preferences. Other examples of type-identifications include Engelmann and Strobel (2004), Dal Bo and Frechette (2011), and Bolle et al. (2012). Random utility models estimate the continuum of types identified by the parameters of utility functions, e.g. Cappelen et al. (2013). We depart from previous research by delving into the dark side of human nature in a game of feudal conflict and mutual destruction.

Our study has four steps. In the first step, we define types by characterizing subjects based on their decision patterns in the dynamic game, using the equilibrium strategy as benchmark: “If you have a similar chance of winning as your co-player, then do not steal; if you have less, then steal an amount that helps equalize chances.” In the second step, we estimate the expected payoffs of each type and check the stability of each type’s strategy in the course of each game and in the course of the experiment. In the third step, we compare across types various self-reported emotions experienced during the experiment. This serves to link the identified behavioral types with temperaments. Indeed, negative emotions motivate the punishment of free riders in public goods games (Joffily et al, 2014), and giving subjects alternative outlets to vent reduces inefficient punishment (Dickinson and Masclet, 2015). Emotions play important roles in resolving organizational conflict (Gelfand and Brett, 2004), and understanding them guides the modeling of motives (Elster, 1998). Most importantly, emotions are essential in the construct of temperaments (Elliot and Thrash, 2002). In the fourth step, we discuss how this clash of temperaments might be characterized in the framework of antisocial preferences and how this mix drives vendettas.

2. Background on the Vendetta Game

2.1 The game

In the VG, two players 1 and 2 decide alternatingly whether or not to steal from one another the probability of winning a lottery. The current state of a game is denoted $P = (p_1, p_2)$, where p_i is player i's winning probability. Stealing takes place in blocks of q. One can steal as many q as the co-player has. When player 1 steals q, then the player 2's winning probability decreases by q but player 1's winning probability increases only by αq, with $0 < \alpha < 1$, i.e. the vector $(\alpha q, -q)$ is added to P. For each q that player 2 steals, $(-q, \alpha q)$ is added to P. The state of play is common knowledge.

The game ends when both players have not stolen for two successive turns each, or when they arrive in a *terminal point* $\bar{P}$ where both players can no longer steal because both hold less than q. In Bolle et al. (2014) it is shown that, for every initial state S, there is a unique $\bar{P}$ and a unique sequence of *endpoint* states $E_k = \bar{P} + k(1 - \alpha)(q, q)$, which are the equilibrium states of all subgames. From every feasible state exactly one E_k can be reached by one act of stealing (including stealing nothing if the state is E_k). This act of stealing describes equilibrium behavior. For example, consider Figure 2, which describes two of the four experimental games.

Figure 2a shows, as shaded cells, the feasible states in the area $P \in [0, 58.3] \times [0, 58.3]$ that can be reached from the initial point (45,45). There are some further feasible states outside this area. The lightly shaded boxes indicate equilibrium states E_k of subgames. In equilibrium, players should acquiesce in the initial endpoint. If a one deviates from equilibrium, then the other should play tit-for-tat to reach one of the lightly shaded boxes, where the game should end.

<Insert Figures 2 about here.>

If a game starts in a non-equilibrium state, then the disadvantaged player with a lower winning probability should steal to arrive at the nearest endpoint, where the game should end. Figure 2b shows a game starting at an asymmetric initial state S, which is not an endpoint. In equilibrium player 2 steals to equalize winning probabilities as much as possible. Non-equilibrium Pareto-inferior states result from further acts of stealing. Applying backward induction, in both figures it is demonstrated that in the endpoints E_1 and E_2 (in Figure 2b also E_3) no player who can steal should steal. Bolle et al. (2014) show that this procedure is generalized to all endpoints, and the conditions for the above equilibria are satisfied under a large variety of social preferences including altruism, spite, inequality aversion (Fehr and Schmidt, 1999), and reciprocity (Charness and Rabin's, 2002). The intuition of the proof is that these self-interest and social preferences satisfy the assumptions required for the equilibrium to hold: players prefer endpoints that are payoff-superior to both disadvantaged states and the remaining feasible endpoints. A player who is not in an endpoint should steal to reach the next endpoint, and one in an endpoint should acquiesce and not steal, anticipating that stealing to advantageous non-endpoints only triggers counter-stealing that results in inferior states.

2.2 The experiment

The experiment was conducted at a British university. In each session, subjects played four VGs, one in each of the four *stages*. At the start of each stage, subjects were randomly and anonymously paired. Pairs were assigned an initial probability (45%-45% in half the sessions or 65%-25% in the other half) of winning a prize of 10 pounds, and told that this assignment will be constant across all four stages of the experiment. The first mover was chosen randomly. Subjects took turns to steal probabilities in multiples of 10% from co-players. The stage ended if both subjects either did not steal for two consecutive rounds each (for robustness to mistakes, allowing for a change of mind) or had no winning probabilities left to steal.

We analyze the data of four main treatments from Bolle et al. (2014).[3] There were six sessions per treatment with eight subjects per session. Subjects played the treatments either with or without between round emotion elicitation. Each treatment was played with an endogenously determined number of rounds. Transfer rates were either 1/3 or 2/3 played in the first or last two stages or in the counterbalanced order. In half the sessions, after subjects had made their decisions in each round, they were asked to rate the extent to which they felt anger, happiness, or surprise, on a Likert scale between 0 (no emotion) and 7 (high intensity of the emotion).

The experiment was fully computerized. Subjects read experimental instructions and answered a control questionnaire before playing the games. Please see Appendix A for the instructions. We used a neutral frame, e.g. saying “taking away” rather than “stealing” winning probabilities. At the end of every session, subjects rated the extent to which they had felt on average during the experiment each of a set of eleven emotions used by Bosman and van Winden (2002), again on a Likert scale between 0 (no emotion) and 7 (high intensity of the emotion). Please see Appendix B for the questionnaire. At the end of the experiment, the computer performed random draws based on final winning probabilities to determine whether one of the subjects for each pair won the 10 pounds and if so which one, or whether neither did. Payments were cumulative across stages, and so subjects could earn 0, 10, 20, 30 or 40 pounds plus a fixed fee of 4 pounds. Average payments were 10.60 pounds for up to about 1½ hours of work. The low payments reflect the prevalence of perpetuated vendettas.[4]

2.3 Aggregate results

[3] We do not analyze all eight treatments tested by Bolle et al. (2014) to avoid unnecessary confounds from treatment variations. In particular, two treatments had time lags between rounds or tasks played in reverse order within rounds, and the two had parameters such as restricted endpoints and extreme transfer rates that do not allow for the wide range of behaviors that the other treatments allow.

[4] Further details on the experimental design can be found in Bolle et al. (2014), and are not central to our analysis and therefore not presented here.

Figure 3 illustrates a typical distribution of final states observed in the experiment. In equilibrium the disadvantaged player 2 should steal 20% from player 1 and no further acts of stealing should occur. Such play was observed only *once* in 48 games tested. In 35 games stealing perpetuated until both players had less than 10% winning probability. As Table 1 shows, this is similar in the other treatments; on average 71% of the games end with minimal winning probabilities. The percentage is significantly lower if, between moves, emotions were elicited, but not when stealing is less efficient (with $\alpha = 1/3$ instead of $\alpha = 2/3$). There is no significant reduction of across stages. We focus on explaining this phenomenon.

<Insert Figure 3 and Table 1 about here.>

3. Identifying types of behavior

Our classification of types is benchmarked on equilibrium behavior described in the previous section. We first distinguish between two different states: 1) "equal/advantaged" where the player should not steal in equilibrium, and; 2) "disadvantaged" where the player steal to reach the nearest endpoint. Actual behavior in these two states can be different. In "equal/advantaged" situations, subjects can play the "greed" strategy by stealing something, or play "equilibrium" by stealing nothing. In "disadvantaged" situations, subject can play "equilibrium" by stealing the amount required to reach the next endpoint, play "appeasement" with stealing less than required in equilibrium, or play "punishment/greed" with more than required in equilibrium.

A player always has the full choice between these behavioral strategies bar two exceptions. We do not use observations in these states to identify types. The first exception is when the game is a step away from the terminal point. Here, the player is "disadvantaged" and can either play "equilibrium" by stealing one unit to reach the terminal point, or play "appeasement" by not stealing, but the "punishment" strategy is unavailable. The second exception is when the player is "equal/advantaged" and the co-player has nothing left to steal. Here the player cannot play "greed".

<Insert Figure 4 about here.>

A player's behavior is described by a three-dimensional vector (q_A,q_R,q_G) with the frequencies of behavior q_A and q_P of "appeasement" and "punishment/greed" when "disadvantaged" and the frequency q_G of "greed" when "equal/advantaged". In both cases, "equilibrium" accounts for the remaining observations. We aggregate over all rounds of a game and over all four games of the experiment. Four subjects were never "disadvantaged" or "equal/advantaged", leaving 188 subjects for the analysis. We perform a hierarchical cluster analysis based on average Euclidian distances (see Appendix C for technical details). There is an outlier cluster of five subjects we call "Meeks" who played mainly "appeasement" and "equilibrium". This cluster occurs for cluster numbers *n*=2 until *n*=7 and beyond. Therefore we aim to identify at least three clusters. The optimal cluster structure is suggested as the minimum of the Davies-Bouldin (Davies and Bouldin, 1979) Index or the maximum of the Dunn-Index (Dunn, 1973) shown in Figure 4. Therefore the optimal number of clusters should be 4, 5, or 6.

<Insert Figure 5 about here.>

If we increase the number of clusters to seven (see Figure 5), the two new clusters “Mixed” and “Gamesmen” differ considerably only in terms of the “greed” dimension q_G. The advantage of dealing with a cluster of “purer” equilibrium types is accompanied by less powerful tests and the difficulty of characterizing the “Mixed” cluster. Therefore, guided by these indices, we shall consider structures with at most 6 clusters. The steps to n=5 and n=4 involve eliminating two small clusters (with two and ten members), which cannot be expected to be characterized by many significant differences with respect to other variables. Therefore we use a cluster structure of n=4. The four remaining clusters may be described as follows.

