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Spiteful Strategies. The ontogeny and the practice of spite in human interaction: an experimental game theory approach and empirical applications

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[DECLARAÇÕES]

Declaro que esta tese é o resultado da minha investigação pessoal e independente. O seu conteúdo é original e todas as fontes consultadas estão devidamente mencionadas no texto, nas notas e na bibliografia.

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Lisboa, ... de ..... de .....

"You're an interesting species. An interesting mix. You're capable of such beautiful dreams, and such horrible nightmares. You feel so lost, so cut off, so alone, only you're not. See, in all our searching, the only thing we've found that makes the emptiness bearable, is each other."
Carl Sagan, Contact

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Abstract

Spiteful strategies. The ontogeny and the practice of spite in human interaction: an experimental game theory approach and empirical applications

André Filipe Anacleto d'Almeida

Spite is defined as an act that causes loss of payoff to an opponent at a cost to the actor. As one of the four fundamental behaviours in sociobiology, it has received far less attention than its counterparts selfishness and cooperation. It has however been established as a viable strategy in small populations when used against negatively related individuals. Because of this, spite can either i) disappear or ii) remain at equilibrium with cooperative strategies due to the willingness of spiteful individuals to pay a cost in order to punish. This thesis sets out to understand whether propensity for spiteful behaviour is inherent or if it develops with age.

For that effect, two game-theoretical experiments were performed with schoolboys and schoolgirls aged 6 to 22. The first, a 2 x 2 game, was tested in two variants: 1) a prize was awarded to both players, proportional to accumulated points; 2), a prize was given to the player with most points. Each player faced the following dilemma: i) to maximise pay-off risking a lower pay-off than the opponent; or ii) not to maximise pay-off in order to cut down the opponent below their own. The second game was a dictator experiment with two choices, (A) a selfish/altruistic choice affording more payoff to the donor than B, but more to the recipient than to the donor, and (B) a spiteful choice that afforded less payoff to the donor than A, but even lower payoff to the recipient. The dilemma here was that if subjects behaved selfishly, they obtained more payoff for themselves, while at the

same time increasing their opponent payoff. If they were spiteful, they would rather have more payoff than their colleague, at the cost of less for themselves. Experiments were run in schools in two different areas in Portugal (mainland and Azores) to understand whether spiteful preferences varied with age. Results in the first experiment suggested that (1) students understood the first variant as a coordination game and engaged in maximising behaviour by copying their opponent's plays; (2) repeating students preferentially engaged in spiteful behaviour more often than maximising behaviour, with special emphasis on 14 year-olds; (3) most students engaged in reciprocal behaviour from ages 12 to 16, as they began developing higher tolerance for their opponent choices. Results for the second experiment suggested that (1) selfish strategies were prevalent until the age of 6, (2) altruistic tendencies emerged since then, and (3) spiteful strategies began being chosen more often by 8 year-olds. These results add to the relatively scarce body of literature on spite and suggest that this type of behaviour is closely tied with other-regarding preferences, parochialism and the children's stages of development.

Keywords: ...Spite ...Experimental Game Theory ...Rationality ...Spiteful Strategies ...Children ...Competiton ...Cooperation

Resumo

Spiteful strategies. The ontogeny and the practice of spite in human interaction: an experimental game theory approach and empirical applications

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As estratégias de malevolência implicam que um indivíduo pague um custo para infligir um custo superior a um oponente. Como um dos comportamentos fundamentais da sociobiologia, a malevolência tem recebido menos atenção que os seus pares o egoísmo e a cooperação. Contudo, foi estabelecido que a malevolência é uma estratégia viável em populações pequenas quando usada contra indivíduos negativamente geneticamente relacionados pois este comportamento pode i) ser eliminado naturalmente, ou ii) manter-se em equilíbrio com estratégias cooperativas devido à disponibilidade da parte de indivíduos malevolentes de pagar um custo para punir. Esta tese propõe compreender se a propensão para a malevolência nos humanos é inerente ou se esta se desenvolve com a idade.

Para esse efeito, considerei duas experiências de teoria de jogos em crianças em ambiente escolar com idades entre os 6 e os 22 anos. A primeira, um jogo 2x2 foi testada com duas variantes: 1) um prémio foi atribuído a ambos os jogadores, proporcionalmente aos pontos acumulados; 2), um prémio foi atribuído ao jogador com mais pontos. O jogo foi desenhado com o intuito de causar o seguinte dilema a cada jogador: i) maximizar o seu ganho e arriscar ter menos pontos que o adversário; ou ii) decidir não maximizar o seu ganho, garantindo que este não era inferior ao do seu adversário. A segunda experiência consistia num jogo do ditador com duas opções: uma escolha egoísta/altruísta (A), onde

o ditador recebia mais ganho, mas o seu recipiente recebia mais que ele e uma escolha malevolente (B) que oferecia menos ganhos ao ditador que a A mas mais ganhos que o recipiente. O dilema era que se as crianças se comportassem de maneira egoísta, obtinham mais ganho para si, ao mesmo tempo que aumentavam o ganho do seu colega. Se fossem malevolentes, então prefeririam ter mais ganho que o seu colega ao mesmo tempo que tinham menos para eles próprios. As experiências foram efetuadas em escolas de duas áreas distintas de Portugal (continente e Açores) para perceber se as preferências malevolentes aumentavam ou diminuíam com a idade. Os resultados na primeira experiência sugerem que (1) os alunos compreenderam a primeira variante como um jogo de coordenação e comportaram-se como maximizadores, copiando as jogadas anteriores dos seus adversários; (2) que os alunos repetentes se comportaram preferencialmente como malevolentes, mais frequentemente que como maximizadores, com especial ênfase para os alunos de 14 anos; (3) maioria dos alunos comportou-se reciprocamente desde os 12 até aos 16 anos de idade, após os quais começaram a desenvolver uma maior tolerância às escolhas dos seus parceiros. Os resultados da segunda experiência sugerem que (1) as estratégias egoístas eram prevalentes até aos 6 anos de idade, (2) as tendências altruístas emergiram até aos 8 anos de idade e (3) as estratégias de malevolência começaram a emergir a partir dos 8 anos de idade. Estes resultados complementam a literatura relativamente escassa sobre malevolência e sugerem que este comportamento está intimamente ligado a preferências de consideração sobre os outros, o paroquialismo e os estágios de desenvolvimento das crianças.

Palavras-chave: ... Malevolência ... Teoria de Jogos Experimental ... Racionalidade ... Estratégias de Malevolência ... Crianças ... Competição ... Cooperação

Contents

List of Figures

List of Tables

1

Introduction

One of the main concerns in sociological and anthropological studies has been to understand how societies maintain their institutions and norms through their actors' interactions, and how their beliefs, desires and information affect their behaviour. Many classical works such as Malinowski's (1984[1922]) account of the Kula and Marcel Mauss's (2002[1954]) accounts of reciprocal exchange of goods attest the capacity of individuals to maintain vast networks of exchange based on systems of trust and reciprocity. These ideas stem from a view that cooperation is an essential part of being in a society.

Yet, on the one hand, a cooperative act may start as a selfish endeavour that is met by a partner with like-minded beliefs and complementary goals, as well as a shared social habitus generating reciprocity strategies. On the other, even courses of interaction subjectively and socially acknowledged as altruistic and cooperative may objectively serve competitive strategies. Taken to the extreme, reciprocity systems can take an overtly agonistic turn into strife for status and social capital (Mauss, 2002[1954]; Bourdieu, 1977), to the point that they may become akin to envious and spiteful games (Elster, 1986; Elster, 1999; Veblen, 1994[1899]). One of such reciprocal change systems can be given by the famous "Potlatch" example from North American and Canadian Indians, where competing chiefs throw lavish feasts for neighbouring tribes where a considerable amount of resources are wasted. Despite this event being portrayed as gift-giving, the obscure objective is to outcompete a neighbour chief in status, as the receiver is

Figure 1.1: A cerimonial act of the Kula (*in*:Malinowski 1922:frontpiece)

then bound to reattribute in likewise manner and eventually lose more resources than his host.

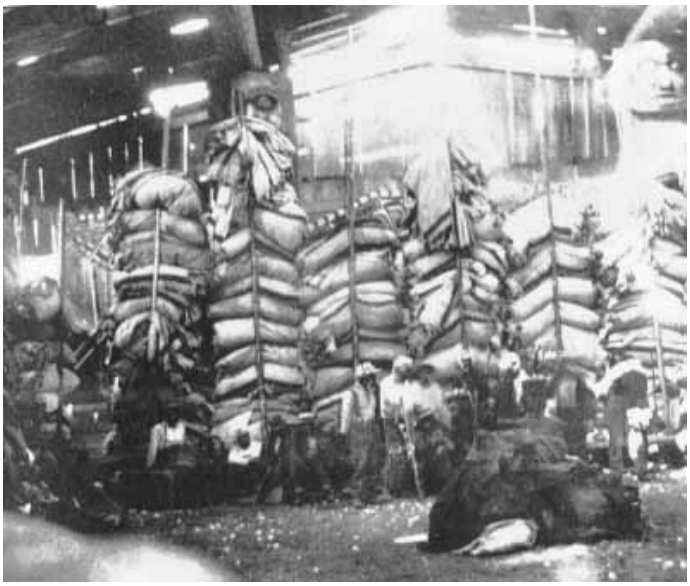

Figure 1.2: A stack of blankets to be gifted in a potlatch (*in*;Meet Myth America blog)

Many other disciplines have focused their research in the evolution and maintenance of cooperation. Axelrod & Hamilton (1981) is perhaps one of the most famous, where cooperation in a prisoner's dilemma game is favoured by repeated interaction. Mathematical modelling has shown other mechanisms to promote cooperation (Chalub et al., 2006; Falk et al., 2005; Hamilton, 1964a; Hamilton, 1964b; Leimar & Hammerstein, 2001; Santos & Pacheco, 2005; Santos et al., 2006;

Trivers, 1971). Evolutionary psychology, on the other hand, has made several attempts at understanding the impact of neurological and emotional processes related to altruism and cooperation on the survival and spread of individuals (Van Lange, 1999; Van Lange et al., 1997; Waal, 1996).

In terms of experimental work, the evolution and ontogeny of cooperation and altruism has dominated so-called experimental game theory studies in the fields of economics, psychology and anthropology (Batson, 1987; Batson et al., 1981; Brownell et al., 2009; Eisenberg & Mussen, 1989; Eisenberg & Fabes, 1998; Fehr & Schmidt, 1999; Gintis et al., 2003; Moore, 2009; Sutter, 2007; Van Lange, 1999). Behind most behaviours analysed in these studies there are strategic decisions which appear to go against the concept of individual rationality, in the sense of individuals acting towards the maximisation of their own selfish interests as measured by the pay-off, a concept originally introduced in game theory (Neumann & Morgenstern, 1944; Tversky & Kahneman, 1986; Nash, 1950; Nash, 1953).

A second behaviour that challenges the concept of rationality is spite. Spiteful behaviour is defined by an act that causes loss of payoff (or fitness, in evolutionary biology modelling) to the opponent. More precisely, this thesis defines that a rational individual chooses a strategy that maximises its own payoff, among all possible alternatives; and that a spiteful individual chooses a strategy that minimises his opponent's payoff, among all possible alternatives. The aim of this work is to compare the motivation and the ability of children and teenagers to react to stimuli that induces behaviour in one or in the other direction. Note that the definitions of rationality and spite are not mutually exclusive. The interesting point, from an evolutionary anthropology point of view, is the viability of non-rational spiteful individuals, particularly in the cases where both payoffs (the focal player and his/her opponent) are decreased by the strategic choice of the focal individual. Loosely speaking, this individual is viable if the self-inflicted harm is lower than the harm to the opponent. In this setting, it is particularly important to discuss the existence of unbeatable strategies, i.e., strategies that guarantee that the opponent's pay-off is never larger than the focal player's pay-off.

It is natural to assume that in a competing, non-cooperative environment, strategies that mix both behaviours will emerge. The likelihood of one or another behaviour will depend not only on the game, but also on the population size (Foster et al., 2001; Gardner & West, 2004a; Lehmann & Reuter, 2006; Sutter, 2007; West et al., 2006a).

Spite is clearly seen in humans (Cartwright, 2000) rather than other primates. Envy and jealousy, its most common emotional expressions, apparently break cooperation. However, on the one hand, spite has been shown to be the underlying motive for punishment of social misbehaviour, and hence of social control (Falk et al., 2005) and on the other it has been argued to be crucial for large-scale cooperation (Jensen, 2010) and competitiveness (Balafoutas et al., 2012) in humans.

It has also been shown both experimentally and empirically that envy is more readily exhibited towards members of one's reference group (be it socio-economic, work colleagues, family, or others) than individuals outside the social group. Spite has been mathematically shown to evolve preferentially in small size groups (Hamilton, 1970), which on social psychological grounds might be tied to the fact that spite only makes sense relative to significant others. This might sound paradoxical, as many sociological studies state that smaller groups are in fact easier for maintaining cooperation (Nee & Ingram, 1998; Olson, 1965). Nonetheless, Elster (1986) describes that in a qualitatively similar group with similarly ranked individuals, envy tends to be acted upon amongst themselves (i.e., those who may be in direct competition for in-group status) rather than those who are far distanced from the actors: a worker tends to envy his colleague who just got a promotion rather than his boss. There is also experimental evidence that punishment is more easily met to members of one's own group than to outsiders (Shinada et al., 2004) as long-term established relationships do not allow as much for errors.

Another important social aspect of spiteful behaviour is that gender differences have been reported concerning the ability for and employment of spite, especially among children, suggesting that gender differences in spite might relate to gender differences in competitiveness (Bügelmayer & Spieß, 2011). These differences could also be accentuated due to perceptions on gender roles and status (Gneezy et al., 2003).

The ability for spite has been shown to be influenced by individual cognitive capacity and comprehension. As demonstrated by Bügelmayer & Spieß (2011), children with higher cognitive skills care more about their position relative to others and decrease other subject's payoff in single games whenever possible. This is consistent with evolutionary theories suggesting that certain cognitive capacities and inhibitory controls are necessary for spiteful acts to occur (Hauser et al., 2009). Costs and benefits of spite must be calculated and consequences taken into account. To forego one's own payoff in order to reduce another person's

payoff demands self-control. Self-control been demonstrated to be positively related to cognitive abilities, as exemplified by the association between patience and cognitive skills (Frederick, 2005).

If spite is a behaviour best expressed with increased cognitive skills, it follows that it is an ontogenic mechanism that should show increased expression with age. However, ontogenic processes can sometimes be influenced by cultural practices. The particularities of cultural beliefs and systems can influence individual behaviour in one direction or the other. For example, there are clear ontogenetic differences in the development of emotional responses and cognitive characteristics in children mainly when considering stimuli defined by cultural inhibitions and socialisation (Bügelmayer & Spieß, 2011), which means that cultural parameters should be controlled in order to attest how they influence a game-theoretical result.