Cluster 1 (**Sharks**): Sharks make up 53% of subjects. Their pure type is (0,1,1), their average type is (0.11, 0.66, 0.92). Most of the time, Sharks steal more than the equilibrium amount. They rarely play equilibrium, and almost never play appeasement.

Cluster 2 (**Educators**): Educators make up 17% of subjects. Their pure type is (0,1,0), their average type is (0.01, 0.85, 0.35). When Educators are disadvantaged, they never play “appeasement” but “punishment” most of the time, because they have been put in the disadvantaged situation by an unkind move of their co-player. When Educators are not disadvantaged, they play “equilibrium” 2/3 of the time.

Cluster 3 (**Gamesmen**): Gamesmen make up 27% of subjects. Their pure type is (0,0,0), their average type is (0.21, 0.33, 0.20). When Gamesmen are disadvantaged, they play “equilibrium” half of the time, punishment or greed one third of the time and appeasement one fifth of the time. When Gamesmen are not disadvantaged, they play equilibrium 80% of the time.

Cluster 4 (**Meeks**): Meeks make up 3% of subjects. Their pure type is (1,0,0), their average type is (0.82, 0.09, 0.28). Most of the time, Meeks play “appeasement”.

Note that subjects rarely constitute pure types. They deviate randomly because of errors or temporary fluctuations of mood, but in rare cases they seem to deviate systematically. An example is shown in Figure 2c When subject 38 (identified as a Gamesman) plays against subject 33 (a Shark) he always plays equilibrium, but when he plays against subject 36 (also a Shark) then his first move (which is the initial move in the game) is equilibrium play, i.e. not stealing, but in all his next moves he acts like an Educator. The two Sharks always play like pure types. The difference is not only that 38 has the first move against 36 and started peacefully, but also that 36 steals higher amounts than 33.

Without a considerably larger data base, however, it does not seem sensible to carry out a cluster analysis with a more detailed description of behavior.

The majority of subjects are Sharks who consistently play “greed”. They seem optimistic that co-players would be convinced of their toughness and be forced into settling for a disadvantageous distribution of winning probabilities. The second and third clusters play “equilibrium” unless their co-players play “greed”, to which each cluster reacts differently: Gamesmen reply with equilibrium play, while Educators reply with punishment.

The behaviors of different types are analogous to the types mentioned in the socio-cognitive model of dual concerns in conflict management (Thomas, 1976; Pruitt, 1983), where individuals are characterized by the concerns they have for personal goals and relationships. Sharks are “assertive” of their personal goals and have low concerns for relationships. Educators are both “assertive” and “collaborative”, with high concerns for relationships and personal goals, and are therefore willing to punish Sharks that try to take from them. Gamesmen are relatively less “assertive” than Educators and instead more “compromising”. Meeks have low concerns for personal goals and “accommodate” others’ demands (if they have high concerns for relationships) or “avoid” conflicts (if they have low concerns for relationships).

4. Performance and behavioral change

<Insert Table 2 about here.>

Table 2 shows that Meeks are the highest earners, and Sharks are the lowest earners. Meeks are the only ones who will settle for disadvantageous outcomes. However, they earn higher than other types on average, because unlike the other three types they are the only type whose behavior does not feed into a tit-for-tat loop of inefficient stealing and counter-stealing. This pays off when they meet less greedy Sharks and non-greedy Gamesmen and Educators.

<Insert Table 3 and 4 and Figures 6 and 7 about here.>

Let us look at behavioral changes of different types *within* games, after losing half of the expected aggregate payoffs (i.e. initial winning probabilities). Our estimates in Table 3 are based on the behavior of 175 subjects in “disadvantaged” situations and 80 in “equilibrium/advantaged” situations who reach the thus defined second half of a game at least once and experience “disadvantaged” situations or “equilibrium/advantaged” situations in both halves of games. All types become greedier and, with the exception of Gamesmen, less appeasing. Gamesmen switch from equilibrium play to punishment. In the course of a game all players become a bit or a lot more shark-like, similar to “reciprocating misbehavior” (Charness and Rabin, 2002) or “escalating entrapment” (Brockner and Rubin, 2012). The greediest players, the Sharks, do not learn their lesson but go on trying to “win” a game which can hardly be won against rational co-players and less than ever against players who fight back more fiercely instead of backing down. In section 6 and in Appendix D we suggest a behavioral model that captures this process.

Behavioral changes *between* games go in the opposite direction. Subjects mellow to become less greedy, less eager to punish, and more appeasing. With the exception of the Sharks, types by and large sharpen their profile: Figures 6 and 7 show that they move closer to that corners that indicate their pure type. From game-to-game, all types become less demanding, perhaps as a consequence of some rational insight; but alas, being victim of others' greed at the beginning of a new game makes them respond with escalations of nasty behavior.

5. Emotions experienced by each type

In this section we look at the emotions experienced by different types. This is interesting for two reasons (for a methodological review of emotions and economics, see Elster, 1998). First, it allows us to match our interpretation of the behavioral clusters estimated above against the emotions that we would expect such types to experience in their interactions – be it intended or induced. Second, it informs us of the subjective utility such types derive from their behavior, assuming utility maximization, and guides the modeling of preferences. We now consider the eleven emotions following Bosman and van Winden (2002): anger, anxiety, contempt, envy, fear, happiness, irritation, jealousy, joy, shame, and surprise. We mainly compare the intensity of emotions Educators and Gamesmen experience against those Sharks. As there are very few Meeks, we shall also mention – albeit briefly – comparisons of Educators and Gamesmen to Meeks.

Before we discuss our results let us make a methodological remark. For every emotion we can make six comparisons between the four types of subjects which results in 66 tests. The probability that we randomly find some significant differences on the 5% or even the 1% level is relatively high under such circumstances. When we look at the averages in Table 5, however, we see an apparent difference between Sharks on the one hand and all other types on the other hand. Therefore we concentrate on the comparison between Sharks and non-Sharks and use the methodologically preferable comparison on the basis of independent sessions. We supplement these 11 tests with 33 comparisons between Sharks and other types on the basis of individual emotions. (With eight subjects per session, most sessions contain three and many only two types of subjects). Table 5 shows no apparent contradictions between the evaluation methods.

<Insert Table 5 about here.>

Our results are summarized in Table 5. To begin with, there are no significant differences between the types in terms of anxiety, happiness, joy and surprise. This suggests that while subjects driven by different motives behave differently from one another, they experience similar degrees of core conflict emotions. It reflects their affective commitment to the interaction (Davidson and Greenhalgh, 1999). Table 5 also tells a story of how emotions vary across behavioral types identified. Sharks are jealous of what others have, and such covetousness motivates stealing. While stealing, they fear that their attempts will be futile and that others (other Sharks, Gamesmen or Educators) will counter-steal from them, i.e. karma. In turn, Gamesmen and Educators get angrier and more irritated when Sharks simply do not follow equilibrium play, especially when such behavior is to everyone's detriment. Anger drives retaliation (Allred, 1999; Dickinson and Masclet, 2015; Hopfensitz and Reuben, 2009).

Conversely, Sharks have less reason to be angry at being unable to keep what was not originally theirs. On the flipside, Gamesmen naturally feel contempt and envy when Sharks steal from them, because of the dominance imposed and the unjustified loss inflicted upon them – but they do not mete out punishment. "Contempt is rarely expressed in an overt statement but rather through ignoring one's counterpart" (Morris and Kelter, 2000, p. 29). Gamesmen suffer in silence by playing "appeasement" 1/5 of the time when disadvantaged. Educators do not feel such contempt and envy, however, as they instead take it out on the Sharks by stealing back. In contrast, it is not in the nature of Meeks to feel jealous. They prefer acquiescing in disadvantaged states.

These four behavioral types relate to *four temperaments* originating from Hippocrates's "four humors" theory of Greco-Roman medicine. Each type has a predominant temperament. Indeed, "[the] four fundamental types […] naturally never manifest themselves in such pure form. Every human being has one basic temperament, with varying degrees of the other three mixed in. (Steiner, 1944)" Eastman (2015) considers the behavior expected of each temperament in games labeled as "Harmony" (e.g. pure coordination game), "Imperfect Harmony" (e.g. stag hunt game), and "Disharmony" (e.g. prisoner's dilemmas and zero sum games).[5] He argues that in game theoretic settings, the *melancholic* temperament is reactive, negative, anxious, ashamed, and fearful; the *choleric* temperament is negative, driving, angry, punishing, and self-punishing; the *phlegmatic* temperament is cool, pragmatic, practical, calm, and stolid; the *sanguine* temperament is optimistic, active, positive, highly individualized, and self-concerned.

Translated to our study, Gamesmen are melancholic, Educators are choleric, Meeks are phlegmatic, while Sharks are sanguine but in an antisocial way. Eastman (2015) consistently argues that the phlegmatic temperament is "helpful in solving Imperfect Harmony games in which one good turn deserves another", the melancholy temperament "helps in resolving difficult Partial Disharmony games without undue conflict", and the choleric temperament "enforce decent behavior in highly difficult Disharmony games like the Prisoner's Dilemma". However, while Eastman argues that the sanguine temperament can aid social interactions in "Harmony" games, he states they also have an antisocial side like the one we have observed in our "Disharmony" Vendetta Game.

6. Comparison with repeated PD experiments

Experimental investigations of repeated PD regularly identify six types of players (Dal Bo and Frechette, 2017, Figure 5, in a survey of mostly infinitely repeated PD experiments): Total deviators, comparable with our Sharks; total cooperators, comparable with our Meeks; two versions of tit-for-tat players, comparable with our Gamesmen who also play tit-for-tat; Grim players who start with

[5] The concept and operationalization of harmony in games was first introduced by Zizzo and Tan (2007).

cooperation and keep it unless the co-player deviates, after that they play always defective; and WSLS (Win-Stay-Lose-Shift) players who keep their strategy under cooperation or when they are advantaged and who change strategy in the non-cooperative state or when they are disadvantaged. If both players play WSLS, then they re-establish cooperation even after random deviations from this state.

The two versions of tit-for-tat differ only according to their initial move; a player who starts with defection and otherwise copies the previous move of his co-player is called a "suspicious tit-for-tat" player. For our Gamesmen this distinction would be highly artificial. While tit-for-tat behavior in repeated PD games is a plausible behavioral hypothesis, Gamesmen in VG play the unique equilibrium, which *requires* imitating their co-players. Nonetheless, our Gamesmen and both tit-for-tat players seem to be similarly motivated.

Our Educators have similarities with Grim players as well as with WSLS players. We must keep in mind, however, that Grim and WSLS are defined for sequences of 2x2 simultaneous move games. Therefore let us characterize them in more general terms. Grim players and Educators punish harder than tit-for-tat players, in repeated PD by always deviating, in VG by stealing more than the equilibrium amount. WSLS player react to a deviation from a cooperative state first like tit-for-tat or Grim players, but after a period in the non-cooperative state they are ready to re-start cooperation. Educators are similar: they are also ready to re-establish a cooperative equilibrium state. Unfortunately, however, WSLS players are almost never identified in experiments so that only Grim players remain as counterparts to our Educators who are certainly more "forgiving" than Grim players.

A last comparison concerns the frequencies of types observed in repeated PD and VG. In Dal Bo and Frechette (2017, Table 10) the results of type identification in six experiments with altogether 17 treatments are reported. On average 3% of the players always cooperate (we have 3% Meeks), 44% always deviate (53% Sharks), 17% play Grim (17% Educators), and 36% play one of the two versions of tit-for-tat (27% Gamesmen).

7. Heterogeneous and extreme preferences across types

As Bolle et al. (2014) and Tan et al. (2015) have shown, even inequity-averse or moderately spiteful subjects should cooperate rather than fight. Moderately spiteful subjects would not spend a dollar to reduce the income of another subject by a dollar. While extremely spiteful subjects would, it is hard to imagine that so many subjects are so spiteful. Stealing in equilibrium states leads to mutual loss. This should be obvious to subjects if they are close to the terminal state of the game, i.e. as backward induction becomes easier. Alternatively, even if players only *pretend* to have extreme preferences to scare co-players, they would still not have the incentive to steal in the endpoint just before terminal states are reached. This suggests that at the outset players pretend to be extremely spiteful, but after many rounds of stealing and counter-stealing they actually become extremely spiteful.

For this explanation to hold, a player must be able to gain an advantage by convincingly pretending to be extremely spiteful. By "convincingly" we mean that pretenders behave consistently with the preference parameter of the type they pretend to be. In turn, players must be able to pretend by signaling, which can be modeled as second order beliefs about the effect one's stealing has on the co-player's beliefs about one being extremely spiteful. Also, extreme spite must be able to develop from repeated bouts of stealing and counter-stealing via reciprocal preferences (following Charness and Rabin, 2002). If so, then vendettas can be modeled by the heterogeneity of preferences as follows.

For generality, assume altruistic preferences $U_i = x_i + a_i x_k$, with x_i and x_k denoting incomes and a_i is the altruism parameter. We assume common knowledge of a_i (i.e. of true types or convincing pretenders who constantly behave according to the pretended preferences) and determine ranges of altruism that give rise to different types of behavior. Tit-for-tat as described above arises from altruism in a "normal" region of $-1 < a_i < \alpha$, where α denotes the share of stolen income that a stealing player receives. The proof is found in Bolle et al. (2014). Next, with both $a_i > \alpha$ players will not steal at all. If a player 1 with $a_1 < \alpha$ meets a player 2 with $a_2 > \alpha$, then player 1 will steal as much as possible and player 2 will not counter-steal. If a player 1 with $a_1 < -1$ meets player 2 with altruistic or mildly spiteful preferences, then a system of endpoints differing from those in Figures 1 and 2 apply. These endpoints give player 1 a higher equilibrium winning probability than player 2. The more spiteful player 1 is, the more player 2 has to leave to him. If, however, both players are sufficiently spiteful, i.e. $a_i < 0$ and $a_1 a_2 > 1$, then a vendetta reaching $\bar{P}$ is inevitable. The graphical proof is found in Appendix D.

<*Insert Figure 8 about here*.>

Thus, it is less plausible that subjects are actually spiteful enough such that $a_1 a_2 > 1$ is satisfied, and more plausible that many of them are altruistic in the "normal" region and pretend to be Sharks with $a_i < -1$. Co-players who do not believe them to be real Sharks act as Gamesmen; those whose preferences have developed to $a_i < -1$ because of their co-player's misbehavior (Charness and Rabin, 2002) mutate into Educators who revert to $a_i > -1$ if their co-player stops stealing. Meeks have $a_i > \alpha$ or assume to be confronted with a real Shark or a persevering pretender.

8. Conclusion

In this paper, we explained how and why feuds initiate and perpetuate. Observations show that subjects have conflicting ideas of how the game should play out. More feuding occurs in the VG than in the closely related Rubinstein (1992) bargaining game, possibly because co-players are perceived to be violating property rights in the VG, whereas they are perceived to be making proposals in Rubinstein bargaining. Following Babcock and Loewenstein (1997), one may interpret vendettas as a result of self-serving biases and conflicting perceptions of what constitutes a fair share. Similarly, experiments show that in many conflicts parties have the same information but rulings have to be decided by judges because of self-serving biases as to one's legal position (Babcock et al., 1995). In our experiment, only Sharks show such self-serving biases, and a sample with 53% of such Sharks suffices for vendettas to prevail.

We identified four behavioral types, which can apply to other conflict situations such as negotiations and dynamic competitions. In the sample, 27% are *Gamesmen* who play equilibrium, 17% are *Educators* who punish greedy co-players or otherwise play equilibrium, 53% are *Sharks* who demand more than their equilibrium share, and only 3% are *Meeks* who demand less than their equilibrium share. This structure emerged from a cluster analysis of the frequencies with which subjects stick to equilibrium behavior or deviate to more aggressive versus more appeasing behavior. Subjects learn to be their type and sharpen their profile from game to game, but *within* games all non-Sharks develop in the direction of Sharks. Only the Meeks surrender. Sharks persist in grabbing more than their co-player, while Gamesmen and Educators insist on equal shares. Sharks can only benefit by stealing from the Meeks, but there are so few Meeks that the Sharks' destructive strategy does not pay off. On average, Sharks earn least and Meeks earn most. The implication is that income-related directional learning occurs between but not within games. Instead, players pursue ambitions of equal or advantageous incomes with increasing stubbornness, i.e. "escalating entrapment" (Brockner and Rubin, 2012). The four types co-exist and clash, thereby perpetuating feuds.

Understanding behavior in the VG sheds light on inefficient feuding in such economic settings, which cannot be explained by existing models of social preferences (Bolle et al., 2014). In the present paper, our new empirical analysis of types helps us extend the understanding of the heterogeneous preferences that organize conflict behavior. Akin to this are typologies of behavioral types known as "sharks, owls, foxes, teddy bears and turtles" derived from dual concerns models (e.g. Thomas, 1976; Pruitt, 1983), which have often been discussed in research on conflict management styles (Falikowski, 2002) and applied in practice (e.g. in managerial training by the Institute for Leadership and Management, UK). This attests to the relevance of our work, which focuses on conflict resolution in a well-defined strategic setting and the confines of a controlled laboratory environment.

We base our type identification on incentivized behavior as Fischbacher et al. (2001) do. Types can then be compared with respect to personal attributes, factors of personality tests, and elicited emotions. A more traditional approach is to define types or personality characteristics (e.g., Big 5 or Big 6) on the basis of questionnaire data, and then test whether these types show different behavior or characteristics are correlated with behavior (Brandstätter and Königstein, 2001; Perugini et al., 201X; Swope et al., 2008). Also dual concern models are usually evaluated on the basis of questionnaires used to elicit emotions and goals in hypothetical negotiations (e.g. Sorensen et al., 1999). Our type structure is based on an experimental game that gave this array of conflict behavior to arise, and opens the path for more experimental evidence concerning conflicts. The comparison with the type identification in repeated PD games (Dal Bo and Frechette, 2017) shows an encouraging correspondence of the behavioral types in VG and PD. The problem with other extant studies is that most of them have too few individual decisions or too few conflict scenarios in which individuals decide. Therefore, the plausibility, consistency, and complementarity to concepts from the literature warrant further tests of the identified behavioral types.

The estimated structure of our data is plausible and supported by measures of the optimal number of clusters and correlations with emotions. Economic objectives of and emotions experienced by these types are mutually consistent. We referred to the literature on the dual concerns model in conflict management (Pruitt, 1983; Thomas, 1976) to show the relevance of our types, and on emotions in negotiations (Allred, 1999; Davidson and Greenhalgh, 1999; Morris and Keltner, 2000). This helped us to understand their motivations better (Elster, 1998; Loewenstein, 2000). On this basis, we suggested a set of behavioral assumptions, which in turn supports the theoretical plausibility of vendettas. Our explanation of "pretend-spite breeds real-spite" is plausible: similar feuds were hardly triggered off in an isomorphic public good settings experimentally studied by Tan et al. (2016).[6]

We also found that punishment by Educators did not influence the behavior of Sharks within games. Such persistence of antisocial behavior stands in contrast to public good experiments where the propensity to punish disciplines free riders (Fehr and Gächter, 2000). When the punished do not know who the punisher is, they can only counter-punish the whole group or a random co-player, so revenge is costly and ineffective (Chowdhury and Gürtler, 2015). When individuals can be targeted and counter-punished, the fear of revenge discourages punishment (Nikiforakis and Engelmann, 2011). In the VG, however, we find that Educators punish despite the risk of being counter-punished by Sharks, and vice versa. Furthermore, Gamesmen and Meeks continue to accommodate or appease. Further, we see that the strategic traits of the respective behavioral types persist through time.

In our experiment, subjects could build reputation only within games, and such reputation could not transfer across games due to the re-matching of co-players. If instead the same players interact repeatedly, then persistent behavior may favorably influence co-player beliefs and behavior in future interactions. This may be formalized as a long-term adaption of preferences or beliefs, which differs from the short-term dynamic preferences and invariable beliefs discussed in the previous section. Under such circumstances, would Meeks be disadvantaged instead? Which type would be most successful in such long-term relationships? We leave these questions to future research.

To conclude, our key message is that in social conflicts the interaction amongst different behavioral types each with their temperaments is crucial in starting and perpetuating feuds. Analysis based on the assumption of a "representative" player is potentially biased because it disregards the heterogeneity of types.