Taking into account that personal beliefs and social, cultural and economic constraints shape individuals' social behaviour, it is nonetheless noteworthy that sociological and anthropological methodologies sometimes fail to account for the specificities of strategic interactions between individuals and the actual mechanisms by which behaviours are manifested. In this sense, an experimental game-theoretical approach provides a fresh and interdisciplinary view-point in order to tackle the problem of spite, how it evolves with cognition and social skills and how it influences human behaviour in a competitive environment.

This thesis will be based on the conduction of game theoretical experiments that will take into account cultural and social aspects and the psychological state of the players, to be assessed by a post-game questionnaire. There is also an interest in not only comparing actors' responses at different ages, but also from different backgrounds, allowing a comparison between an island population (which the reader will discover in chapter 4 of this thesis), and a mainland population (described in Chapters 5 and 6).

This question is relevant for anthropology as learning how spiteful strategies are played at different ages and across populations will allow understanding how social systems and structures in interaction contexts can be affected by relativizing behaviour. Despite the common sociological view that small groups are better for cooperation (Nee & Ingram, 1998; Olson, 1965), these are also more prone to localised competition (Gardner & West, 2004a). Localised competition could be considered a breeding ground for spiteful interactions to occur, as payoffs are more directly and easily comparable between individuals (Gardner & West,

2004a; West et al., 2006a). This could have implications on how certain institutions, such as the public school system, construct their assessment system and how competitive versus cooperative tasks are attributed by teachers. This can also have an important effect in pinpointing what drives spiteful strategies by performing controllable experiments and opposing them to observational data.

Humans have common behaviours that could be classified as spiteful. Envy and jealousy are perhaps the most common of them. Unfortunately, there are few experimental studies of spite. However, spiteful choices (as described above) have been reported to appear spontaneously in subjects between 3 to 6 years old (Fehr et al., 2008a) and appeared more often than chance at ages 5 to 8 in a face-to-face experiment designed to replicate studies of altruism in chimpanzees (House et al., 2012). There is also a positive argument for mixed strategies and the influence of age on the choices being made regarding altruistic or competitive behaviour. Studies with children report that younger children tend to be more selfish and that pro-social choices increase as children become older (Fehr et al., 2008a; Harbaugh et al., 2003; Hook & Cook, 1979). In fact, most developmental studies tend to conclude that children are selfish towards unrelated individuals (Damon, 1977; Eisenberg & Fabes, 1998). Individuals are assumed to be interested in maximising their own pay-off; however, their observed behaviour frequently contradicts this assumption. One possible explanation is that they take into account others' pay-offs (Camerer, 2003). In this context, competitive and strategic behaviour also appears to drive the emergence of altruistic and other-regarding preferences (Forber & Smead, 2014).

It seems that humans are capable of spite in a number of situations. The question to be asked at this point is why is there such a mechanism when spiteful behaviour is scarce in nature? Trivers (2005) has explained that in our everyday behaviour and neurophysiology, we respond to so-called one-shot encounters as if they were the first in a chain of interactions. Envy, malevolence and revenge are costly actions that prepare the body for being cheated upon in future interactions even if they are not to happen. This means that humans base much of their social lives in the prospect of future social contact, and that social and cultural constructs can be formed on the basis of single events. For example, gender inequalities may be one of the consequences of gender-specific capacities for spiteful behaviour. If males were more spiteful than females, it could mean that the former could outcompete the latter. This can have an impact on how social institutions devise their norms and could indicate the need to account for spiteful strategies in a given context.

Another example of implications of this work could be attributed to school systems. If indeed gender differences and cognitive capacity are related to an individual's spiteful affinities (as defined above), should this mean a shift from absolute to relative grading in evaluations? Do spiteful individuals also preferentially act altruistically, taking into account that both mechanisms require other-regarding preferences, ultimately resulting in inequity aversion? And how does accounting for spiteful strategies improve on how institutions are devised and thought about? Is it correct to state that smaller groups are better at cooperation when there is evidence that reduction in the scale of competition makes the evolution of spite viable even when whole populations are considered (Gardner & West, 2004a; Hamilton, 1970; West et al., 2006a)?

I will address these questions by incorporating an interdisciplinary approach that will cover Biological and Cultural Anthropology, Economic Sociology, Mathematics, Game Theory and Evolutionary Psychology. The main methodology to be used is a game-theoretical experiment (which will be described extensively in Chapter 3) that provides a new game paradigm. This will be hereby referred to as the Spite Game. Although this thesis discusses evolutionary processes in great length, the experimental process will look for the proximate explanations of causation, or the mechanisms behind spiteful behaviour, and development, if spiteful behaviour is an ontogenetic process (Cartwright, 2000) for the mechanisms behind spiteful behaviour. Furthermore, an informal observation process will take place in the schools where the experiments will be made as well as interviews that will allow attesting cultural and social parameters that could influence the behaviours being portrayed. This will hopefully be an advance on how competitive and cooperative behaviour are studied in the field of Anthropology.

The thesis is organised in the following manner: In chapter 2, I provide a literature review covering the theoretical background of this study. Firstly, I will address the biological basis of spite and how it can evolve in nature, followed by an account of biology based studies of spite in humans. Secondly, I will explore the socio-cultural foundations of spite, with special focus on how some reciprocal exchange systems can be discussed as spitefully competitive. Some classical anthropological works will be discussed in this light, along with more contemporary works on competition in society. Another section will review the relevance of the evil eye as a superstition directly related to the emotion of envy and its practical form, spite. Next, I will review the supposed gender differences in the propensity to compete or cooperate, in order to assess whether spiteful behaviour is influenced by biological gender or whether this premise is a social and cultural

construct. Following the cultural background of spite, I will provide an account of the psychological mechanisms of this behaviour, including the neurobiology of spite and its development and how 'emotional algorithms' (Loch et al., 2006a) can be the underlying mechanism of emotional expressions that can lead to eliciting spiteful responses. In the last section I will discuss the sociological implications of spite and how it can be a precursor of communal strategies. This last section will also demonstrate how game theory is a useful tool when studying human behaviour.

Chapter 3 displays the main methodologies of this study and the protocols applied to the game-theory experiments, describing all subjects, experiments and statistical analysis tools, as well as the software and steps taken in the computer based experiments. The interview scripts, questionnaire and observational methods used will be described in the remaining sections of the methodology.

Chapters 4, 5, 6 and 7 present the results, providing the analytical outcomes of each experiment separately starting from chapter 4 "Much or more: experiments with rationality and spite with school children", a study made in the Azores on a population of 350 children with a face-to-face game. Here the reader will see the first evidence for spite being an ontogenic process and the foundations for the experiments in the following chapters. Chapter 5 presents the results of the anonymous computer-based experiments in a different population, extended by post-game questionnaires and observational data. Chapter 6 presents the results of face to face computer based experiments on a smaller sample of the same population. The final results chapter (7) shows the preliminary results of a dictator experiment with younger children, in which spiteful preferences emerge around 8 years old.

Chapter 8, reviews and discusses all the evidence and results from the experiments along with the data on informal observations and interviews. Ultimately, this chapter aims at understanding the competitive inclinations of children and teenagers in the schools being studied. The comparison of face-to-face versus anonymous interactions will allow answering whether or not status is indeed the starting point for spiteful behaviour or if children and teenagers exhibit theses preferences naturally. The final chapter summarises my arguments and the main points that make this work a contribution for biological, anthropological and sociological knowledge and reinforce the importance of interdisciplinary approaches to major questions in both the social and the life sciences.

2

Theoretical Background

2.1 Introduction

In this chapter I will discuss all the aspects of spiteful behaviour addressed in this thesis. First, the reader will glance at the evolutionary perspectives on the study of spite, starting from the first ever biological studies of this behaviour up to the most modern mathematical modelling analysis. Secondly, I will provide a cultural/social perspective on spite, and how it can be a product of social upbringing. This perspective will focus on ethnographic examples of this behaviour by looking at classic literature and social facts that have not previously been considered as spiteful. Social facts theorised by Mauss (2002[1954]) such as the potlatch and the kula will be argued to be spiteful in nature since the apparent reciprocity is obligatory and implies destroying personal goods in order to outrank others and this reciprocity cycle is based upon trickery and deceit more often than cooperation (Sahlins, 1972). I will also focus on possible gender differences on spiteful interactions as related to competitive behaviour and finally will try to review the arguments on how much spiteful behaviour is a natural or nurtural phenomenon. Following this exploration, I will give an account of the sociological aspects of spiteful behaviour as well as its psychological underpinnings, discussing the concept of "emotional algorithms" as the universal basis of emotional displays and how these algorithms may be displayed ontogenically through the practice of spite. Finally I will focus on the game theoretical and

experimental data that has preceded this study as a means of justifying the pursuit of new results and new explanations regarding the evolution, ontogeny and sociology of spiteful behaviour in humans.

2.2 Spite as a biological concept: the evolutionary descriptions of spite

2.2.1 Social Behaviour

Social behaviour in animals and humans has been a hot topic for biologists for a long time. Social behaviour is now organised in four different classes: The first two are Selfishness and Mutualism. By incurring in these behaviours, the actors benefit from their own behaviour.

The last two are Altruism and Spite. With this type of behaviour, actors see their fitness reduced/impaired by their actions. Gardner & West (2004a) exemplify these four behaviours in a simple graph shown below:

		Effect on recipient	
		+	-
Effect on actor	+	Mutual Benefit	Selfishness
	-	Altruism	Spite

Figure 2.1: The four fundamental behaviours as seen by biology

Until the 1960's, biologists could not explain behaviours like altruism because of their costs to the actor. Hamilton (1964a) demonstrated that genes for altruism can increase an individual's inclusive fitness (the fitness of its gene pool and not the individual itself, which means the individual's relatives benefit from his actions of altruism), provided that the cost to the actor is smaller than the benefit to the recipient multiplied by the relatedness of the recipient to the actor. This gave rise to the famous Hamilton's (1964) Rule:

$$rb > c$$

2.2.2 Spite, the original definitions

Hamilton (1970) was also the first to define a theoretical model for spite. This model was derived from the same principles as his model for the evolution of altruism. He defined spite as a form of altruism in reverse towards individuals negatively related to the perpetrator. According to his theory, harm to recipients who are negatively related could be selected for even if the harming individual gains no benefits. This negative relatedness occurs when a recipient is less likely to share the actor's genes than a randomly chosen individual in the population. Spite can be selected for because it ultimately reduces the frequency of competing alleles in the gene pool.

2.2.3 Relatedness and Spite

Relatedness can be defined ultimately as a regression measure (West et al., 2006a). Positive relatedness occurs when two individuals share more genes than average and negative relatedness occurs when two individuals share fewer genes than average. For spiteful behaviour to "work" and only be directed towards negatively related individuals, the actor must be able to identify which individuals are positively related to itself. This can be done in two ways. The first is through kin discrimination, which means the actor recognises its genealogical kin. Also, the more kin it recognises the less it is related to everyone else. A possible mechanism to achieve kin discrimination is through greenbeard genes. When kinship cues are absent, a gene coding for a trait genetically associated with the spite gene, allows the actor to identify positive and negative relations[1]. This way, it can limit spiteful behaviour to individuals that do not have the same marker, ensuring the recipients of spite to be sufficiently negatively related (West et al., 2006a; Gardner & West, 2006).

Wright's coefficient (1965) is a function of the association between individuals with respect to their genes at a given locus. Hamilton (1970) understood that relatedness (R) was in principle a regression coefficient. When describing kin selection theory, relatedness is the regression (slope) of the recipient's genetical breeding value on that of the actor. Negative relatedness can plausibly arise between social partners as it depends upon the genetic composition of the whole

[1]For example, one could consider a population of actors where all individuals that have the spite gene have green beards and all others have brown beards. This means that individuals with green beards are related and refrain from acting spitefully against each other.

population. This can be illustrated assuming that a recipient carries the actor's genes with average frequency p and the frequency of the actor's genes in the population is $\bar{p}$. If ($p > \bar{p}$), then an increase in its reproductive success translates into increased frequency of the actor's genes in the population. Conversely, if ($p < \bar{p}$), an increase in its reproductive success translates into decreased frequency of the actor's genes in the population, and hence a negative inclusive fitness benefit for the actor $(RB < 0)$. As both situations above involve a positive benefit $(B > 0)$ to the recipient, coefficient of relatedness must be positive in the former instance $(R > 0)$ and negative in the latter $(R < 0)$.

But how large a negative relatedness is likely to arise? For spite to occur, relatedness to the population as a whole must be zero, and hence satisfy $(1/N)+[(N-1)/N]R = 0$. Rearrangement gives $R = -1/(N-1)$ and therefore, the average relatedness between the actor and its social partners is negative (Hamilton, 1970; Gadagkar, 1993; Pepper, 2000). If the focal individual can identify, and refrain from being spiteful to, a number of positively related genealogically close social partners (kin discrimination), then relatedness to recipients becomes even more negative. For very small populations, where negative relatedness can be nontrivial, individuals might be expected to pay reasonable costs to inflict damage to social partners. Negative relatedness (and hence spite) is therefore possible, but this tiny population condition caused Hamilton (1970); Hamilton (1971) to regard spite as merely the "final infection that kills failing twigs of the evolutionary tree" (Gardner & West 2004, p. 1197), and not a general phenomenon contributing to adaptive evolution [2].

Finally, competition can be a valid assessment for relatedness. According to Gardner & West (2006, p. R663)

> If relatedness to the victims of spite is sufficiently negative, then spite can be favoured by kin selection. This negative relatedness is expected to be very small in large populations, unless the actor can identify a huge number of kin. However, if individuals mainly compete locally with social partners then relatedness measured relative to the average competitor can be strongly negative even in very large populations.

However, a reduction in the sphere of competition would benefit kin and non-kin

[2] This is also called Hamilton's small population view on spite.

alike and free-up more competition space for everyone. Because of this problem, Wilson (1975) proposed a new definition for spite. In this alternative definition, he considered the effects of spiteful behaviour on non-interacting third parties. A third-party could be anyone who is related to the actor or at least sufficiently not negatively-related. He argues that "the spiteful individual lowers the fitness of a competitor while reducing that of his own or at least not improving it, however, the act increases the fitness of the brother to a degree that more than compensates" (Wilson, 1975, p. 119). The way this is selected for is when $C_A + C_R.r_R < b_X.r_X$, a three party extension of the Hamilton's rule. Here C_A and C_R denote the costs to actor and recipient, b denotes benefits and r denotes the actor's relatedness to the recipient R and the third-party X (Foster et al., 2001). In other words, if a positively related third party receives the benefits of a spiteful action that ultimately outweighs the costs to the actor, then spite can evolve. This definition offered a solution by suggesting that spite could be favoured without negative relatedness if the act benefited positively related individuals. This view however, has received much criticism because it is considered as selfish and not spiteful.