References

Allred, Keith G. 1999. "Anger and retaliation: Toward an understanding of impassioned conflict in organizations." *Research on Negotiation in Organizations* (7): 27-58.

Anbarci, Nejat, and Nick Feltovich. 2013. "How sensitive are bargaining outcomes to changes in disagreement payoffs?." *Experimental Economics* 16 (4): 560-596.

[6] Stealing results in efficiency losses, and equates to withdrawing public good contributions. The VG is therefore isomorphic to public good games where contributions start high and can be decreased.

Babcock, Linda, and George Loewenstein. 1997. "Explaining bargaining impasse: The role of self-serving biases." *The Journal of Economic Perspectives* 11 (1): 109-126.

Babcock, Linda, George Loewenstein, Samuel Issacharoff, and Colin Camerer. 1995. "Biased judgments of fairness in bargaining." *The American Economic Review* 85 (5): 1337-1343.

Bae, Johngseok, and John J. Lawler. 2000. "Organizational and HRM strategies in Korea: Impact on firm performance in an emerging economy." *Academy of Management Journal* 43 (3): 502-517.

Binmore, Ken, Peter Morgan, Avner Snaked, and John Sutton. 1991. "Do people exploit their bargaining power? An experimental study." *Games and Economic Behavior* 3 (3): 295-322.

Blanco, Mariana, Dirk Engelmann, and Hans Theo Normann. 2011. "A within-subject analysis of other-regarding preferences." *Games and Economic Behavior* 72 (2): 321-338.

Bolle, Friedel, Yves Breitmoser, Jana Heimel, and Claudia Vogel. 2012. "Multiple motives of pro-social behavior: evidence from the solidarity game." *Theory and Decision* 72 (3): 303-321.

Bolle, Friedel., Jonathan H. W. Tan, and Daniel .J. Zizzo, 2010. "Vendettas." Research note: *People Management Magazine*, 17 Jun, 36. Chartered Institute for People Development.

Bolle, F., J. H. W. Tan, and D. J. Zizzo. 2014. "Vendettas. American Economic Journal: Microeconomics, 6: 93-130.

Brandstätter, H. and Königstein, M., 2001. Personality influences on ultimatum bargaining decisions. *European Journal of Personality*, *15*(S1).

Brockner, Joel, and Jeffrey Z. Rubin. 2012. *Entrapment in escalating conflicts: A social psychological analysis*. Springer Science & Business Media.

Charness, Gary, and Matthew Rabin. 2002. "Understanding social preferences with simple tests." *The Quarterly Journal of Economics* 117 (3): 817-869.

Chowdhury, Subhasish M., and Oliver Gürtler. 2015. "Sabotage in contests: a survey." *Public Choice* 164 (1-2): 135-155.

Dal Bó, Pedro and Guillaume R. Fréchette. 2011. "The Evolution of Cooperation in Infinitely Repeated Games: Experimental Evidence." *American Economic Review*, 101(1): 411-429.

Dal Bó, Pedro and Guillaume R. Fréchette. 2017. "On the Determinants of Cooperation in Infinitely Repeated Games: A Survey." *Journal of Economic Literature*, forthcoming.

Davidson, Martin N., and Leonard Greenhalgh. 1999. "The role of emotion in negotiation: The impact of anger and race." *Research on Negotiation in Organizations* 7: 3-26.

Davies, David L., and Donald W. Bouldin. 1979. "A cluster separation measure." *IEEE transactions on pattern analysis and machine intelligence* 2: 224-227.

Dickinson, David L., and David Masclet. 2015. "Emotion venting and punishment in public good experiments." *Journal of Public Economics* 122: 55-67.

Dunn, Joseph C. "A fuzzy relative of the ISODATA process and its use in detecting compact well-separated clusters." (1973): 32-57.

Eastman, Wayne Nordness. *Why Business Ethics Matters: Answers from a New Game Theory Model*. Springer, 2015.

Elster, Jon. 1998. "Emotions and economic theory." *Journal of Economic Literature* 36 (1): 47-74.

Falikowski, A., 2002. *Mastering Human Relations*, 3rd Ed., Pearson Education.

Fischbacher, Urs, Simon Gächter, and Ernst Fehr. 2001. "Are people conditionally cooperative? Evidence from a public goods experiment." *Economics Letters* 71 (3): 397-404.

Gelfand, Michele J., and Jeanne M. Brett. 2004. *The handbook of negotiation and culture*. Stanford University Press.

Harbring, Christine, Bernd Irlenbusch, Matthias Kräkel, and Reinhard Selten. 2007. "Sabotage in corporate contests–an experimental analysis." *International Journal of the Economics of Business* 14 (3): 367-392.

Hopfensitz, Astrid, and Ernesto Reuben. 2009. "The importance of emotions for the effectiveness of social punishment." *The Economic Journal* 119 (540): 1534-1559.

Hörisch, Hannah, and Oliver Kirchkamp. 2007. *Less fighting than expected: experiments with wars of attrition and all-pay auctions*. No. 2008, 023. Jena Economic Research Papers.

Joffily, Mateus, David Masclet, Charles N. Noussair, and Marie Claire Villeval. 2014. "Emotions, sanctions, and cooperation." *Southern Economic Journal* 80 (4): 1002-1027.

Johnson, Michael P. 2010. *A typology of domestic violence: Intimate terrorism, violent resistance, and situational couple violence*. UPNE.

Loewenstein, George. 2000 "Emotions in economic theory and economic behavior." *The American Economic Review* 90 (2): 426-432.

MacLeod, D., 2007. United Nations Peace Is Fragile. The Inspiration Room. Last accessed Nov 24 2016: http://theinspirationroom.com/daily/2007/un-peace-is-fragile/).

Morris, Michael W., and Dacher Keltner. 2000. "How emotions work: The social functions of emotional expression in negotiations." *Research in Organizational Behavior* 22: 1-50.

Nikiforakis, Nikos, Charles N. Noussair, and Tom Wilkening. 2012. "Normative conflict and feuds: The limits of self-enforcement." *Journal of Public Economics* 96 (9): 797-807.

Perugini, M., Tan, J.H. and Zizzo, D.J., 2010. Which is the more predictable gender? Public good contribution and personality. *Economic Issues*, *15*(1), pp.83-110.

Pruitt, Dean G.. 1983. "Strategic choice in negotiation." *American Behavioral Scientist* 27 (2): 167-194.

Rubinstein, Ariel. 1982. "Perfect equilibrium in a bargaining model." *Econometrica: Journal of the Econometric Society*): 97-109.

Sorenson, R.L., Morse, E.A. and Savage, G.T., 1999. A test of the motivations underlying choice of conflict strategies in the dual-concern model. *International Journal of Conflict Management*, *10*(1), pp.25-44.

Steiner, R., 1944. *The Four Temperaments*, New York: Anthroposophic Press.

Swope, K.J., Cadigan, J., Schmitt, P.M. and Shupp, R., 2008. Personality preferences in laboratory economics experiments. *The Journal of Socio-Economics*, *37*(3), pp.998-1009.

Tan, Jonathan H.W., Yves Breitmoser, and Friedel Bolle. 2015. "Voluntary contributions by consent or dissent." *Games and Economic Behavior* 92: 106-121.

Thomas, Kenneth W.. 1992. "Conflict and conflict management: Reflections and update." *Journal of Organizational Behavior* 13 (3): 265-274.

Vitello, B., 2016. Steppenwolf's 'Fundamentals' examines conflict between ambition, integrity. Daily Herald. Last accessed May 15 2017: http://www.dailyherald.com/article/20161123/entlife/161129515/

Zizzo, Daniel John, and Jonathan HW Tan. 2007. "Perceived harmony, similarity and cooperation in 2× 2 games: an experimental study." *Journal of Economic Psychology* 28 (3): 365-386.