To summarise, there are two main views on spite: Hamilton (1970) refers to spite as loss of inclusive fitness in both parties, a fact which is favoured by Natural Selection. Wilson (1975) refers to spite as deferred reproductive benefits to kin. However, a direct benefit would mean that actions are selfish and not spiteful. Nonetheless, the definition of Wilsonian spite is still acceptable as it relaxes the conditions necessary for spite to evolve. The main differences between Wilsonian spite and general concepts of selfishness are that: i) selfishness implies disregarding others' payoffs and ii), aiming for the maximisation of payoff, while wilsonian spite implies other-regarding preferences and minimising the opponent's payoff.

2.2.4 Examples of spite in biology

2.2.4.1 Spite in invertebrates

Some authors have been trying to investigate spiteful behaviour in animals. Foster et al. (2001) found three examples in eusocial insects that cover all of Hamilton's (1970) or Wilson's (1975) principles for spite.

The first spiteful behaviour is worker policing which several species of insects engage in: Hymenoptera insect workers invest time and energy to kill other workers' male offspring at no direct reproductive benefit to themselves. A third-party, the queen's male offspring, indirectly benefit from the action, which makes

the behaviour selected for. Honeybees and vespinate wasps engage in egg-eating, while queenless ants perform direct aggression to reproductive workers. These behaviours are all selected for because they conform to Wilsonian spite (Foster et al., 2001).

The second type of spiteful behaviour is sex allocation bias. Hymenoptera[3] workers, being more related to brother's than to sisters because of haplodiploidy[4] (Ridley, 2003), are expected to bias sex ratio to females. Male killing by the Hymenoptera, represents Wilsonian spite because females obtain a delayed reproductive benefit. There is also empirical data that suggests workers bias sex allocation by selectively killing males rather than helping females which makes the behaviour spiteful and not nepotistic altruism (Foster et al., 2001).

The third type of behaviour is green beard queen killing in fire ants. This behaviour is based on the green beard gene in *Solenopsis invicta*. Heterozygous workers that carry a certain allele at Gp-9 locus kill queens in the colony that lack it. Workers directly kill the queens that do not possess the b allele, which is a greenbeard in the classic Dawkins (1999[1976]) sense where carriers of altruism gene have greenbeards allowing them to identify each other (West & Gardner, 2010). This type of behaviour should conform to Hamilton's more stringent classification of spite. However, the greenbeard queen killing may be favoured by selection through a benefit to a third-party (the queens who carry the b allele) turning it into Wilsonian spite (West & Gardner, 2010).

Nonetheless, the fire-ant system also meets the conditions predicted by Hamilton (1970) for spiteful behaviour. These are:

1. Negative relatedness:
   (a) Allele b in worker is negatively related to BB locus in queens
2. Kin discrimination
   (a) Achieved through greenbeard direct identification of non-gene carriers
   (b) Spiteful actions have little cost because benefits are small
   (c) Fire-ants suffer no direct cost because they are sterile

[3] An insect order that includes ants, bees and wasps.

[4] Haplodiploidy is a sex-determination system defined by the number of sets of chromosomes an individual receives. An offspring formed from the union of a sperm and an egg develops as a female, and an unfertilised egg develops as a male. This means that the males have half the number of chromosomes that a female has, and are haploid. Another feature of the haplodiploidy system is that lethal and deleterious alleles will be removed from the population because they will automatically be expressed in males, hence selectively killing males will remove such mutations from the population.

2.2.4.2 Spite in Bacteria

Bacteria also provide some interesting examples of spiteful behaviour. Some bacteria explode in a shower of antibacterial toxins called bacteriocins to kill their competitors (Gardner & West, 2004a). Because there is genetic linkage between the toxin gene and a gene that gives immunity to the toxin, the closest relatives of the suicidal cell are spared, which means that only those cells that are negatively related to it are killed. This behaviour has been observed in every bacterial species in which it has been looked for (Gardner & West, 2004a; West et al., 2006b).

Another possible spiteful trait is the phenomenon of cytoplasmic incompatibility (Hurst, 1991), whereby male insects carrying the bacterial parasite Wolbachia sterilise mating partners that do not carry the bacterium. It has long been appreciated that inbreeding avoidance generates negative relatedness between mating partners, and although this may usually be very weak, it is strong enough to select for spiteful behaviour in this system because males do not transmit Wolbachia and hence this behaviour carries no cost to the spiteful bacterium (Gardner & West, 2004a; West et al., 2006b; Hurst, 1991).

2.2.4.3 Spite in Mammals

Some authors have been trying to find examples of spite in mammals and following will be a review of such examples.

In their study of prairie dog infanticide practices, Dobson et al. (2000) explain that marauding mother prairie dogs leave their own litters vulnerable to infanticide, in order to kill others, entailing a direct fitness cost which would make the behaviour spiteful instead of simply nepotistic. Under this model, infanticidal marauding occurs or not depending on the degree of relatedness to other females (hence they will tend to attack the more negatively related they are to another female) and on the degree of competition for genetic representation. The characteristics of breeding and dispersal may set the stage for competition over opportunities for female offspring to recruit into the social group as breeders. There is a relationship between infanticide, cooperation and competition. The elimination of the infants of others increases probability of recruitment of one's own offspring into the breeding population, which means this is extreme nepotism where closest relatives are favoured over distant ones. Nonetheless, infanticide can be spiteful at equilibrium because marauders show decreased fitness as well as protectors compared to when marauders are rare or absent. The most

common type of infanticide is perpetrated by lactating mothers on the infants of related adult females within the coterie, even though the perpetrators' own offspring may be killed while they are marauding (Dobson et al., 2000).

Jog & Watve (2005) also claim that elephants are spiteful because they defecate in water holes after using them. This behaviour would leave the used water hole crowded with parasites which would infect other competitors. Although this does not entail a cost to the elephant, it does not bring it any direct benefits either because elephants are nomadic (Dionisio, 2007).

2.2.4.4 Spite in Primates

If spite evolved in the human lineage, is it an ancestral trait that evolved early in the primate lineage a long time before australopithecines first appeared or is it rather a derived trait specific to *Homo sapiens*?. If the former is true, then there should be evidence of this behaviour in extant primates today. However, spite in primates has been extremely hard to find and several attempts at describing this behaviour have not been successful. The following paragraph will discuss the various evidence and experiments in the literature.

2.2.4.5 Spite in monkeys

The first attempt at describing spite in primates was made by Brereton (1994) with his study of free-ranging stump-tail macaques. This particular species of macaque, *Macaca arctoides*, engages in extensive sexual interference behaviour. This behaviour is considered to have evolved in parallel to a specific stumptail genitalia architecture that allows a macaque to be tied 2 or 3 minutes to the female posterior to ejaculation. Without the genital tie to inhibit an agonistic male from retaliating, sexual interference by competitors would be too costly. To explain sexual interference, both proximate and ultimate causes have been suggested. In invertebrates, including primates, it is generally assumed that its ultimate explanation is inter-male reproductive competition.

If one considers that the primary objective of sexual interference is to improve the interferer's fitness, then it is simply a selfish behaviour. However, in stumptail macaques, where individuals of all age-sex classes participate, interference may be spiteful. By inflicting a cost on the intruder and enough stress upon the mating male and female to delay conception, the intruder is not receiving an immediate but a return benefit. Also, immatures may be participating on behalf

of their mature kin (which conforms to the wilsonian spite description). Brereton (1994) tries to prove his theory making the following points: (i) sexual interference in stumptail macaques inflicts stress on the mating pair; (ii) is tactically spiteful by imposing a greater cost on the mating pair than on the intruder; and (iii) is ultimately beneficial reproductively for the intruder when associated with alternative reproductive tactics.

Brereton (1994) approaches spiteful behaviour in an interesting manner. He claims that

> A spiteful act is one that reduces the reproductive fitness of both the recipient and the perpetrator of the action and is behaviour best classified as 'strongly spiteful' (...). An action may be equally costly to both parties, or strongly spiteful, but can continue to be classified as spiteful as long as the actor does not benefit directly (...)therefore, it is not necessary that a loss in reproductive fitness be demonstrated, only that the risk of a loss exists. How does one measure the risk of an act? It is essentially unmeasurable, but this does not make such a risk any less real or a spiteful act any less spiteful (Brereton, 1994, p. 131)

This means that the threat of retaliation and significantly longer tie durations during matings, as compared to those without interference, may signal a potential cost in reproductive fitness for the recipients. Intruders were never observed to attempt to mate with the opposite sexed member of a mating pair after intruding, reducing the probability of the behaviour being selfish. Brereton (1994) however, claims that this spiteful behaviour is what he calls a "return-benefit". Spite with a return-benefit postulates that even though an act performed by a perpetrator is potentially costly at the time in terms of ultimate reproductive fitness, it may eventually serve to accomplish a relative net benefit for the actor compared to the recipient. The benefit is gained when a second directly beneficial act ultimately occurs which does more than counter balance the cost that the original act incurred. He goes on to claim that spiteful behaviour can be selected for particularly if it is associated with a second act, which ultimately provides a net return for the actor. When this occurs, the original act of spite should then be considered a delayed act of selfishness.

When viewed in this restricted manner, all social behaviour, including spite, altruism, as well as cooperation, becomes selfish by definition, and this is clearly not the case. All three, plus selfishness, should theoretically exist because the relative gain acquired by the perpetrator of such an act (be it in net or reproductive benefit or cost) always equals or exceeds that acquired by the recipient. Spiteful behaviour may therefore be more common than previously suggested when return benefits are recognised and associated. Hence, not only has sexual interferences been selected for because it may impose an equal or greater net loss in reproductive fitness on the recipient, but also because the opportunity exists within stumptail society which allows it to be potentially associated with a return-benefit through alternative mating. Individuals that mate alternatively, i.e., individuals that do not comply with the established hierarchy when mating, but do not interfere in the matings of others will be selected against because they will reproductively lose.

Brereton (1994) claims that sexual interference should be termed spiteful because it entails a risk of cost to the perpetrator and can cause a direct fitness cost to the recipient. However, he also claims that this could lead to a return-benefit in case the perpetrator engages in alternative mating behaviour. The term spite involves direct fitness losses for the perpetrator or malevolent attacks without any possible benefit, be it delayed or immediate. In this case, there is always the case that the perpetrators genes will not spread, turning the competition less represented in the group's gene pool.

2.2.4.6 Spite in apes

Studies made in chimpanzees also claim that spite is not a trait common to our most direct ancestors. Jensen et al. (2007a) performed experiments in captive chimpanzees at the Max Planck Institute where they tested whether or not these primates could be spiteful or altruistic in three different experimental settings.

Chimpanzees were neither found to be altruistic nor spiteful; they were not other-regarding, though the possibility that they were averse to disadvantageous inequity cannot be ruled out. The presence of - and payoffs to - another individual had no influence on the actor's choices. Kinship had no effect on altruism, though kin were less likely to make any choice at all than were non-kin. The opportunity for altruism or spite did not influence the motivation or decision-making latencies of chimpanzees.

In the third experiment chimpanzees were given the opportunity to be really spiteful. If the actor had no action, the recipient would eventually receive the banana after a set time. Therefore, individuals averse to disadvantageous inequity would be spiteful, individuals with no aversion to disadvantageous inequity would either do nothing or choose altruistically, and individuals lacking other-regard would show no clear preference. The authors found that there was no difference in how quickly chimpanzees chose to be spiteful or altruistic. Kinship had no effect on whether or not the actors did nothing when paired with the alpha male. Two of the six actors showed some possible signs of altruism. However, it is noteworthy that these individuals were also the only two individuals who begged from, or harassed, the recipients after pulling the food towards them - suggesting the possibility that they assessed the probability of getting food for themselves to be higher if they pulled the food towards the recipient than when the recipient received the food passively.

When comparing the three experiments it is apparent that the chimpanzees were influenced by personal payoffs as they were less likely to do nothing when they directly benefited, as opposed to when they did not benefit at all. It was also clear that neither the presence nor the absence of a recipient had any overall effect on subjects' choices across the three experiments. Making a choice was influenced solely by personal outcomes irrespective of gains or losses to other chimpanzees. Since not choosing could be interpreted as either passively spiteful (disadvantageous inequity aversion) or as passively altruistic (absence of disadvantageous inequity aversion), the common denominator was mere passivity (inequity indifference). In the absence of any possibility of obtaining food, chimpanzees preferred to do nothing, regardless of how this affected the other chimpanzee or not. It is perhaps surprising, however, that spite was also completely absent; if chimpanzees were averse to disadvantageous inequity, as suggested by Brosnan et al. (2005), it seems likely that they should have acted to eliminate unfair outcomes. It seems most likely that chimpanzees are not other-regarding and are indifferent to inequity in a food-acquisition context.

Jensen's (2006) findings were later corroborated by Jensen et al. (2007a) when exposing the chimpanzees to an ultimatum game. It seems that chimpanzees are rational maximisers not sensitive to fairness. Chimpanzee responders did not reject unfair offers when the proposer had the option of making a fair offer, they accepted almost all nonzero offers, and they reliably rejected only offers of zero. These results contrast strongly with those of adult humans, who reject 8/2 offers most often when a fair (5/5) option is available for the proposer and least

often when the alternative for the responder is even more selfish than the 8/2 option (Jensen et al., 2007a)[5]. It is considered that sense of fairness is one of the starting points for human spite (mostly in the form of what is known as altruistic punishment, a concept that will be described below in subsection 2.2.6.

2.2.4.7 Spite in Humans

Spiteful behaviour in humans can be shown in several ways. It can take the form of Hamiltonian spite (1970) (harming those who are more negatively related like a distant cousin); Wilsonian spite (1975) (harming others to benefit a third party, which can either be the group itself or a specific related individual), it can be driven by kin selection, group selection, religion and economics. Human spite is probably driven by the emotions of envy and malevolence (Elster, 2000). However, it can also be driven by a twisted sense of altruism. Suicide bombing maybe be argued as a spiteful behaviour that translates into a personal sacrifice for the good of a cause, which can be read in this sentence as group. It is wilsonian spite in the sense that relatedness is shifted from genes to culture, and everyone that is not part of the same creed is very negatively related to the perpetrator. However, suicide bombers are being altruistic in the sense that they are punishing those they believe to be the causers of harm to their group. In fact, this definition is akin to what Durkheim as described as altruistic suicide (Jones, 1986). They are, we might consider, punishing those who do not follow the rules of the group.

Trivers (2005) adds that aggression is the starting point for spiteful behaviour. Most Jamaican youngsters react to low offers in an ultimatum with a flash of anger. Anger is not a mere emotion; it is a costly physiological arousal for immediate aggressive action. Functional Magnetic Resonance Imaging (fMRI) work shows that unfair offers are met with activation of a part of the recipient's brain involved in negative emotions (primarily anger and disgust) and control functions involving conflict, and the higher the activation, the greater the chance that such an offer will be rejected (Sanfey et al., 2003). In short, in everyday behaviour and neurophysiology humans respond to so-called one-shot encounters as if they were the first in a chain of interactions. Envy, malevolence and revenge are costly actions that prepare the human body for future interactions even if they are not

[5]In ultimatum games, players get the chance of proposing a splitting of a communal pie between themselves and another player. Common game theory allocation notation determines the split of the pie proposed. In this case, 8/2 can either mean 80% of the pie for the proposer and 20% for the pie for the recipient, or more specifically, an allocation of 8 units of the incentive for the proposer and 2 units of the incentive for the receiver.

to happen (Trivers, 2005; Elster, 2000). This could mean that repeated interactions and a sense of fairness and justice are possibly hard-wired and have evolved with anatomically modern humans (Trivers, 2005).