Tables and Figures

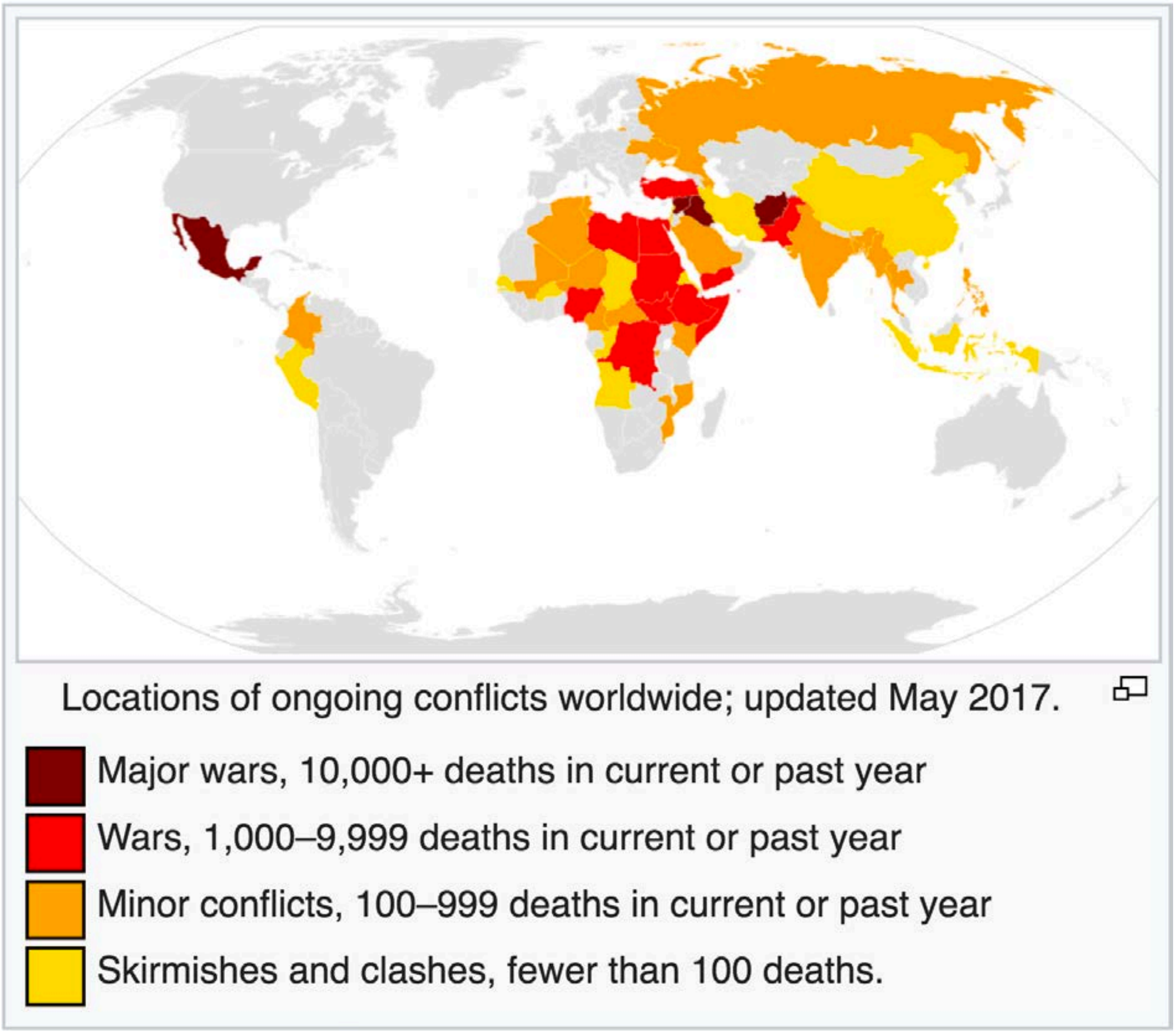

Figure 1: Locations of ongoing conflicts worldwide

(Source: https://commons.wikimedia.org/wiki/File:Ongoing_conflicts_around_the_world.svg accessed May 15 2017)

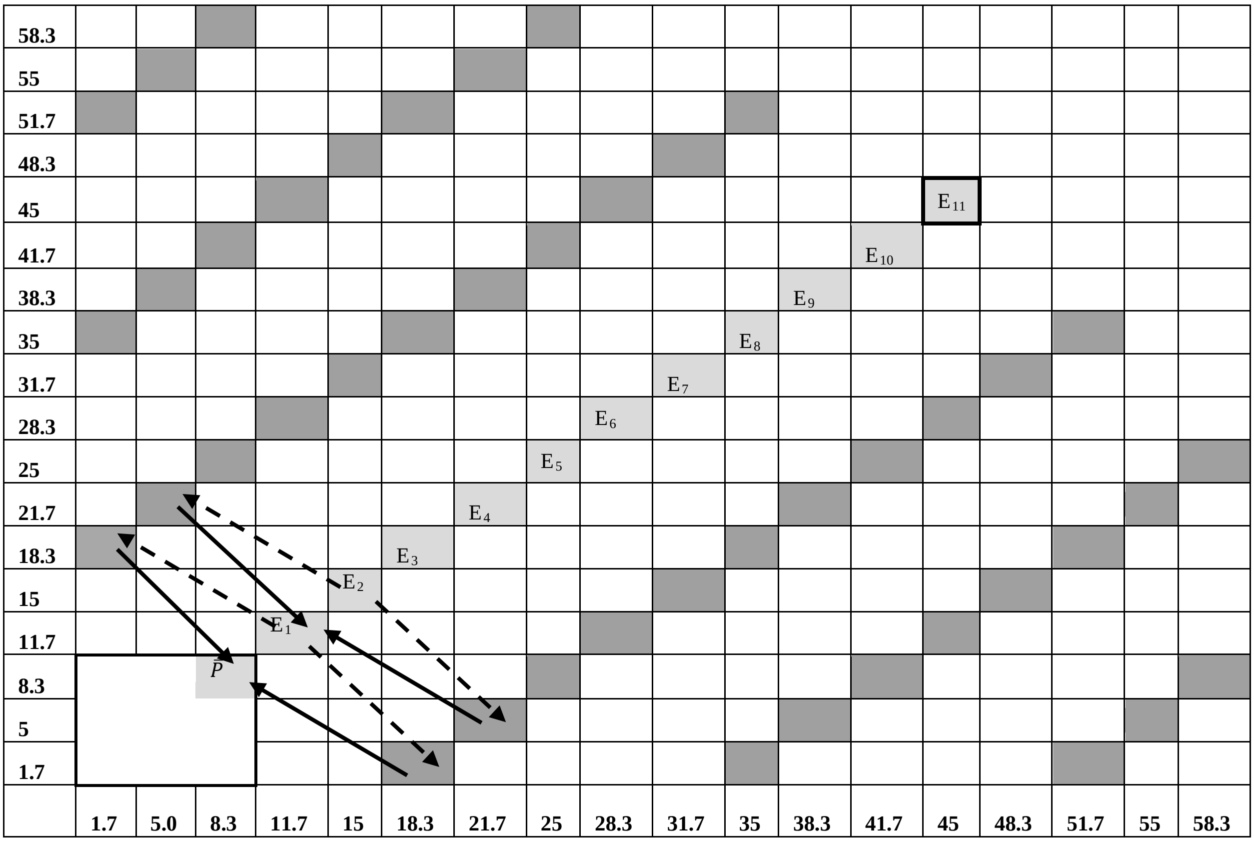

Figure 2a: The feasible states and endpoints of the Vendetta Game with α = 2/3 and $S = (45\%, 45\%)$. Player 1's winning probability is found on the horizontal axis.

Notes: Shaded areas indicate feasible states. Lightly shaded areas are the equilibrium states of all subgames (under Fehr-Schmidt inequality aversion or altruistic preferences $U_i = x_i + a_i x_k$, with x_i and x_k denoting incomes and $-1 < a_i < \alpha$). The box at the origin contains the terminal states, in particular $\bar{P} = E_0$. The initial state is $S = E_{11} = (45\%, 45\%)$. Bold (broken) line arrows indicate examples of equilibrium (non-equilibrium) moves.

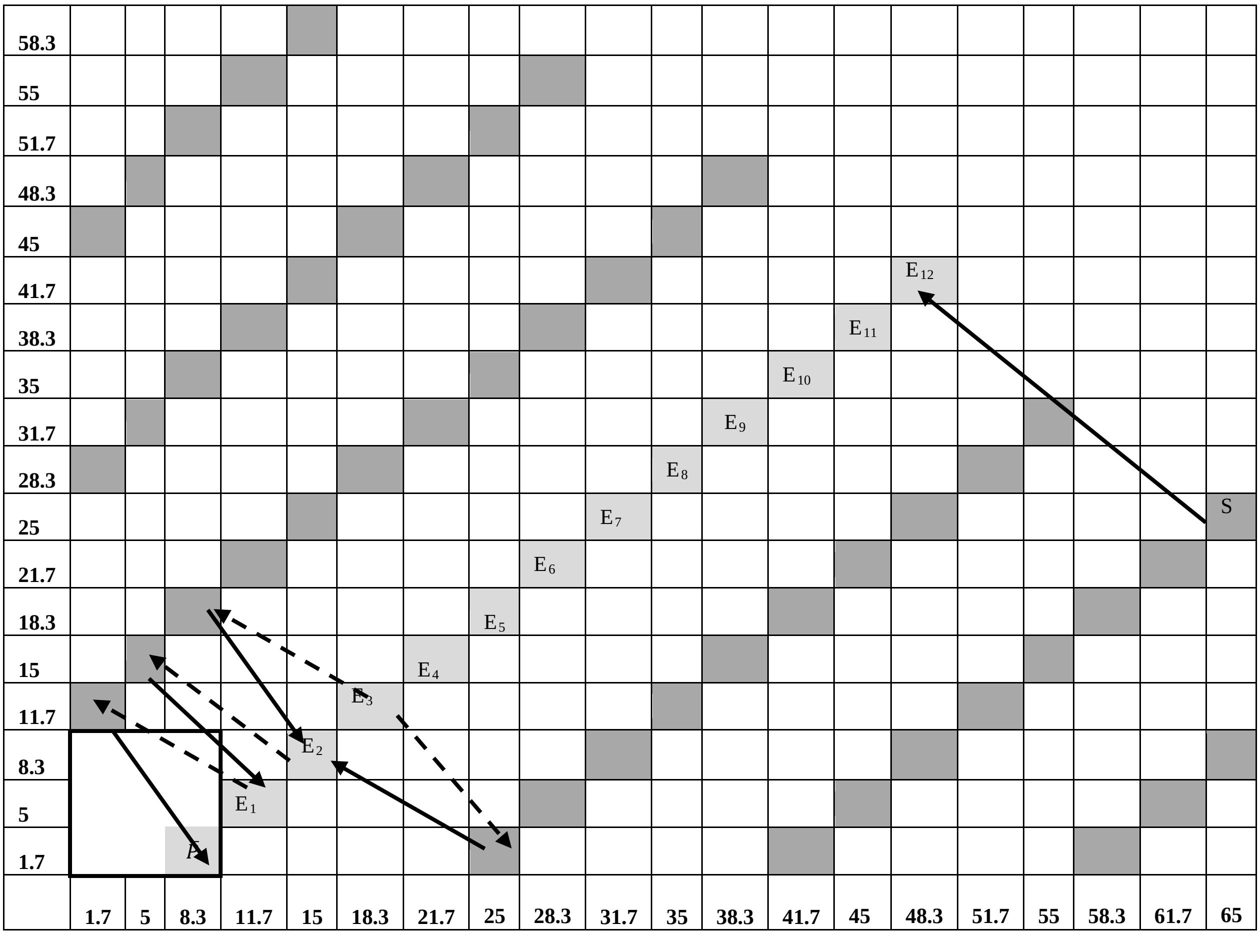

Figure 2b: The feasible states and endpoints of the Vendetta Game with α = 2/3 and $S = (65\%, 25\%)$.

Notes: Shaded areas indicate feasible states. Lightly shaded areas indicate the equilibrium states E_k of all subgames (under Fehr-Schmidt inequality aversion or altruistic preferences $U_i = x_i + a_i x_k$, with x_i and x_k denoting incomes and $-1 < a_i < \alpha$). The box at the origin contains the terminal states, in particular $\bar{P}$. The initial state is $S = (65\%, 25\%)$. Full (broken) line arrows indicate examples of equilibrium (non-equilibrium) moves.

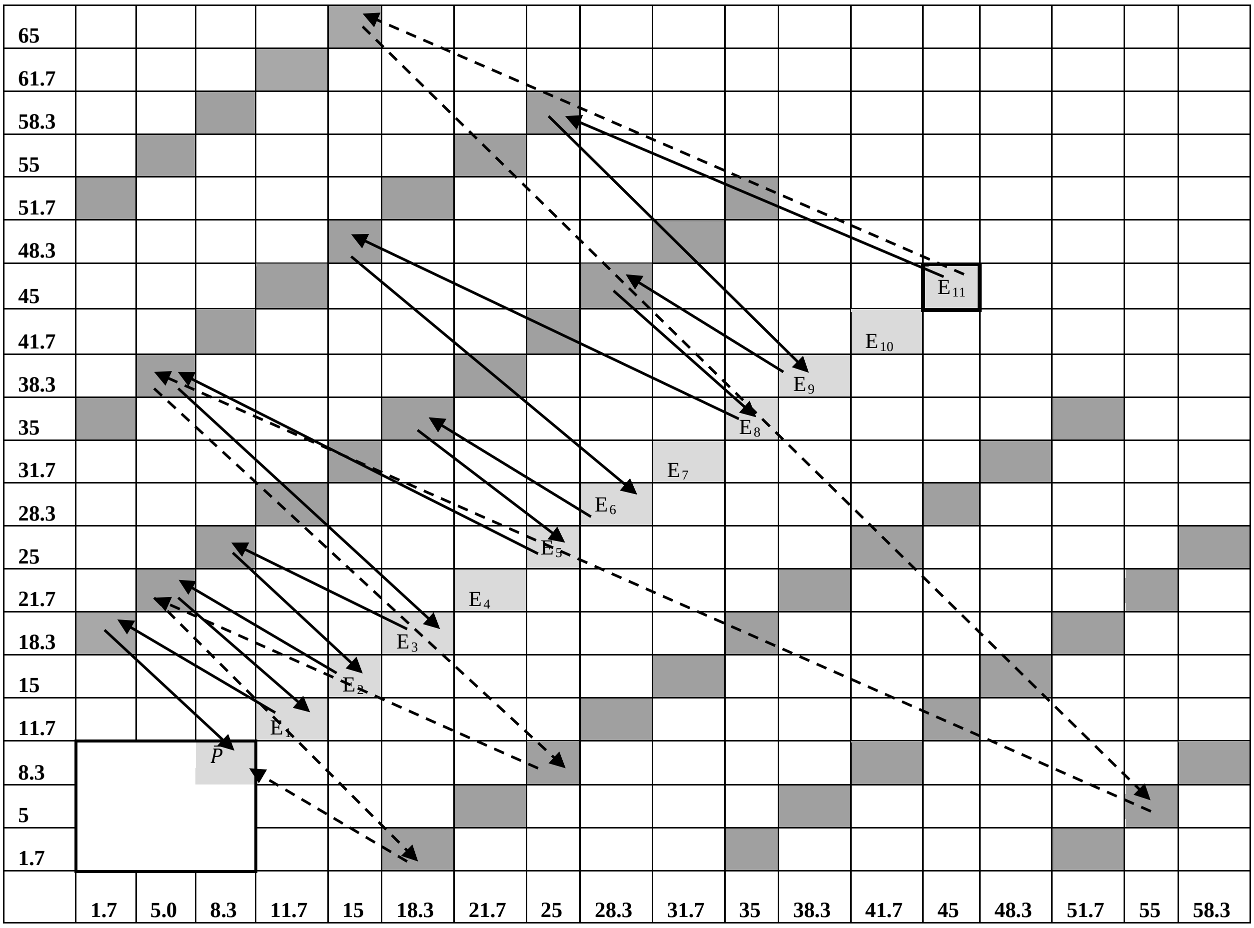

Figure 2c: Two example games of subject 38 (No 8 in session 3), vs. subject 33 in broken arrows (38 had the initial move and did not steal), and vs. 36 in full arrows. (36 had the initial move). α = 2/3 and $S = (45\%, 45\%)$. Player 38's winning probability is found on the horizontal axis.

Notes: Shaded areas indicate feasible states. Lightly shaded areas are the equilibrium states of all subgames (under Fehr-Schmidt inequality aversion or altruistic preferences $U_i = x_i + a_i x_k$, with x_i and x_k denoting incomes and $-1 < a_i < \alpha$). The box at the origin contains the terminal states, in particular $\bar{P} = E_0$. Player 38 has been categorized as *Gamesman* and subjects 33 and 38 as *sharks*.

58.3																				
55																				
51.7																				
48.3		1																		
45																				
41.7																				
38.3														1						
35																				
31.7																				
28.3											1									
25																				S
21.7														1						
18.3			2					1										1		
15		1																		
11.7																				
8.3					1															
5				3					1											
1.7			35																	
	1.7	**5**	**8.3**	**11.7**	**15**	**18.3**	**21.7**	**25**	**28.3**	**31.7**	**35**	**38.3**	**41.7**	**45**	**48.3**	**51.7**	**55**	**58.3**	**61.7**	**65**

Figure 3: The feasible states and endpoints of the Vendetta Game with α = 2/3 and $S = (65\%, 25\%)$

Notes: Shaded areas indicate feasible states. Lightly shaded areas are the equilibrium states of all subgames. The box at the origin contains the terminal states, in particular $\bar{P}$. The initial state is $S = (65\%, 25\%)$. The numbers in the boxes indicate how often an experimental game ended there.

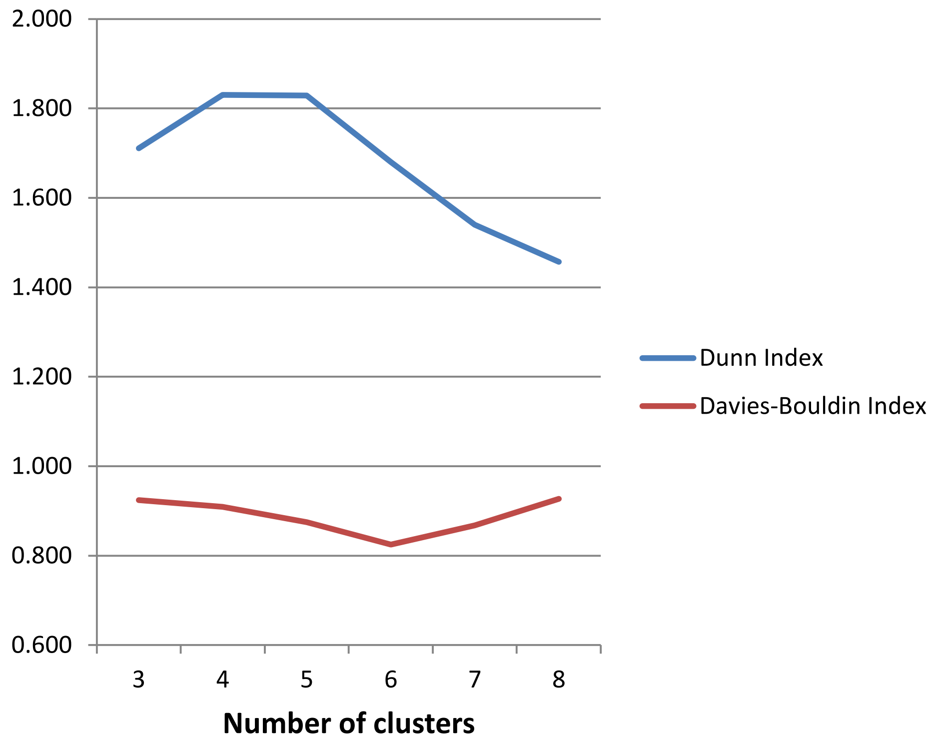

Figure 4: The Davies-Bouldin and the Dunn Index for different numbers of clusters.

n=2	n=3	n=4	n=5	n=6	n=7
			GreedApp (10)	GreedApp(10)	GreedApp(10)
			0.47 0.28 0.84	0.47 0.28 0.84	0.47 0.28 0.84
	Sharks(100)	Sharks(100)			
	0.11 0.66 0.92	0.11 0.66 0.92	**Sharks(90)**	Sharks(90)	Sharks(90)
			0.07 0.70 0.93	0.07 0.70 0.93	0.07 0.70 0.93
Average(183)					
0.12 0.60 0.62		**Educators(32)**	Educators(32)	Educators(32)	Educators(32)
		0.01 0.85 0.35	0.01 0.85 0.35	0.01 0.85 0.35	0.01 0.85 0.35
	Educators(83)				
	0.13 0.53 0.26				**Mixed(17)**
					0.28 0.45 0.42
		Gamesmen(51)	Gamesmen(51)	**Gamesmen(49)**	
		0.21 0.33 0.20	0.21 0.33 0.20	**0.21 0.35 0.18**	**Gamesmen (32)**
					0.18 0.29 0.06
				Minority(2)	Minority(2)
Meeks(5)	Meeks(5)	Meeks(5)	Meeks(5)	Meeks(5)	Meeks(5)
0.82 0.09 0.28	0.82 0.09 0.28	0.82 0.09 0.28	0.82 0.09 0.28	0.82 0.09 0.28	0.82 0.09 0.28

Figure 5: Dendrogram. In every stage (*n* clusters) of the clustering process, the clusters in bold letters are united. In parentheses the numbers of class members are reported. In the line below the cluster names are the average frequencies (q_A,q_R,q_G) of the three dimensions (Appeasement, Punishment, or Greed).