In a biological sense, humans are agonistic in a number of situations that can be costly and bring no benefit, immediate or delayed, to the perpetrator. In an economic sense, spite is often perpetrated by dominant companies for a delayed benefit of achieving market hegemony in the long run (Winters, 1991). By lowering product values to an unbearable low value, the dominating company is harming itself but at the same time it is damaging the competition even more by drastically reducing their market shares (Winters, 1991).

Punishment can also be spiteful in nature. Bolton & Ockenfels (2000) predict punishment of any co-player when the aggressor's relative payoff is lower than the average one; Levine (1998) posits the existence of spiteful types who punish indiscriminately and type-reciprocal agents who punish selfish or spiteful co-players. In the ultimatum game, responders might reject offers due to envy, inequity aversion, reciprocity, spite, or to punish a violation of an equity norm, while punishment in the public goods game can be explained in terms of envy, inequity-aversion, reciprocity, spite, or as a reaction to a transgression of cooperation norms (Leibbrandt & López-Pérez, 2008).

It seems that humans are capable of spite in a number of situations, some due to inequity adversity, some to malevolence and some to envy. The question to be asked at this point is why there is such a mechanism, when clearly our most close primate relatives seem to be oblivious to such behaviour? Examples of spite are actually quite scarce and mostly occur in eusocial insects and bacteria (West & Gardner, 2010; Foster et al., 2000; Foster et al., 2001). Part of the evolutionary biology scientific community has been trying to answer such questions by developing mathematical models that take into account not only Hamilton's (1970) description of spite but other causes that might influence the occurrence of spiteful actions. These models will be explored in the next paragraphs.

2.2.5 Testing Models of Spiteful Behaviour

One of the main questions regarding spiteful behaviour is why is it so hard to find in non human animals? The answer was actually given by Hamilton himself and has driven many researchers to lean over this subject. Hamilton (1970) claims that:

- Spiteful actions cost something
- An animal normally does not have a way of recognising which members of its species have less than average relatedness with itself
- Spite should be favoured in populations that are small and precarious. However, the prevalence of spite would hasten the extinction of these small populations (Dionisio, 2007; Hamilton, 1970).

Nonetheless, it is clear by what was presented above that there are examples of spite and it is possible that it can be an evolutionary stable strategy (ESS) (Smith & Price, 1973; Smith, 1982). As we have seen, the first author to describe an alternative view of spite was Wilson (1975), where he supports that spiteful behaviour is an ESS when the actions of the perpetrator benefit some third party, mostly by the same mechanisms of kin selection for altruism (Hamilton, 1964a; Hamilton, 1964b; Smith & Price, 1973). Wilson's model explains spite as a form of "reverse" altruism where the perpetrator harms a more negatively related individual for the benefit of a more positively related third-party (Wilson, 1975; Foster et al., 2000; Foster et al., 2001).

One of the first alternative spite theories after Wilson was given by Brereton (1994) in his study of sex interference which has been extensively described above. Here he claims a return-benefit spite with delayed benefits to the perpetrator. This theory suffers from the same susceptibility to criticism as Wilson's theory because there is a benefit associated to the act, even if a delayed one. More recently, models were refined to include what is called the scale of competition. This concept shows that some acts that might be confused as plainly selfish, actually become spiteful when the scale of competition increases together with the potential for less random breeding (West et al., 2006a; Foster et al., 2001). The possibility that spite is favoured by local competition has not been fully considered.

Localised competition between relatives can reduce or remove selection for altruism amongst relatives. With limited dispersal in a viscous population, individuals would tend to associate with kin. However, this relies on the assumption that density-dependent regulation is global with no decreased competition. If density-dependent regulation occurred at the level of the social group, then the recipient's increased success would be paid by the group. Without kin discrimination, relatedness of the actor will have been equally raised by population viscosity. This population viscosity does not necessarily favour indiscriminate altruism (Gardner & West, 2004a). This means that there was need for a new way of calculating relatedness and incorporating competition into the equation.

Instead of using relatedness as a regression measure between individuals, Queller (1994) reformulated the coefficient of relatedness defining it relative to a reference population of competitors, with a part of them being locals and the remainder average members of the global population (Gardner & West, 2004a; Queller, 1994). Frank (1998) further added to this by introducing a separate scale of competition parameter to be incorporated into the benefit component of Hamilton's rule (Hamilton, 1964a), which was the proportion of local against global competitors allowing to predict when social behaviours were favoured by natural selection (Frank, 1998; Gardner & West, 2004a). Nevertheless, even though the importance of the scale of competition was acknowledged for altruism, the way it impacts spite is still not yet fully appreciated. With increasingly local competition (smaller focal populations), altruism would be disfavoured while the selection for spite could be enhanced.

Hamilton (1970) described that spite could only evolve in small populations. However, the competing sub-section of the population is what is of interest. As competition becomes more local, the reference population shrinks to the size of only a few individuals (small N) and/or a significant proportion of positively related kin, such that the negative relatedness towards other potential recipients is not random, which in time enhances the selection for spite (Gardner & West, 2004a).

> If relatedness to the victims of spite is sufficiently negative, then spite can be favoured by kin selection. This negative relatedness is expected to be very small in large populations, unless the actor can identify a huge number of kin. However, if individuals mainly compete locally with social partners then relatedness measured relative to the average competitor can be strongly negative even in very large populations. (Gardner & West, 2006, p.R663)

The more competition is local, the more fitness is dominated by success relative to the social group average, and so altruism is less favoured and hence,

> Spiteful behaviour incurs a direct cost and reduces the success of social partners, so that more spiteful individuals can have a higher success relative to the group average, suffering a reduction

> in absolute fitness. When competition is global and fitness proportional to absolute success, spite cannot be favoured, but as competition becomes increasingly local fitness is increasingly determined by success relative to social partners, so that spite can be a winning strategy (Gardner & West, 2004, p. 1198), see also (Gardner & West, 2004a; Hamilton, 1971; Queller, 1994; Frank, 1998).

Gardner & West (2004a) derived Hamilton's rule (1964) by using a direct fitness approach through the direct (neighbour modulated) fitness maximisation (Taylor & Frank, 1996). This led to a three-party extension to Hamilton's rule for spiteful interactions also given by Foster et al. (2001), although the latter is a consequence of analysis rather than its starting point.

$$R_1 B + R_2 D > C$$

This form can be used to discriminate Hamiltonian and Wilsonian forms of spite (Hamilton, 1970; Hamilton, 1971; Wilson, 1975; Foster et al., 2000; Foster et al., 2001) where R_1 is the relatedness to the victims of spite, B is the benefit, R_2 is the relatedness to the third party that receives any direct benefits D and C the costs. Wilson (1975) proposed that spite aimed at non-negatively related individuals is possibly favoured if it also results in a benefit to a positively related third party. However, a direct benefit to positively related individuals ($D > 0$) is not always necessary for spite to occur. Negative relatedness is dependent on the ability to discriminate which individuals are less related than the average competitor and also it increases as competition becomes more local, so that there is potential for spiteful behaviours to involve both negative relatedness to victims and positive benefits to positive relations. The relaxation of competition due to spite is absorbed into the negative relatedness term when it is measured relative to the average competitor (Gardner & West, 2004a).

The scale at which competition occurs (more local vs more global) can also be largely influenced by different rates of dispersal for males and females. Kin selection theory suggests that indiscriminate altruism could be favoured when limited dispersal leads to higher levels of local relatedness in a given population (Hamilton, 1964a; Hamilton, 1964b; Johnstone & Cant, 2008). These constraints exist so that individuals can interact mostly with relatives without having to use active

discrimination on their part (Johnstone & Cant, 2008). However, limited dispersal may also lead to increased local competition among relatives. This would ultimately reduce payoff for altruism towards kin because any benefits conferred to one relative are likely to reduce the fitness of other competing relatives (Johnstone & Cant, 2008). However, results show that spite is difficult to achieve under increased competition. Johnstone & Cant (2008) start from a simple inclusive fitness argument and take into consideration kin selection. They claim that harming behaviour as they call it, is only favoured when it represents a form of selfishness in a complete-mixing population model[6], meaning the act has to have a fitness benefit to the perpetrator, making it simply selfish. However, it has been shown by Nakamaru (2006) that spiteful behaviour can be promoted under lattice models. This happens because, unlike complete-mixing models, individuals rarely interact with each other randomly even in one single group. Spatially structured models like the lattice are useful for human society and behaviour as much as biological and ecological phenomena. The lattice model is useful when we want to know the effects of neighbourhood on the dynamics of a human population. Nakamaru (2006) also claim that a lattice structured population promotes the evolution of spiteful behaviour, especially under a specific life-history assumption called the score dependent viability model (Nakamaru & Iwasa, 2005)[7]. What this means is that under structured models of interaction, spiteful behaviour is selected for while in certain complete-mixing models it is portrayed as selfish. Given that most human interactions occur in structured form, the former are more reliable.

2.2.6 Spite and Altruism, how are they different?

The evolution of cooperative behaviour by punishment seems intuitively to be a phenomenon apart from the evolution of spiteful behaviour. However, there is evidence that indicates that this is not quite the case. Human society is based on cooperation at a number of different levels. However, whoever cooperates has to reduce his own fitness to help others in an altruistic act (Hamilton, 1964a; Hamilton, 1964b). There are many explanations for the mechanisms that promote the evolution of cooperation. For example, altruism among kin is explained by the inclusive fitness theory (Hamilton, 1964a). Cooperation among kin may have

[6] A complete-mixing model assumes that all individuals are homogeneous and can interact with equal probability.

[7] Networks of social interactions though, are more complicated than those described by lattice models (see Barabási, 2009 for a complete description of network types and their influences on behaviour).

been essential for establishing what we know as a community when human society was taking its first steps. However, in recent times, cooperation among non-kin has become fundamental for our society. Several theories have been put forward to explain widespread cooperation among non-kin. The main explanation put forward was that of Reciprocal Altruism (Trivers, 1971), where altruistic acts would be repaid until a balance was achieved. Another important theory is that punishing selfish players promotes the evolution of cooperation (Brandt et al., 2003; Hauert et al., 2007; Nowak, 2006a; Bshary & Grutter, 2005; Nowak & Sigmund, 2005; Gardner & West, 2004b). Other explanations argue that groups are the units selected for and that group selection is one of the causes of widespread non-kin cooperation in humans (Wilson & Sober, 1994; Alexander & Bargia, 1978) and others still that indirect reciprocity are the drivers for such cooperation (Nowak, 2006a)

A major problem with the punishment theory is that the individual who punishes a free-rider has to incur a cost, a situation that can be considered similar to spite. In order to explain this phenomenon, there have been some attempts at studying the co-evolution of cooperation and punishment. If the individual is an Altruist-Punisher (AP) (Nakamaru & Iwasa, 2006), it can cooperate with others and reap the benefits of such cooperation (Sigmund et al., 2001). Several works show that an AP can invade a two-person game lattice structured habitat full of selfish players (Nowak & May, 1992; Nakamaru & Iwasa, 2006; Nakamaru & Iwasa, 2005). Also, Monte Carlo simulations seem to confirm that a spatially structured habitat promotes the evolution of an AP with a small number of starting AP's (Nakamaru & Iwasa, 2006). These studies conclude that the AP is spiteful by nature because it also loses fitness for punishing. Nonetheless, the future benefits he obtains by enforcing cooperation can also be considered selfishness. The AP can also be simply considered altruism as there are latent benefits to be obtained from cooperation for his kin, if one takes a view based on kin selection and acknowledges reputations (Nakamaru & Iwasa, 2005; Nakamaru & Iwasa, 2006; Sigmund et al., 2001). Saijo & Nakamura (1995) and Saijo (2008) found that in a voluntary contribution mechanism experiment that spiteful subjects free ride with low marginal return, which casts doubt on the efficacy of a theory based on altruism. Also, Ito et al. (1995) identify two behavioural principles: share maximisation and difference maximisation, both of which can be considered principles to justify spiteful behaviour.

Some studies have shown that spiteful behaviour is linked to cultural background. Toda et al. (1978) showed that nearly 50% of children in elementary

schools in several countries use spiteful behaviour strategies. Japanese children were found to be more spiteful or competitive than children in the United States, Greece, or Belgium (Toda et al., 1978). Frohlich et al. (1984) found difference maximising behaviour in simple binary choice problems. They also showed that Canadian students were more spiteful than American students, with the former having a stronger inclination toward difference maximising than the latter.

Work that contests Hamilton's theory that spite can only occur in small populations (Hamilton, 1970; Dionisio, 2007) claims that parasites can be used as weapons in spiteful behaviour. Dionisio (2007) argues that, (i) a harmful mutant is willing to pay a fitness cost to increase the probability of passing a parasite to non-kin hosts. Regardless of the fitness costs of the mutant, the 'recipient' would suffer a considerably higher fitness cost; (ii) immunity to a certain parasite enables a kind of kin-recognition. Also, immune systems allow hosts of a certain group to recover from a given disease while non-related hosts would die of the same infection and facilitate kin recognition; (iii) there can be a composite population of spiteful individuals made of sub-populations with migration between them which would refute Hamilton's (1970) low population threshold.There is a further argument towards refuting Hamilton's (1970) concerns on spite. Regarding the costs to the perpetrator, the author states that the ratio cost to actor/cost to recipient, can be very low. This can be accomplished if several parasites or pathogens arise from a single host. The cost of directing infection from kin to non-kin susceptible hosts does not increase when potential recipients increase. Also an infected, 'non-spiteful' host can propagate this effect by re-transmitting a parasite toward other wild-type hosts (Dionisio, 2007). Regarding the ability to recognise kin, he states that animals may have difficulty recognising kin and non-kin members. However, 'immune systems' may play a role of recognition without cognition. Immunity among vertebrates may prevent infection among kin-members. Finally, regarding small populations, he states that probably all species live in subdivided populations instead of a single panmitic population (Dionisio, 2007), which could mean that spite is more widespread than commonly assumed.