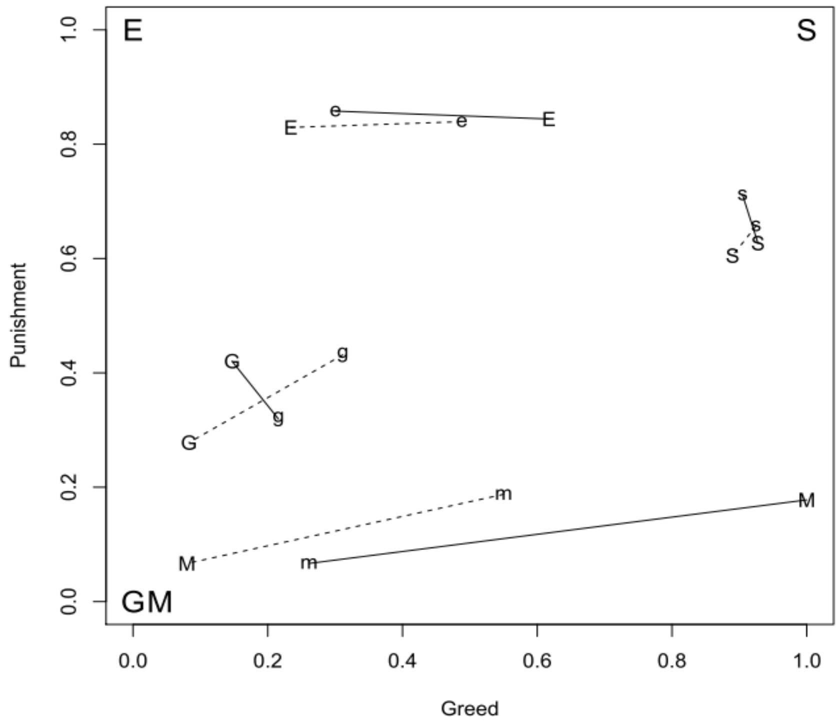

Figure 6: Type shares of greed and punishment behavior in first half (lowercase letters) and second half (uppercase letters) of a game, connected by a full line, and in the first two and the second two games, connected by a broken line. The capital letters in the corners indicate the positions of pure types.

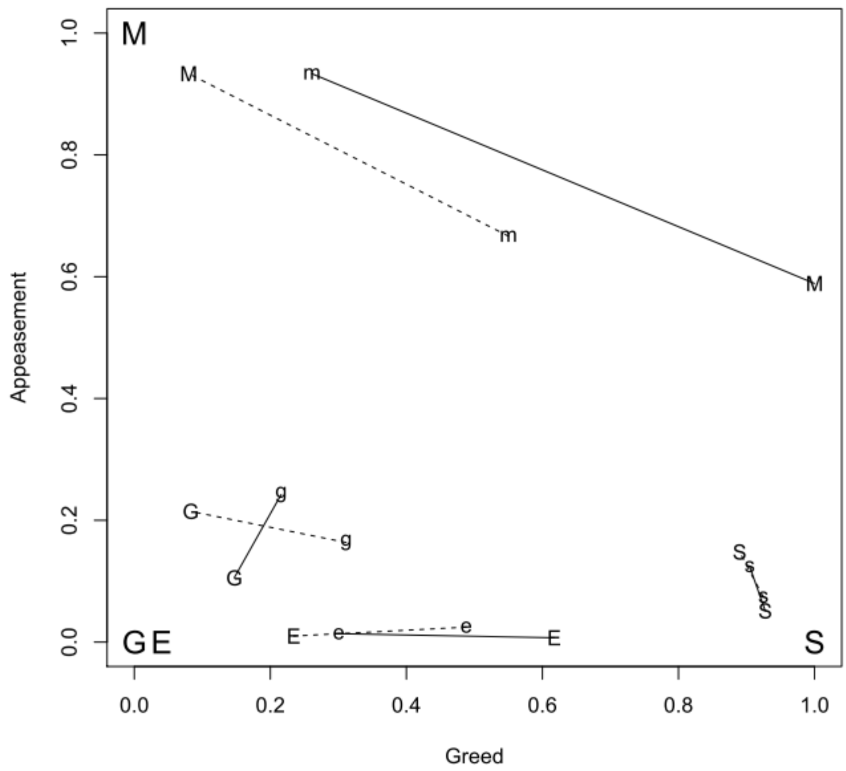

Figure 7: Type shares of greed and appeasement behavior in first half (lowercase letters) and second half (uppercase letters) of a game, connected by a full line, and in the first two and the second two games, connected by a broken line. The capital letters in the corners indicate the positions of pure types.

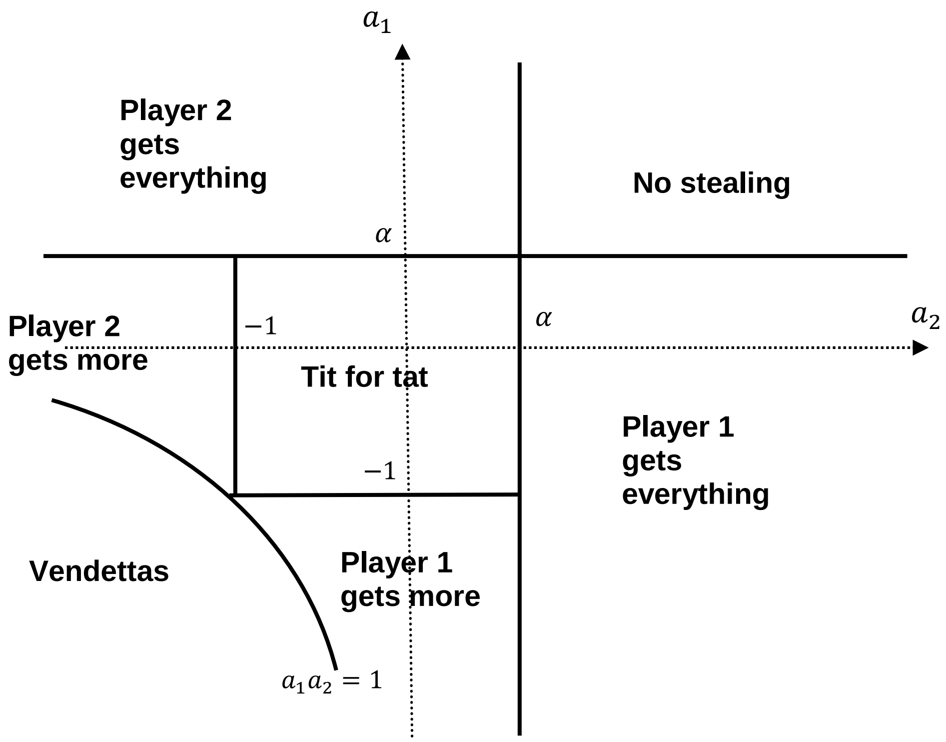

Figure 8: Equilibria with normal altruism (tit for tat), extreme spite $a_i < -1$, and extreme altruism $a_i > \alpha$.

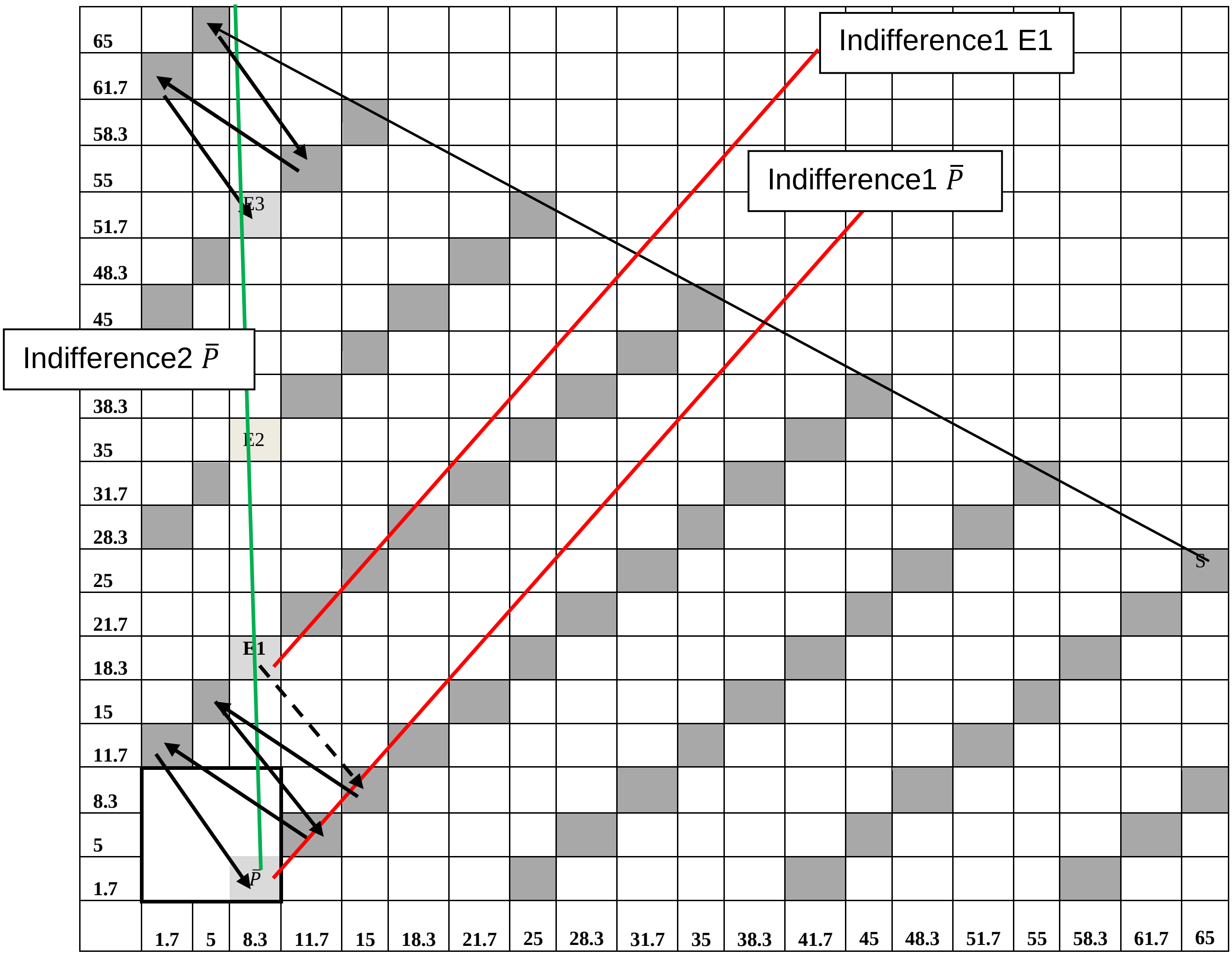

Figure 9: The feasible states and endpoints of the Vendetta Game with α = 2/3 and $S = (65\%, 25\%)$. Players with altruistic preferences $U_i = x_i + a_i x_k$, player 1 (vertical axis) with $a_1 < -1$, player 2 with a_2 being positive but rather small.

Notes: Shaded areas indicate feasible states. Lightly shaded areas indicate the equilibrium states E_k of all subgames. The box at the origin contains the terminal states, in particular $\bar{P}$. The initial state is $S = (65\%, 25\%)$. Full (broken) line arrows indicate examples of equilibrium (non-equilibrium) moves.

Treatment	**EB**	**EN**	**IB**	**IN**	**Average**
α = 1/3	54.2	83.3	52.1	72.9	65.6
α = 2/3	62.5	89.4	75	81.3	76.1
Average	58.4	84.4	65.7	77.1	70.8

Table 1: Percentage of games that ended with both players having less than 10% winning probability.

Cluster	1. Sharks	2. Educators	3. Gamesmen	4. Meeks
Own income	9.6	15.9*	19.5*	23.0*
Co-player's income	9.5	15.3*	19.0*	27.3*

Table 2: Average final income (winning probabilities). * indicates a significant difference to cluster 1. (Mann-Whitney U-test, two-sided, 5 % level)

	Disadvantaged			Equilibrium or Advantaged	
Cluster	Appeasement	Equilibrium	Punish/Greed	Greed	Equilibrium
1. Sharks	-7.3**	+15.7***	-8.4	+2.9	-2.9
2. Educators	-0.7*	+2.0*	-1.4*	+31.7**	-31.7**
3. Gamesmen	-13.7***	+3.6	+10.1	-6.9	+6.9
4. Meeks	-34.4*	+23.3	+11.1	+73.8	-73.8

Table 3: Aggregate behavioral changes (percentage points) from the first half of a game (joint winning probability > 45%) to the second half of a game (joint winning probability ≤ 45%). * (**, ***) indicates significant changes in a two-sided Mann-Whitney U-test on the 5% (1%, 0.1%) level).

	Disadvantaged			Equal or Advantaged	
Cluster/Beh.	Appeasement	Equilibrium	Punish/Greed	Greed	Equilibrium
1. Sharks	+7.4*	-2.2*	-5.2	-3.5**	+3.5**
2. Educators	-1.5	+2.4	-1.0	-25.4*	+25.4*
3. Gamesmen	+5.1	+10.2	-15.4	-22.8**	+22.8**
4. Meeks	+26.7	-14.6	-12.1	-47.0*	+47.0*

Table 4: Aggregate behavioral changes (percentage points) from Games 1 and 2 to Games 3 and 4. * (**) indicates significant differences in a Mann-Whitney U-test on the 5% (1%)-level.

Cluster	Anger	Anx-iety	Con-tempt	Envy	Fear	Happi-ness	Irrita-tion	Jea-lousy	Joy	Sha-me	Sur-prise
1. Sharks	1.7	2.5	2.2	1.7	1.5	3.2	2.8	1.4	2.9	0.9	3.4
Non-Sharks	2.9**	2.0	2.8*	0.9*	0.7*	2.9	4.6§	0.8	2.4	0.8	3.4
2. Educators	3.0**	2.4	2.4	1.0	0.5**	3.3	4.6***	1.1	2.6	0.7	3.5
3. Gamesmen	3.1§§	1.8	3.0*	0.8*	0.8*	2.6	4.7§§	0.7*	2.3	0.7	3.5
4. Meeks	1.0	1.2	1.8	0.2	0.8	4.0	3.0	0.0*	2.4	1.4	2.0

Table 5: Average end-of-session emotions (on a scale from 0 to 7 increasing with intensity) in the four clusters. * (**, ***, §, §§) indicates significant difference to cluster 1 with $p<0.05$ (0.01,0.001, 10^{-4}, 10^{-5}). For the comparison Sharks vs. Non-Sharks: two-sided Wilcoxon matched pairs signed-rank test based on average emotions in the 24 sessions. For the comparisons Sharks vs other types: Mann-Whitney U-test, two sided, based on individual emotions.

Appendix

A. Instructions

You are participating in an experiment on decision making. Please raise your hand if you have any questions at any point in the experiment. The experiment is divided into 4 stages. At the end of the experiment you will be paid the sum of the earnings obtained in each stage, plus a participation fee of 5 pounds.

There are eight participants in the experiment, all of which have received the same set of instructions as you have. In each stage, you will be randomly matched with another participant (the **coparticipant**). Your coparticipant most likely changes from stage to stage.

Task: At the start of each stage you and your coparticipant are assigned an initial probability of winning a prize of 10 pounds. The probability of winning the prize is known as **winning probability**. You are assigned the same initial winning probability throughout the experiment, and your coparticipant is also assigned the same initial winning probability throughout the experiment. The computer display shows both your and your coparticipant's winning probabilities.

You and your coparticipant take turns in making choices. The computer determines which of you is first to choose. You are asked to choose how much winning probability to take away from your coparticipant. Amounts taken have to be multiples of 10% (so they can be 0%, 10%,20%, 340%, 40%, etc.), and up to as much as your coparticipant has at present.

A **conversion rate** is specified on the computer display. For every 10% winning probability that you take away from the coparticipant, your winning probability increases by the winning probability taken away multiplied by the conversion rate (and rounded to the nearest percentage point), up to a maximum of 100%. For example, if the conversion rate were 0.5 and you took away 40% from the coparticipant, then your winning probability would go up by 20%. The conversion rate may change from stage to stage.

On the computer display you will find two bars; one shows your winning probability and the other shows your coparticipant's winning probability. After your coparticipant has chosen, and it is your turn, the bars will be updated to show you the winning probabilities as a result of your coparticipant's choice. During your round, the bars will show you winning probabilities for any given amount you take away from your coparticipant.

If neither you nor the coparticipant takes away (or can take away) winning probabilities for two consecutive turns, then the stage is over and the resulting winning probabilities are used to determine who wins the prize. A random draw takes place to determine if you or your coparticipant is the winner, or if neither of you is the winner (i.e. there is no winner).

Please fill in the questionnaire and call for the experimenter before you begin. Feel free to raise your hand for assistance at any point of the experiment.

B. End of Experiment Questions[7]

Please rate the extent to which you have felt on average the following emotions **during the experiment**, on a scale between 0 (no emotion at all) and 7 (high intensity of the emotion). <u>There are no right or wrong answers</u>.

1. Anger _______
2. Anxiety _______
3. Contempt _______
4. Envy _______
5. Fear _______
6. Happiness _______
7. Irritation _______
8. Jealousy _______
9. Joy _______
10. Shame _______
11. Surprise _______

C. Cluster analysis

Cluster analysis is a kind of data mining for finding groups of similar subjects (or objects) based on a number of attributes (in our case three). Without having any hypotheses, it finds groups of subjects that are compact (i.e. close together according to some measure) yet well separated (i.e. have a large distance to one another according to a related measure). We use the most often employed Euclidian distance between our three dimensional characterizations of subjects. Clusters should have minimal distances to the centroid of groups while the distance between the centroids is maximal. While the former criterion is improved with a larger number of clusters, the latter deteriorates. Evaluations of the tradeoff are computed using the Davies-Bouldin Index (Davies and Bouldin, 1979) and the Dunn Index (Dunn, 1973).

[7] Note: set of emotions is taken from Bosman and van Winden's EJ paper.

When n clusters have been identified with centroids x_i, average distances s_i to centroids x_i, and distances $d(x_i, x_j)$ between clusters i and j, then the Davies-Bouldin index is defined as $\frac{1}{\mathrm{n}}\max_{i,j}\{\frac{s_i+s_j}{d(x_i,x_j)}\}$. With an increasing number of clusters the s_i values as well as the minimal distance between clusters decrease. Lower Davies-Bouldin indices indicate better cluster structures. The Dunn-index is defined as $min_{i,j}\{d(x_i, x_j)\}/\max_i\{s_i\}$, i.e. the Dunn-index is more worst case oriented than the Davies-Bouldin index. Higher Dunn indices indicate better cluster structures.

D. Equilibria with an extremely spiteful player: a graphical analysis

We analyze the equilibrium play between a player 1 with $a_1 < -1$ and a player 2 with $a_2 > -1$ and under the assumption of common knowledge of the a_i. Let us first assume that player 1 (vertical axis in Figure 9) has an altruism coefficient "just" below -1, and that player 2 has an altruism coefficient "just" above 0. Then the equilibrium states in Figures 1 and 2, the diagonal states originating in $\bar{P}$, are no longer preferred to $\bar{P}$ by player 1 and are thus no equilibrium states. All states to the right of the "Indifference1 $\bar{P}$" line in Figure 9 are, for player 1, worse than $\bar{P}$, to the left they are preferred to $\bar{P}$. All states to the right of the "Indifference2 $\bar{P}$" line are, for player 2, preferred to $\bar{P}$, to the left they are worse than $\bar{P}$.

<Insert Figure 9 about here.>

Therefore only cells between the lines can be endpoints without further stealing. E1 is an endpoint because stealing would necessarily lead to $\bar{P}$. With the same reasoning, only cells between the lines "Indifference1 E1" and "Indifference2 E1" (practically identical with "Indifference2 $\bar{P}$") are preferred by both players to E1. E2 is an endpoint because any stealing from E2 would lead to E1 or $\bar{P}$. With the same reasoning we can show that E3 is an endpoint and that there are no further endpoints. E3 cannot be reached directly from the initial distribution of probabilities, but on the path indicated in the figure.

If player 1 is a bit more spiteful, then his indifference curves rotate counter-clockwise to the left without any consequences on equilibrium states. If player 2 is more altruistic, then his indifference curves will rotate to the left and he will be contented with even less than E3. If he is spiteful, then his indifference curves rotate to the right and the sequence of endpoints is no longer on a vertical line and equilibrium provides him with more income, but still less than player 1. If players are so spiteful that player 1's indifference curve "Indifference1 $\bar{P}$" has a smaller slope than "Indifference2 $\bar{P}$" (the case $a_1a_2 > 1$), then there is no combination of winning probabilities which both prefer to $\bar{P}$.