On a different note, Lehmann & Reuter (2006) have argued that spite and altruism are two sides of the same coin and that previous approaches have just been focusing on one aspect or the other. Their idea is based on the observation that inclusive fitness theory provides an explanation for the evolution of social traits that reduce the fitness of the actor: first, a trait can be altruistic and spread because the actor increases the fitness of his relatives. Secondly, the trait can be spiteful and

spread because it reduces the fitness of a recipient who is less likely to share genes with the actor than is an individual taken at random from the population. They also claim that Hamilton's (1970) analysis is based on fitness effects and specify that spiteful traits have a negative effect on the actor's personal fitness ($c > 0$). Furthermore, Foster et al. (2001) already correctly dismissed definitions of spite based on the effect of a behaviour on the actor's inclusive fitness, or on those in which a fitness cost is compensated by a delayed fitness benefit. Some authors however, do not make any distinction between effects on fitness and effects on fecundity, and consequently define spiteful traits as those that decrease the actor's fecundity (Vickery et al., 2003; West & Gardner, 2010; Johnstone & Bshary, 2004). On the contrary Lehmann & Reuter (2006) argue that using fitness rather than fecundity makes the application of concepts such as spite and altruism possible to traits that do not involve individuals that directly interact, opening the possibility to think about these traits under kin-selection (Hamilton, 1964a). On the one hand, behaviours that are spiteful to their direct recipients would probably have a positive fitness effect on other individuals in the population. Spite against negatively related individuals leads to an increase in fitness (or altruism) towards the (obviously positively related) rest of the population. On the other hand, an altruistic trait directed against positively related individuals would result in a fitness decrease (or spite) in the rest of the negatively related population (Lehmann & Reuter, 2006).

When taking into account Lehmann & Reuter (2006), the definition of spite given by Wilson (1975) coincides with that of Hamilton (1970). The difference is that, whereas Wilson concentrates on the positive effects on the relatives' fitness, Hamilton focuses on the negative effects to the negatively related recipients. According to Lehmann & Reuter (2006), spite and altruism do not represent different evolutionary forces but are two sides of the same selection pressure acting on a specific social trait. Whenever a mutant allele resulting in a cost for the actor spreads through kin selection, it does so both increasing the fitness of relatives and decreasing that of less or unrelated individuals (Lehmann & Reuter, 2006). It appears that different views of spite and altruism derive from concentrating on different stages of the lifecycle. Several authors have interpreted spite and altruism as separate phenomena either by defining them from the physical interaction at either the adult or juvenile stage (Foster et al., 2000; Foster et al., 2001) or from effects on fecundity and not fitness (Vickery et al., 2003; Gardner & West, 2004a; Johnstone & Bshary, 2004; Lehmann & Reuter, 2006).

2.2.7 Final remarks

Keller et al. (1994), when looking at the stringent classification of spite, said that spiteful animals are yet to be discovered. The examples described in this theoretical discussion do show that there are a very limited number of instances of spiteful animals. However, humans seem to be the spiteful animal par excellence, a fact that can be derived of it having the capacity for feeling and expressing emotion and other-regarding preferences to an extent not seen in any other animal (Burnham, 2003). Our closest living relatives, the chimpanzees, appear to be rational maximisers that do not regard others well or ill being (Jensen et al., 2007a; Jensen et al., 2007b; Silk, 2007). This can be understood as a logical thinking process. If one does not care about a neighbour, one also wouldn't bother being spiteful to him. Modern humans, who were defined as *Homo economicus* (Read, 2009), seem to act non-rationally in their economic decisions, as anger, envy, and malevolence seem to affect simple choices in games. Also, cultural background influences not only impact behaviour in general, but also spiteful behaviour in particular as demonstrated by cross-cultural experiments (Toda et al., 1978; Saijo, 2008; Ito et al., 1995). Following the discussion of the biological background of spite and how this behaviour has been explored in the life-sciences, it is now appropriate to delve into how society and culture influences this type of behaviour and the how literature in the social sciences include many of the arguments explained above in different concepts.

2.3 Spite as a cultural phenomenon

2.3.1 Introduction

In this chapter the reader will be taken on a journey through the ethnography of what I believe are spiteful behaviours. The section will first start with an account of reciprocal exchange systems, as defined by Mauss (2002[1954]) using the paradigm of the potlatch total social facts. I will argue that these are in fact spiteful competitive systems that can be taken to an extreme. The Potlatch of the indigenous canadians and the Kula of the Trobriand Islanders (Malinowski, 1984[1922]) will be the main such systems discussed, linking these phenomena with spiteful behaviour. Next, I will argue that fear of magical punishment and

desire to control with debt are the principal driving forces behind spiteful exchange systems. Also, the origin of beliefs in the evil eye will be discussed as a protection against spiteful individuals and strategies, looking at how concepts from classical Mediterranean anthropology such as the "amoral familism" theory equate to the models that theoretical biologists have been putting forward to describe spite. The following section will explore how cultural differences in the notion of fairness can facilitate the occurrence of the kinds of seemingly reciprocal exchange systems studied and how competition is one of the basis of such systems. Then I will explore the theme of gender differences in competitive behaviour in both social and biological contexts, as well as how these differences are expressed ontogenetically. Finally, I will make a remark on how the construction of gender roles in different cultures might make cultural gender construction seem as a biological difference.

2.3.2 The Gift: obligational reciprocity as a spiteful enterprise

When describing the social practice of the Gift, (Mauss, 2002[1954]) claims that giving is an obligation and an economic interest at the same time. It is also a spiritual phenomenon where gift exchange between males can incite the spirits of ancestors to be generous towards them. Gift exchange is not only an exchange between humans, but also an exchange between men and the supernatural.

The gift rests on it being obligatory to receive, and obligatory to give. To refuse hospitality, presents, trade or forging of alliances of blood by the exchange of women is the same as declaring animosity. The giver is coerced to give and the receiver to receive. Pending reciprocation, the giver gains a claim on the everything the receiver owns, a spiritual link it seems. Despite this spirituality, there is a spiteful underlining to gift if the persons who participate in gift exchange rival in their generosity; there is an inherent potential for competitive behaviour in a system that seems based on cooperation. Status is the real currency being exchanged and this competition can be agonistic in nature.

For example, (Mauss, 2002[1954]) explains that a clan cannot refuse to provide hospitality, share meals, receive presents or deny blood and alliances under the penalty of war being declared on them. Because of this, men often rival in their generosity (Mauss, 2002[1954]) in distributing more and more powerful gifts, thereby gaining hold over the receivers who do not reciprocate accordingly. In a sense, this can be considered as Wilsonian spite because by partaking with

resources (i.e., paying a cost) chiefs are hoping for a future status benefit (which ultimately would lead to greater reproductive success in the terms theoretical biologists describe it as in Smith (1982)). Gift systems have been liked to a form of insurance system (Baker & Swope, 2005), because paying a high premium would lead to higher future benefits. However, the fact that donations are often destroyed, and that the gift giving rituals are usually rife with accounts of suspicion and disdain, makes this assumption less clear.

2.3.2.1 The Potlatch and Kula

The potlatch is described by Mauss (2002[1954]) as the exchange of gifts within a tribe or between tribes, carried out by the tribes' chiefs [8]. In the potlatch, a feast is thrown consuming most of the resources collected by a group during a certain time period as an "offering" to neighbouring chiefs. These feasts can consume an entire village's resources, as well as some important spirit houses. This destruction of property eventually led the potlatch to be banned by the authorities during the last century, which was met with disagreement by its practitioners.

During a great potlatch, what is leftover from the sacrificial ritual is often scattered in the sea. According to Mauss (2002[1954]), the Koryan Whale ritual develops the theme of resource sacrifice quite clearly. The sacrificial destruction he describes was meant to be a donation that is reciprocated and was common in most American Northeast and Asian form of potlatch. This destruction is not meant solely as a display of wealth. As Mauss (2002[1954]) describes, slaves were killed, coins were thrown to the sea and sumptuous houses were burnt to the ground as a sacrifice to the spirits and the gods. Hence the sacrificial contract implied not only a reciprocation from the neighbouring tribes but also from the gods themselves. This is an important, which will be described further in section 2.3.3.

The kula is possibly one of the most well studied and known examples of ethnography ever written. Immortalised by the seminal work of Bronislaw Malinowski (1984[1922]) *The Argonauts of the Western Pacific*, the kula is a trading system taking place in Melanesia in which men embark in long sea travel in to exchange special items. Despite the kula having been described extensively before, it will be discussed in this study in a new light as a spiteful interaction.

[8] Here, the concept of chief is used generally as leader. Because many of the societies herein described do not have similar social and hierarchical structures, it seemed fitting to use more general rather than specific terminology

The kula is centred on two kinds of valuables or *vaygu'a*, *mwali* (arm-shells) and *soulava* (necklaces), with other minor valuables of secondary use. The *mwali* are transmitted from west to east and the *soulava* are transmitted from east to west. The two valuables circulate against each other, and are traded for their opposite but never for each other. From above, the arm-shells move counter-clockwise and the necklaces clockwise around a giant circle of islands and communities (Malinowski, 1984[1922]; Strathern, 1983; Leach & Leach, 1983).

The *vaygu'a* are a public good, a communal property that cannot be owned privately by any man or kept in one's possession for very long. The items themselves have little economic value or impact in the lives of the trobriandese. However, *mwali* and *soulava* have immense social value and meaning because they are part of the kula exchange. The shells accumulate their value as they circulate among partners around the kula ring. Arm-shells are ranked in value against each other as are necklaces inter-ranked amongst each other. The more the items are traded, the more they are valued, with some items having names and what are called shell-histories (Malinowski, 1984[1922]).

The valuables are exchanged according to the principle of reciprocity, like value for like value. The reciprocation of valuables must be delayed, not simultaneous, transactor A going to B to seek a prestation shell x, B returning later to A for a reciprocating shell y, C coming to A to seek shell x, and later A going to C to get a reciprocating shell z and so forth. This practice, according to the description above, should clearly be cooperative and provide the basis for a sound "traditional economy". However, when considering how exactly the exchanges take place, one realises that the exchange is an obligation, and one not taken lightly. The first gift of a *vaygu'a* is called an opening gift or *vaga*. The *vaga* definitively compromises the receiver to a retribution gift, called the *yotile*, which is translatable as a clinching gift (as it clinches the transaction). The retribution gift can also be called the *kudu* (that separates and releases the retribution) and must be of equivalent value as the former. These "gifts" can be taken by force or surprise in case of conflict, or even by magical revenge if the original donor regards his *yotile* as poorly reciprocated (Mauss, 2002[1954]; Malinowski, 1984[1922]). Here we can glimpse the almost "oppressive" nature of the gift. When we further consider Mauss's (2002[1954]) description of the kula exchange process, we begin to understand why gift giving can be spiteful. First of all, those who start the kula travel with nothing and even refuse to ask for meals as when they are visited in the following year they will have to repay everything with interest. When regarding the exchange itself, we see that

> The donation assumes the form of solemn ceremonies, the receiver disdains the received gift, even is suspicious of it and does not keep it until the moment it is thrown at his feet. The donor assumes an exaggerated modesty and asks forgiveness for giving only scraps, tossing the gift at his rival's feet. (Mauss 2002[1954], p. 81)

The spiteful nature of the kula is represented here in two aspects, the disdaining and the suspiciousness of the gift, and the fact that reciprocators are considered rivals instead of cooperative partners. Here, the kula can be described as a status-seeking endeavour portrayed as "generosity". The larger the value is of the *vaygu'a* given, the higher the prestige and larger the return. However, this is also true for the next individual in the exchange chain, leaving each participant to be locked in a circle of prestige and debt, meaning that the greater the prestige, the greater the cost to be paid in the following kula expedition.

Another aspect that points out to the spitefulness of the kula interaction is how it is organised and who participates. If we take into account what has been discussed in the previous section, the relationship between spite and kinship is an important factor for the maintenance of this type of behaviour. Actual exchanging takes place only between individuals, though these individuals often move as a single kula community from one island or area to another. Kula exchanges occur between kula partners, individuals who are in fixed lifelong relationships with each other, unless serious breaches take place. The association that is created by the kula exchange tends to form a sort of clan among participants (Leach & Leach, 1983).

The Kula is highly gendered and ties in with notions of male banding that will be described in the section on gender and spite below. With rare exceptions, only men can be kula participants. A kinsman brings a man into the kula at adulthood, usually the father or a mother's brother. A man may have a minimum of two partners, one on either geographical side, or multiple sets of partners up to large numbers such as one hundred or more as in the case of local leaders (Malinowski, 1984[1922]; Mauss, 2002[1954]). A man's partners normally come from the kula communities to his proximate geographical locations either side, though they sometimes come from within his own kula community. Partnerships are linked in chains around the ring, but a man exchanges only with partners to his proximate left and right, not with everyone around the entire chain of which he is one link. Kula participants solicit particular shells from their partners with

preliminary gifts of valued items, which should be themselves ultimately reciprocated. Transactors do not haggle with their partners over relative value in exchanges (Malinowski, 1984[1922]; Strathern, 1983; Leach & Leach, 1983).

Men gain considerable prestige from participating in the kula. A large amount of utilitarian trade in essential and luxury resources takes place on kula expeditions, though this kind of exchanging is conceptually and behaviourally separate from kula exchange to the participants. Kula partners do not trade or barter in a utilitarian sense with each other. Except in minor details, the transactional rules of kula exchange are the same all around the ring (Leach & Leach, 1983). The actual process of exchange within the kula provides a valuable indication of its spiteful nature. When we read Malinowski's passage on the nature of the gift, we see that

> the *vaga*, as the opening gift of the exchange, has to be given spontaneously, that is, there is no enforcement of any duty in giving it. There are means of soliciting it (*wawoyla*), but no pressure can be employed. The *yotile*, however, that is, the value that is given in return for the value previously received, is given under the pressure of a certain obligation. (Malinowski 1922:353)

Because those who travel in the kula essentially travel with nothing, the expectation is that they receive *yotile* for the *vaga* they have previously given, and receive *vaga* for the next time around when they are themselves visited, creating a constant imbalance between the exchangers (Strathern, 1983). Unlike an actual reciprocal system where the book-keeping of given and received is always in balance (Trivers, 1971), those who partake in the kula expeditions seek a constant imbalance, aiming at controlling others by debt, while simultaneously building prestige as great gift-givers.

Many other interpretations have been put forth as the main reason behind kula exchange. Nonetheless three are dominant in the literature, these are: (i) recirculation of material resources; (ii) prestige competition and (iii) social communication (Leach and Leach 1983). Despite the differences of these explanations, they have not been singled out by any author as a definite interpretation of the kula (Leach & Leach, 1983). Nonetheless, an account of the general principles behind each of these is given, without focusing on the depth of linguistic and conceptual properties latent to them. The first explanation is related to the recirculation of resources from the different islands that participate in the kula. This

argument focuses on the fact that the kula is a symbolic contract sustaining peace in a hostile environment by promoting trade of valued resources distributed unequally among islands that have distinct ecological realities (Leach & Leach, 1983; Rivers, 1999[1926]; Brookfield & Hart, 1971; Hage, 1977). The islands involved in the kula have different natural resources and even the commonly available goods are often differently distributed across them. Moreover, some of the labour specialisations that are common among the islanders (pottery, basketry, skirt making, ornaments, among others) are also located differently (Hage, 1977; Leach & Leach, 1983). The hypothesis behind this argument is that the kula minimises these differences in resource disparity while at the same time reducing the risk of conflict (Leach & Leach, 1983). However, there are also weaknesses regarding this explanation, as it does not account for the actual focus of the kula itself, i.e., the *mwali* and *soulava* shells. It also fails to account for the fact that some islands that are wealthy in most of the common resources of that region engage in the kula in the first place (Leach & Leach, 1983).

Another explanation that has gathered the most support is based on prestige competition. It is the most akin to what is being described in this thesis for gift-exchange systems. Because open warfare between members of communities would be completely disruptive, the kula would offer a platform for ritualised competition without the extreme costs of physical aggression (Leach & Leach, 1983; Uberoi, 1962; Weiner, 1988; Weiner, 1976). Moreover, not only prestige competition explains why the kula is centred on ritual exchange of symbolic items and why chiefs are the main actors in the kula social habitus (Bourdieu, 1977), but also explains why the kula is male biased.

2.3.3 Punishment through magic? How fear of magical retaliation maintains reciprocity

Recently, there has been much evidence, both theoretical and experimental, that punishment is one of the prime forces behind the human ability to cooperate (Gintis, 2000; Dreber et al., 2008; Hauert et al., 2007; Henrich & Boyd, 2001). However, in reciprocal systems such as the Potlatch and the Kula, there is limited information on how the system is enforced other than the obligation of the gift itself or the religious and spiritual properties that support the *weltanschauung* of the practitioners (Mauss, 2002[1954]; Malinowski, 1984[1922]). One of the best considerations on the spiteful nature of the gift, although done unwittingly is the classical work of Sahlins (1972) *Stone age economics*. In his work, Sahlins discusses

how the concept of *hau* as described by the Maori culture can also be related to magical practices, and that the fear of magical retaliation (or punishment) maintains the reciprocal exchange. For the Maori he claims, the normal procedure for restitution in the case of failure to reciprocate was witchcraft (*makutu*), usually initiated by the individual who felt deceived in the reciprocal transaction. He further explains that sorcery against a non-reciprocator was usually practiced with the goods of the deceiver serving as the vehicle of magic, which is also know to the Maori as the *hau* (Sahlins, 1972).

This idea has further eco in a Maori descendant's account of historical Maori medical practices (Buck, 1910). In his thesis, Buck argues that transgressions against a certain community could be punished in a similar way. The sorcerers aimed at destroying the *hau*. Thus, when the subject on whom magic was to be applied was obviously not present at the magical ceremony, some representation of the *hau* was necessary, i.e., the perpetrator's goods or *ohonga*. It could be apparel, hair, food or anything the subject had touched (Buck, 1910). This explains why the Maori were so fearful of leaving any parts of themselves in public (such as nail trimmings, hair shavings or food leftovers) and took great precautions for their enemies not to obtain *ohonga*. For example, the location where the chief's hair was cut was sacred and guarded, and anyone tampering with the location would be attacked. Also, the majority of the people would burn (except in a cooking fire) or bury it (Buck, 1910). Magic was also invoked due to the emotion most associated with spite: envy. Envy that was felt for the fame of a warrior, or the power of a chief in the entertainment of visitors and other actions which caused his fame to spread, could lead to *makutu* being employed, often by another family branch who were being outshone (Buck, 1910). Inevitably, spiteful behaviour is more advantageous in situations where the scale of competition is reduced rather than when it is amplified. The *makutu* besides being directed against the individual might be directed against the family as a whole. In the latter case, the result of the *makutu* would be that the family would become less productive. Another argument that could be made is that fear of magic also prevented overachievement of fame and status and thus enforced some degree of levelling to keep the reciprocal system of the gift intact, and hence providing a strong incentive for cooperation and reciprocity to be maintained. As Sahlins (1972, p.155) puts it

> the fear of punishment sent through the hau of goods is indeed a supernatural sanction, and a valuable one, for enforcing repayment of a gift. The main emphasis of the fulfilment of obligation lies, as the

> work of Mauss himself has suggested, in the social sanctions-the desire to continue useful economic relations, the maintenance of prestige and power.

This quote emphasises that prestige and power seeking is in fact the ultimate individual goal of a potlatch economical exchange, set aside as a collective level function. Moreover, when giving, a person communicates its desires and plans, but also attempts to control others by debt, which is ultimately a spiteful enterprise (Weiner, 1988).

More recently, ethnographic accounts have shown that redistribution of wealth is more related to dismissal of witchcraft accusations than fair sharing behaviour, as the example of the Pimbwe from Tanzania where wealthy individuals share their resources as a way to avoid witchcraft accusations (Paciotti & Hadley, 2003).

2.3.4 Spite as a cultural belief: The evil eye

As was discussed in the previous section, spiteful actions can take the form of magical retaliation against a non-reciprocator. However, the examples shown earlier are taken from social and cultural contexts completely different to those of the subjects being studied in this thesis. One would have to be hard-pressed to encounter similarities (either culturally or psychologically) between early 20^{th} century Trobrianders and Maoris and 21^{st} century Portuguese children and teenagers. In order to approach the ethnographic examples given to the population being studied, I will now provide an account of how spiteful behaviour and beliefs in the evil eye are connected in mediterranean societies.

One so called superstitious belief of the Mediterranean region that fits into this analysis as a spiteful, magical retaliation is the evil eye. This belief is so wide-spread in the Indo-European and Semitic world it has been labeled as universal (Dundes, 1992). From *der bose Blick* (Germany) , *le mauvais oeil* (France), *la fascinación* (Spain), *det onda ogat* (Finland), *malocchio* (Italy), *mau olhado* (Portugal), *drishti* (Sanskrit), *najar* (Gujrati), *vista fuente* (Mexico) *to nazar* (Arabic), the Evil Eye spans the European, Arab and Indian landscapes alike (Dundes, 1992). Not remarkably, it is linked with the emotion that is hypothesised as inducing spiteful behaviour, envy. Etymologically, the very word envy is directly linked to the belief in the evil eye. The Latin word for envy, *invidia*, consists of the verb *videre* (to see) and the prefix *in* (against). Quite literally, to be envious is to cast the evil eye,

to see against someone. All the major influent religious books in Mediterranean cultures such as the Bible, Talmud and Koran all reference the evil eye, as well as some sacred Hindu books (Dundes, 1992).

2.3.4.1 Origins of the evil eye

Belief in the evil eye appears to have stemmed from Ancient Mesopotamian civilisations. Extensive accounts as those from Seligmann's classic *Der böse Blick* cite ancient Assyrian and Babylonian texts (Thomsen, 1992). Moreover, this was further established in an Anthropological Symposium on the evil eye, proposing its core influence to be the Near East, Mediterranean and South East Asia (Thomsen, 1992). It was suggested that this belief had its origins in early Near Eastern peasant societies, known for their sudden shift from hunter-gatherer to sedentary patterns of life, in which plough agriculture and dairy farming combined with premodern urbanisation (Thomsen (1992) citing Maloney, 1976). It seems that transitions in lifestyle are associated with this belief, a fact that will be discussed later on when the emergence of spiteful strategies as the basis for human cooperation is discussed.

Ancient Mesopotamian accounts are not that many, when compared to references to witchcraft (Thomsen, 1992), making it difficult to regard belief in the evil eye as widespread as previously assumed. Nonetheless, discoveries in the last 20 to 30 years have doubled the known references to the evil eye and they have in common the fact that the evil eye is associated with witchcraft and caused by "evil people" (Thomsen, 1992). In her analysis of these ancient texts, Thomsen (1992) suggests that victims of the evil eye could have had their reputations affected. The evil eye is described with expressions such as "binding", "ensnaring" and "causing illness to people" (Thomsen, 1992). As the reader may recall from the previous sections, gifts are described by Mauss (2002[1954]) with similar expressions (the "clinching gift", which ensnares the reciprocal bond, as described in section 2.3). Also, the fact that people who engaged in obligational reciprocity systems tended to disdain and avoid not only eye contact with the giver but also the object - as its *hau* could cause sickness - provides yet another linking point (Mauss, 2002[1954]; Malinowski, 1984[1922]).

Despite not being as widespread as previously considered, belief in the evil eye has a deep historical record in ancient Mesopotamia, from the end of the

third millennium up until the Late Babylonian periods (Thomsen, 1992). Considering that there are theories that relate Mesopotamian languages with Tamil languages in India (Dandekar, 1969), one could postulate that belief in the evil eye was passed on from Mesopotamia to India and then to the Indo-European world. However, similarities between descriptions of evil eye and descriptions of gifts could suggest a "hard-wired" pattern of behaviour that spans cross-culturally.

2.3.4.2 The evil eye in Contemporary Society

The evil eye is a belief very characteristic of Mediterranean and Levant societies and, as shown in the previous section, has very deep historical roots. Although it is commonly acknowledged in these areas, behaviour related to the evil eye can be seen in many examples, from North American sports all the way to Mexican work efforts (Foster, 1972). This section will now refer to examples of evil eye belief in contemporary societies and how they affect the competitive behaviour of the individuals who share this belief.

Envy is highly attached to belief in the evil eye. Despite not being an entirely universal human emotion, the "emotional algorithm" that gives origin to envy is a shared human characteristic (Loch et al., 2006b). Because envy is such a destructive emotion, there is a marked effort in many cultures to neutralise the perils associated with it. According to Foster (1972), there can be two distinct axes by which mankind views envy: a competition and a fear axis. Spite falls within the axis of competitive envy as the emotion is not only recognised but also acted upon. Raising envy in others is also a mechanism by which one's own status is gained.

2.3.4.3 The Mediterranean Example

Given the close proximity between the Mediterranean area and belief in the evil eye, one might wonder what is so special about this region that almost all of its traditional cultures share this construct. When reading classic accounts on the state of Mediterranean anthropology, we become aware that there is a consensus on the affinities between people of North Africa, Levant and Southern Europe (Gilmore, 1982). These affinities are not only bound by similar eco-geographies but also in cultural constructs such as the "honour and shame" complex (Schneider & Schneider, 1973).

Many researchers (Houston, 1967) believe the Mediterranean is so uniform it

is seen as a single entity, such that Southern Iberia and Morocco could belong to a single continent and Andalusia nothing more than an extension of the Maghreb (Gilmore, 1982). Tied in with a rich history of circulation of peoples and cultures, and linked by a base religious identity (the monotheistic creeds of the Levant), Mediterranean people had to respond to its ecological problems in such similar ways not only just in crop systems but in the use of similar technologies such as the heavy wheeled plough and reliance of minifundia, an almost universal social feature in the Mediterranean landscape from the Algarve to Tunisia (Boissevain, 1979). Socio-culturally, there are also great similarities between different people in the Mediterranean area. Gilmore (1975) discusses how communities are bound to their local patron saints both spiritually and territorially and how the evil eye belief is widespread, the results of perhaps gregarious small, densely populated neighbourhoods.

Another remarkably widespread characteristic of Mediterranean socio-cultural aspects is the reliance on patronage rather than official bureaucracy (Davis, 1977) as well as clearly noticeable cultural contradictions. Social egalitarianism is often mentioned by locals as a hallmark of Mediterranean ideals and yet, it coexists with remarkable socioeconomic differentiation, differentiation of material resources and intense social stratification (Davis, 1977); Agnatic emphasis and male dominance attitude coexists with a reality of matrifocality where female contributions to household income are substantial (Gilmore, 1982). Women themselves live in the contradiction of "appearance and reality" (Friedl, 1967) a constant balance between the perceived roles of male power and prestige projected outwards, and inwards control of the most important social unit, the family.

2.3.5 Status Competition as a way of life

Much like everywhere else where there is social stratification, the Mediterranean world is no stranger to class struggle. However, there has been a large tendency to misleadingly confuse "class" with "status" under the roof of social stratification studies. This confusion had long been addressed by sociological studies and social stratification can take many forms: religious, ethnic, etc. These can obviously overlap with class but are a different analytical category to class structure. Indeed, status and prestige can both reveal and hide class differences (Gilmore, 1975).

Status and prestige are the basis of "honour" systems and competition among

social equals for honour and reputation led to the appearance of several explanatory models such as the "limited good" (Black-Michaud, 1975), "social atomism" (Gilmore, 1975) and "agonistic society" (Pitt-Rivers, 1977). These models explain how neighbours perceive each other as rivals, but at the same time as sources of benefits, be they economic, social or sexual. This ambiguous view causes the emergence of tense relationships within communities, with antagonism being repressed by cordial and ritualised reciprocity (Gilmore, 1975). One of the most discussed models regarding Mediterranean life is the "amoral familism" model by Banfield (1958). Amoral familism concerns the high levels of cooperation within a family unit as contrasted with the high levels of suspicion, envy and prevention of everyone else getting ahead. This concept should sound familiar to the reader, as this is the basis of negative relatedness as discussed by Hamilton (1971) when explaining spite as a biological problem.

Banfield (1958) commences his argument by contrasting the publications in an American local newspaper about communal efforts such as donations, volunteering, and fund-raising for communal improvement with the lack of interest shown by the inhabitants of Montegrano (a fake name for the town of Chiaramonte in Southern Italy) regarding communal life. He postulated that this way of life was explained by "the inability of the villagers to act together for their common good or, indeed, for any end transcending the immediate, material interest of the nuclear family" (Banfield, 1958).

According to Banfield (1958), Montegrano was a community relatively isolated from its neighbours with an agrarian economy based largely on subsistence agriculture in minifundia. This context translated into a scenario of scarcity for the local villagers. Because the typical villager was not able to save money, the uncertainty regarding the future in Montegrano led it's inhabitants to be quite anxious and melancholic, leading to the most typical description of what life was like in Montegrano: misery.

Banfield (1958) described the difference between what is essentially a low standard of living and life in misery as merely cultural. The low status of peasants coupled with a fatalistic view of life are responsible for the Montegrano villagers *weltanschauung*. The life of individuals out of their own control, belongs to the divine or simply to luck. The behavioural pattern of a typical Montegrano villager followed the rule: "maximise the material, short-run advantage of the nuclear family: assume that all others will do likewise" (Banfield, 1958, p.85). This general rule of behaviour led to a series of consequences for life in Montegrano.

Firstly, in a society where individuals act according to such an ethos, public ventures are undertaken only if there are immediate benefits for those partaking, making the participation in public ventures nearly impossible. Secondly, in Montegrano society individuals had no responsibility in public affairs as this was the sphere of public workers and they alone were responsible to act in this respect. Finally, there was a clear notion that organisations are imposed onto the village from outside, mostly because the two main organisations in Montegrano at the time were the Church and the State. In this respect, law was just another aspect of Montegrano life that could be bent at will if the cost/benefit relation of going against it was advantageous. Bribing public workers was seen as normal practice and any appeal to the common good is mostly considered to be fraudulent, which translates in the notion that public office is considered by both the electors and the elected as a possibility of gaining material advantage for the family.

This means that Montegrano's poverty struck world was rooted in distrust, envy and suspicion among its inhabitants. Neighbours seemed to refuse any communal effort, except whenever where personal gain was to be had. Moreover, Banfield (1958) described most of the villagers as acting spitefully[9], going to great lengths to impede neighbours from reaching any form of success. This pattern of behaviour, Banfield argued, stemmed from a psychological ethos of scarcity where the villagers of Montegrano believed that the welfare of others hindered their own gain. In order words, acquisition of wealth and status can be seen as a zero-sum game. Hence, Montegrano is described as an everyday battleground where cooperation only occurred when there was something to gain on a personal level - which was close to impossible, since others' gains would be systematically perceived as one's opportunity losses. This ethos would lead to social isolation and the prevalence of poverty. Because the villagers were unable to cooperate in order to solve communal problems, there were no efforts to build infrastructures or pool resources for improvement of daily life. One such example is the lack of effort by local merchants in pooling resources to build better roads.

Banfield (1958) described the ethos of amoral familism as rooted in a combination of land-tenure conditions, high mortality rate, and absence of other community building institutions. However, his most debated argument was that the envious attitude and distrusting nature of the Montegrano people stems from very strong blood ties. Here the nuclear family is a substitute for social capital

[9] According to the definition being advocated by this study.

and everyone outside it is exploitable if honour and reputation are to be augmented (Banfield, 1958). In an amoral familism context, the other, herein referring to non-relatives, is nothing more than an entity that is engaged insofar as there are benefits to be obtained for the family unit. Whether it be cooperative or spiteful actions, amoral familism draws parallels with the concept of familial selection or kin selection proposed by (Hamilton, 1964a) and widely accepted in Biology today.

Among anthropologists of the Mediterranean however, this theory was highly contested and is no longer accepted (Gilmore, 1982). It was argued that Banfield's fundamental explanation for the source of this type of behaviour, a deep-rooted psychological ethos based on strong blood ties, was not entirely correct. A number of explanations would be highly likely such as the socio-economic context where the study was made or the highly rigid social dichotomies (Wichers, 1964). Maybe the Montegrano villagers acted the way they did because of the social and economic conditions that were forced onto them and not because it is in their psychological nature to do so. One of the interviews described in Banfield's book is of special importance to this idea. A teacher claimed: "Truly, I have found no one who interests himself in the general welfare. On the contrary, I know there is tremendous envy of either money or intelligence" (Banfield 1958 pp.20), while criticising the ethos regarding community life in Montegrano, this teacher actually invokes two enviable characteristics that are immediately perceived as higher status: money and intelligence. Corruption, lack of authority organisation, patronage and other aspects in Montegrano life in the 1950's could have equally provoked amoral familism behaviour rather than the explanations Banfield provided (Lever-Tracy & Holton, 2001). Moreover, there has been a clear tendency to use capitalism and it's shortcomings as a universal explanation for Mediterranean patterns of behaviour. One of the reasons for the nepotism portrayed by amoral familists and their behaviour as envious competitors is a response to the core pressures of a capitalist system that exploits workers (Schneider & Schneider, 1973). However there is a clear assumption of the connections and not many alternatives provided, especially regarding the similar norms that guide the exploiters as well as the exploited (Banfield, 1958; Gilmore, 1982). However, it is not the the 'amoral familism' theory as a universal and definite explanation for this kind of behaviour, but rather its typification of a very real pattern of behaviour that concerns us here. Even those authors who criticise the theory acknowledge these same patterns in their own research. In a study in Italy that tests amoral

familism and argues against it, the authors admit that anyone outside the household is to be distrusted (Miller, 1974; Miller & Miller, 1978). In Sicily, competitive envy is commonly exhibited among locals (Schneider & Schneider, 1973). Further east, in Cyprus, Loizos (1975) admits that locals consider non-related individuals as competitors that can be exploited for the betterment of the nuclear family, a view shared by Greeks who consider it to be virtuous to deceive or cheat anyone who is not kin (Campbell, 1976). In Morocco and Lebanon the same patterns have been described, even though they were discarded as mere "dependent variables" (Gilsenan, 1976; Rabinow, 1977). More recently, it was shown that there is a link between strong family ties and both low trustworthiness and low participation in political life (Alesina & Giuliano, 2010; Alesina & Giuliano, 2011).

What is of concern to this thesis is not the fundamental reason why villagers were poor or lacked cooperative endeavours, but exactly those patterns of behaviour. Culture, in the most basic conception possible, is responsible for creating and transmitting behaviours. However, humans as biological entities are also liable to adaptions, biological or behavioural, to certain environmental characteristics, like the low productivity of lands and impossibility of creating surpluses in agricultural practices (Gilmore, 1982). In this sense, it is necessary to find links between what constitutes biological and cultural modes of transmission of certain behavioural patterns.

2.3.6 Competition and Cooperation in traditional societies

Spiteful behaviour, as described in the previous section on the evolution of spite, could occur due to "negative kinship" (Hamilton, 1970; Hamilton, 1971; Foster et al., 2001; Gardner & West, 2004a; West et al., 2006a). However, how could we describe the phenomenon that makes seemingly reciprocal systems such as the ones described above spiteful? One could argue that these systems are maintained by similar principles of scale of competition, which is described by Sahlins (1972) as "the span of social distance between those who exchange conditions (...) Reciprocity is inclined toward the generalised pole by close kinship, toward the negative extreme in proportion to kinship distance". Often, the term non-kin is also a synonym for a stranger or enemy and Sahlins (1972) proposed a model for kin relations (affinal and blood) based on social distance starting from a household, formed by a series of sectoral rings that are isomorphic to the need for reciprocation. This model is very much akin to the green-beard mechanism by which spite and altruism evolve in nature (West & Gardner, 2010). However in

this instance kinship is measured relative to the household and not a phenotypic marker based on genes (See Figure 2.2).

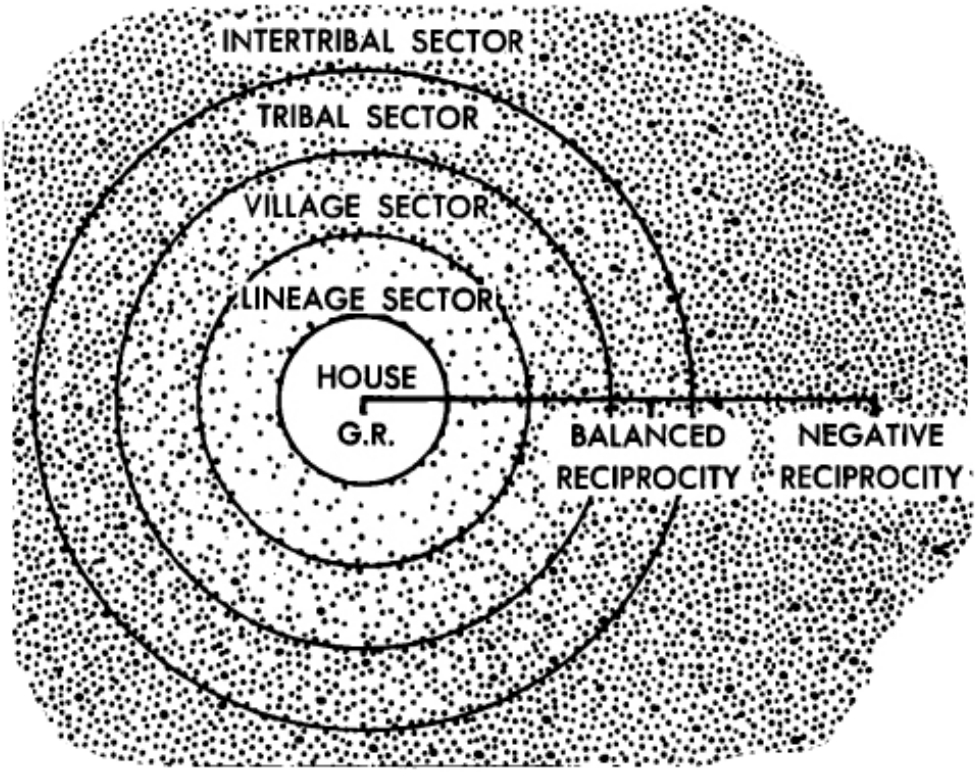

Figure 2.2: Model for reciprocation as a function of kin distance. (*in*: Sahlins 1972, p. 199)

As the traditional societies of the Trobrianders were both socially and also spatially organised according to kinship, the closeness of kin who should provide assistance was both social and spatial, meaning that "Kinship-residential groupings from this perspective comprise ever-widening comembership spheres: the household, the local lineage, perhaps the village, the subtribe, tribe, other tribes" (Sahlins 1972, p. 198). Here, Sahlins (1972) describes a system similar to the mathematical model put forth by Hamilton. Indeed, with each ring grows the distance between the household and the identifiable kin, to the point where "Negative reciprocity" becomes the norm. In fact, he identifies several ideas that are compatible with the theories presented by Hamilton (1964a) and Trivers (1971) for the evolution of cooperation and altruism. Sahlins (1972) also defines that sharing outside the house-hold occurs with mistrust and a certain amount of feeling of being taken advantage of. As he claims, "chicanery" is the most common form of social relationship outside the "kinship" circle (Sahlins, 1972). He further argues for the use of the "gift" as not required and creating an unbalanced reciprocity mechanism that will ultimately turn an individual into a high status individual as "The esteem that accrues to the generous man all to one side, generosity is usefully

enlisted as a starting mechanism of leadership because it creates followership" (Sahlins 1970, p.199).

In an interesting sentence that sums up much of what biologists define as spiteful behaviour (Foster et al., 2001), Sahlins (1972) describes that in certain situations, the sharing circle is compressed and the "negative reciprocity" circle expands, so that "the whole sectoral scheme of reciprocities is altered, compressed: sharing is confined to the innermost sphere of solidarity and all else is devil take the hindmost" (Sahlins, 1972)

2.3.7 Cultural notions of fairness and propensity for spite

Fairness is the basis for most modern political and justice systems. Reciprocal systems such as the potlatch and the kula are based greatly on a fair return of a gift that was given (Malinowski, 1984[1922]; Leach & Leach, 1983; Mauss, 2002[1954]). However, the system is what is know as "hyper-fair", i.e., the offer of gifts is of great value in order for the giver to obtain prestige. This "hyper-fair" behaviour is argued to be spiteful as the giver sacrifices his possessions to the receiver, so that the receiver will later have to expend a greater cost when returning the gift or lose face and incur in punishment. Failure to do so results in a punishment, usually of magical properties as discussed above.

However universal the notion of fairness may be, there are very different cultural responses to fairness. We can acknowledge this by evidence that describes certain cognitive adaptations of human-kind. Behaviours learnt in a local environment during early developmental years may become part of the subconscious mind (El Moulden et al., 2012; Quartz & Sejnowski, 2000), as shown by cross-cultural differences in the susceptibility to optical illusions, hand-eye coordination, and male stress and aggression levels (Segall et al., 1966; Cohen et al., 1996; Henrich et al., 2006).

Anthropologically, cultural differences are described as differences in ways of informants seeing the world, how they construct their cultural reality with information from what they see as their culture and how they perform in them. When studying these differences, this vision is also greatly influenced by how the particular anthropologists' theoretical premises, ideas about the culture being studied and, of course, their own culture interact with the informants, the anthropologist is also performing culture. Despite the richness and depth of information that

can be obtained by this method, it is hard to pinpoint particular aspects of behaviour that can be statistically comparable cross-culturally in any given context. The only way around these constraints is to consider experiments that focus on a single particular behaviour that can be statistically analysed with several variables and compared across different locations, countries and social paradigms. It was this type of analysis that was performed by Henrich et al. (2005) in a cross-cultural study of economic preferences in the ultimatum game[10].

In the Henrich et al. (2005) paper, 15 small-scale societies were studied by using two economic games: the ultimatum game and the public goods game (PGG)[11]. What Henrich et al. (2005) found was high cross-societal variation in the sense of fairness and also in willingness to cooperate (in a public goods sense). According to the authors, the observed differences could be explained by the ethnographical properties of each society studied.

Henrich and colleagues (2005) explain that the fact that "group-level measures of economic and social structure statistically explain much of the between-group variance in experimental play suggests that there may be a relationship between game behaviour and patterns of daily life in these places" (2005:812). One of the societies studied, the Orma, recognised the PGG as similar to a community-based effort whenever a public good such as a road or a school is to be built. This effort, which they name *Harman*, was used to describe the ultimatum experiment as the *harambee-game* and resulted in offers with a mean of 58%. Of all the subjects, 25% contributed the totality of the sum given for the partition (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001). This could mean that fairness was heightened by the similarity of the game to a system that is not anonymous. One of the consequences of the *Harman* might be that high donors receive high prestige and social status, which in several small-scale societies is much more appreciated than money as a currency (Mauss, 2002[1954]).

A case that is particularly more interesting for this section is the ultimatum

[10]The ultimatum game is defined as a game between two participants in which a sum of money is given to one player. That player is then asked to share that money in any percentage she so desires. If the proponent rejects the offer, then none of the players receive any sum. In economical theory, a rational player should share the minimum amount possible and accept any offer that is non-zero, because something is always better than nothing. Please refer to the section on experimental evidence for a further discussion on ultimatum games and spiteful behaviour.

[11]A public goods game is a game where multiple players are given the choice of contributing or not a sum to a common pool. This choice is anonymous (to eliminate reputation effects) and a after everyone has made their choice, a multiplication of the pot is made and redistributed to all players, regardless of their contribution or not. Public goods games can find echo in many real-life situations such as social security systems, saving the environment among others.

game results of the Au and Gnau societies of Papua New Guinea. Here, many proposers offered more than 50% of the total sum available and still had the highest rejection rates of all societies studied (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001). At face-value, this would mean that these societies have different views on fairness or have little knowledge of what is viewed in the modern western world as economic values. However, this could not be furthest from reality. As discussed above, societies in these regions engage in potlatch-like systems recurrently and offering and rejecting what can be considered generous offers have a parallel in what has been described above for the kula and potlatch. The gift is first and foremost a spiteful interaction aimed at future gain in status, which means that high gifts imply reciprocation at some future time. As explained above, there is great fear of magical punishment for not returning a gift. Moreover, debts accumulate and make the recipient subordinate to the donor in future interactions in case of non-repayment, which consequently leads to large unsolicited gifts being offered and often refused (Henrich et al., 2005; Henrich, 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Malinowski, 1984[1922]; Mauss, 2002[1954]; Leach & Leach, 1983; Sahlins, 1972). Ontogenetically speaking, growing in potlatch and kula-like societies possibly imprints such preferences for high offer and high rejection as rational. Both the practice of giving "generously" and refusing "generous" offers can be considered spiteful as there is an objective in imposing a cost to the opponent. The proposer pays a cost of losing much of his sum to inflict a higher cost to the opponent in the form of binding him to reciprocation. The receiver is being spiteful because it rejects the offer, loosing both its amount and causing the proposer to loose theirs.

Another society studied in this paper was the whale hunting peoples of the island of Lamella, Indonesia (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Gintis, 2000). Here more than 60% of the proposers divided their sum half and half, and those who did not offered a value higher than that. The real-life parallel of the game with Lamalera experience is that a large catch is often carefully shared among those who participate in the hunt as well as those who had indirect roles in its success. However, it must be noted that the sum of money involved in the split was equivalent to 10 days' wages, a sum large enough to elicit this sort of response (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Gintis, 2000). Another society with similar characteristics is that of the Aché from Paraguay (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Gintis, 2000). After a successful hunt, hunters will forfeit their cut while the meat is equally shared among households. (Kaplan & Hill, 1985). While dividing

the sum given by the researchers, the Aché proposers were likely to perceive the ultimatum game as dividing meat. This is argued by Heinrich and colleagues (2005) as leading to 79% of proposers offering either half or 40%, and 16% offering more than half without any offers being rejected (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Gintis, 2000).

A contrasting society studied is that of the Hadza. Here offers were low and rejection rates were high (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Gintis, 2000). Despite being a society who also shares the outcomes of a hunt, most ethnographic descriptions account for the unwillingness to do so (Marlowe, 2004; Woodburn, 1968). Some ethnographic descriptions account for tactics to avoid sharing such as sneaking in at night with the product of a hunt (Marlowe, 2004). The reason for food sharing among the Hadza is the same as one of the reasons described above for the continuation of potlatch, as cooperation and sharing are enforced by fear of punishment in the form of informal social sanctions, gossip, and ostracism (Elster, 2000; Elster, 1999; Blurton Jones, 1984; Gurven, 2004). As will be described in the following sections on the sociology of spite, fear of punishment may be more efficient than the application of punishment itself (Elster, 1986). Henrich & Boyd (2001) report that many Hadza proposers tried to avoid sharing, and several of them were punished by rejection of the split.

In a contrary direction, the Tsimane and Machiguenga (Henrich et al., 2005; Henrich & Boyd, 2001; Henrich et al., 2001; Gintis, 2000) societies engage in virtually no cooperation, sharing or any other type of exchange outside the local family unit (Henrich & Boyd, 2001; Henrich, 2005). Ethnographically, both groups disregard fear of social sanctions and seem not to care too much about others' opinions. In anonymous interactions both groups made low ultimatum game offers (Henrich & Boyd, 2001).

However, interesting as these results may be, they were only done in certain groups of said populations and not the entire populations, which could mean that statistical results may be biased. This means that, when comparing two different human groups, the differences in behaviour reported are normally interpreted as cultural differences (Oosterbeek et al., 2004). Because most of these studies are made only in one location of a specific country or group, there could be considerable intra-group differences that are being misinterpreted, as was demonstrated by the contradicting views of cross-country comparisons between the U.S. and Japan (Oosterbeek et al., 2004; Roth, 1995; Buchan et al., 2004). In a meta-analysis

study of 75 studies comprising 25 countries (from developed and developing nations alike), Oosterbeek et al. (2004) found no difference in proposer behaviour across regions, but instead found differences in responder behaviour. They also found that pie size has a considerable effect on both proposers and responders alike, meaning that it could be that fairness is a human cultural universal. Because fairness is a sentiment that requires other-regarding preferences, it opens the door for spitefulness as well.

Paciotti & Hadley (2003) also performed strategy maximising ultimatum games in two different ethnic populations of Tanzania, the Pimbwe and Sukuma, across various villages. They found that the Sukuma have a preference for sharing and not maximising their monetary gains regardless of the possible rejection risks. On the other hand Pimbwe were found to consider these risks. As in the Henrich et al. (2005); Henrich & Boyd (2001); Henrich et al. (2001) results described above, pie size affected rejection rates. Pinbwe individuals were asked whether they would accept offers of a fixed amount starting from 100 shillings and upwards. It was found that "offers of 100 shillings face an approximately 50% chance of rejection, 200-shilling offers face a 33% chance of rejection, and offers of 300 shillings face only a 15% chance of rejection" (Paciotti and Hadley 2003:12). In an Ultimatum Game context, responders who reject offers are spitefully punishing the proposers, as the rejection implies a cost to the responder to inflict a higher one on the proposer (Marlowe et al., 2011). In the context of the experiment by Paciotti and Hadley (2003), the differences in rejection rates are argued to be related to the cultural variables regarding social control institutions. On the one hand, Pimbwe participants demonstrated higher rejection rates, which was explained as reflecting the absence of strong local social control institutions, with most social disputes being resolved violently or by recurring to state authorities. On the other hand, Sukuma punishment is dealt with by local social institutions and is a collective effort of the local ethnic elders. Paciotti & Hadley (2003) further explain that the differences might also be related to the cultural notions of fairness and inequality. The Pinbwe are more concerned about inequality between wealthy and poor individuals and often gossip on how individuals obtain their wealth, and they are less likely to share with other Pinbwe outside the village community. In contrast, Sukuma are aware that herding is a fluctuating economic activity and periods of wealth and poverty are often short-lived. Moreover, during their development, the Sukuma learn that sharing with their ethnic group is mandatory, regardless of where they live (Paciotti & Hadley, 2003; Wisjen & Tanner, 2002), and those who fail to share are often punished by their institutions. The Pimbwe on

the other hand have sharing rules but are not required to give generously, especially to those outside the village or clan. Paciotti & Hadley (2003) emphasise that although both ethnic groups are altruistic, the degree of self-sacrifice is contingent on cultural and institutional rules, such as was hypothesised by (Boyd & Richerson, 2009) and (Marlowe et al., 2011).

2.3.8 Gender differences in spite: reality or construction?

The social sciences have generally viewed gender differences in behaviour as a social construction, influenced by social and cultural factors. Explanations that have focused on biological origins of gender behavioural differences have been disregarded, except for the effect that hormones exert in the behaviour of the sexes (Maccoby & Jacklin, 1974). With the emergence of evolutionary psychology, evolutionary explanations for sexual differences in behaviour eventually became more accepted (Buss, 1989). Currently, behavioural differences in genders are viewed as the interplay between genetic and socio-cultural differences or, the interplay of nature and nurture (Gottlieb et al., 1998). In this section, I will analyse the evidence for gender differences in competitive behaviour by looking at results from experimental and observational data, ultimately considering whether differences in behaviour are due to sexual selection, gender construction or the interplay between these factors.

2.3.8.1 Evidence of gender difference in evolutionary contexts

Competitive behaviour has been studied empirically since the late 20th century. However, there has been a bias towards researching the aggressive and dominant behaviour of boys rather than that of girls (Pietro, 1981; Maccoby, 2000). More recently, there has been an attempt to focus on both genders' behaviour regarding relationships. Particularly, some authors studied the nurturing (Taylor et al., 2000) and others the competitive aspects (Crick et al., 1999) of social relationships of girls and women.

Unfortunately, evolutionary explanations for gender differences in behaviour have focused on adults and largely failed to regard ontogenetic processes (Wrangham & Peterson, 1996). Moreover, those studies that do account for ontogeny of gender differences in behaviour do not do so in terms of costs and benefits, making evolutionary analysis difficult to achieve (Eagly & Wood, 1999; Archer, 1996; Bjorklund & Pellegrini, 2002; Geary, 1999; Geary et al., 2003; Hamilton, 1964a;

Trivers, 1971; Trivers, 2005). Only a few studies have considered costs and benefits but have done so separately. Some have considered the possible benefits of being emotionally intimate (Taylor et al., 2000) and others the costs (Geary et al., 2003).

Evolutionary explanations for sexual differences in behaviours are based on the analysis of different selection pressures males and females are subjected to, mainly sexual selection (Andersson & Iwasa, 1996). Sexual selection refers to both competition within a gender and sexual choice between genders (Andersson & Iwasa, 1996). In this view, the gender that is more invested in parenting tends to be more careful in choosing mates and the gender that is less invested is more engaged in competition over access to sexual partners (Clutton-Brock, 2009; Andersson & Iwasa, 1996). Humans are different from most animals because men also have a huge investment in their children, albeit not as much as women do (Eagly & Wood, 1999; Geary, 1999). In the rest of the animal kingdom, intra-sexual competition commonly involves physical threats and fights between two males (Andersson & Iwasa, 1996) that eventually result in a hierarchy. Another characteristic of male competition is that coalitionary behaviour is a very common method for overthrowing said hierarchy. The only manner in which the reproductive costs of a coalition can be reduced is if the coalition partners are kin (Hamilton, 1964a; Hamilton, 1964b). To develop and maintain a coalition requires effort and advanced cognitive capabilities coupled with a balance between cooperative and competitive strategies (McNally et al., 2012). The risk of other males competing for positions within a coalition hierarchy is always present (Goodall, 1986). Nonetheless, once a hierarchy is established, groups often stabilise leading to a reduction of internal conflict. There is also evidence that its members obtain considerable health benefits (Sapolsky, 2005). This idea is mirrored by what was discussed in the previous section: by being organised according to kin proximity, traditional societies [12] facilitated cooperative and coalitionary behaviour between kin (Sahlins, 1972).

Despite suggesting that there is an evolutionary advantage for average size differences and aggression and competitive motivations between males and females, this does not entail that females are not competitive or aggressive. It has

[12]It must be taken into account that "traditional societies" are being considered at the time of a particular ethnographic record. It should be clarified that these may have changed recently due to novel political systems, world events and other factors and hence may no longer reflect a particular society social system or cultural praxis. Nonetheless, there is intent in utilising older ethnographic data in order to understand certain cultural and social practices with the least influence possible from novel westernised political systems or religions.

been proposed that females can often be more aggressive when competing for resources that lead to successful reproduction and that secondary sexual characteristics are not the result of selective pressures for competitive aggression (Clutton-Brock, 2009). Nonetheless, there are ethnographic examples that point towards coalitionary behaviour being more frequent in men than in women. In some populations, participation in group hostilities is mostly done by men with concerns over control of resources and reproduction and those who do not take part of these actions risk a lower social status and less children than those who do (Horowitz, 2001; Kelly, 2005). The Kula and the Potlatch can also be seen as examples of mostly male dominated competitive systems (Mauss, 2002[1954]; Malinowski, 1984[1922]; Leach & Leach, 1983).

The available evidence on socio-ecological modes suggests that male philopathry was dominant during human evolution (Foley & Lee, 1989). However, this assumption could prove difficult because of the variability in migratory patterns of human groups. Today, close to seventy five per cent of traditional societies are patrilocal, and only around fifteen per cent are matrilocal (Murdock, 1981; Harris, 1993). A social system based on male biased philopatry is also supported by genetic evidence. In their study of Eurasian Y-chromosome migrations, Wells and colleagues found that men in a number of communities are more closely related than women and that migrations of a larger distance are more commonly composed of groups of men (Wells et al., 2001). Hammer and colleagues conducted a similar study where the effects of male philopatry were more evident at the regional and local scale rather than an across-continent scale (Hammer et al., 2001).

When considering the evidence above, it is reasonable to assume that there are different motivations for males and females for promoting a cooperative or competitive activity. While nepotism, muted aggression and tolerance for non-reciprocation might characterise relationships between male kin, (De Waal, 2000; Hamilton, 1964a; Trivers, 1971; West et al., 2007), reciprocal activities between male non-kin must be enforced by other mechanisms that assure these relationships are maintained without free riding (Trivers, 1971). In traditional societies, emotional mechanisms such as guilt over failing to reciprocate, monitoring of the exchanges in a relationship, feelings of anger, betrayal, and ultimately rejection of relationship partners who do not fully reciprocate are of pivotal importance (Geary et al., 2003; Elster, 1986; Trivers, 1971). Moreover, belief systems based on magic and fear of magical retaliation play an even greater role in maintaining cooperative ties (see section 2.3.3). Competition in such contexts can lead to open warfare, political negotiations for marriage partners and wife-raiding (Knauft et

al., 1987; Chagnon, 1988) and status seeking in systems of gift-giving by males (Mauss, 2002[1954]; Malinowski, 1984[1922]; Sahlins, 1972; Leach & Leach, 1983).

2.3.8.2 How gender is constructed in these contexts

Despite a possible evolutionary gender differentiation between propensities for competition, its expression is affected by cultural influences. For example, in cultures or subcultures where aggression is a necessary trait to secure resources, boyslay behaviour is more related to aggression compared with cultures in which resources can be attained by other means (Horowitz, 2001; Wilson & Daly, 1985; Daly & Wilson, 1990). Also, dyadic competition between boys does not necessarily involve actual physical conflict. Play fighting has been shown to function as a determinant of social dominance in a peer group, rather than as practice for actual fighting behaviours (Bjorklund & Pellegrini, 2002; Pellegrini & Smith, 1998). In adolescent boys, physical dominance may contribute to the achievement of social dominance regarding their peers and teachers, but physical aggression is not the only way to become socially dominant as other strategies of a more prosocial and cooperative nature may help secure resources and higher status (Hawley, 1999).

Seeking challenges can also be considered a competitive behaviour as individuals will attempt to outcompete others by selecting harder tasks. Niderle & Yestrumskas (2008) found that, independent of how individuals performed in a previous money-earning task, men chose the following harder tasks 50% more often than women. Gneezy et al. (2003) and Gneezy & Rustichini (2004) suggested that women may not be as adept as men to performing in competitive environments, mostly due to their beliefs about self-performance. Women may be less prone to enter gender balanced competitive environments when compared to men (Gneezy & Rustichini, 2005; Gupta et al., 2013). Also, Niederle & Vesterlund (2007) have found that men and women presenting similar levels of performance in both a competitive and non-competitive task showed differences in deciding whether to enter in a subsequent tournament, with men entering the tournaments more often than women for any performance level. Gender differences in preferences for competition itself, but also gender differences in confidence about self-performance may explain these results.

Another example can be given on how the academic achievement of girls and

boys is different depending on whether or not they came from mixed sexed environments. Here, boys typically performed better and girls worse than in single-sex environments (Kessler et al., 1985; Brutsaert & Van Houtte, 2002). Moreover, psychologists argue that the gendered aspect of individuals' behaviour is brought into play by the gender of others with whom they interact (Maccoby, 1998), strengthening the idea that constructed gender roles are reinforced not only by genders but also by the expectation of how each gender should behave before the other. In terms of attitudes towards risk, women were found to generally be more risk-averse than men, especially in childhood (Eckel & Grossman, 2002). However, there seems to be evidence that these are likely shaped by parental background, as better off parents lead to riskier children (Byrnes et al., 1999; Booth & Nolen, 2012).

2.3.8.3 Ontogenetic and gender differences in competition

Having discussed the possibilities for male-based philopatry being one of the prime movers of gender differences in competitive and cooperative behaviour, let us now discuss the evidence. Regarding boy's coalitionary behaviour, it has been shown that they tend to form larger social groups than girls and also are more adept at participating in competitive behaviour with other groups of boys (Eder & Hallinan, 1978; Lever, 1978; Omark et al., 1975; Waldrop & Halverson Jr, 1975). This is especially demonstrable in the context of sports competition, where there is a marked tendency for boys to engage in hierarchies with clear role differentiation (Maccoby, 1998; Omark et al., 1975; Lever, 1978). Ontogenetically, there is evidence suggesting that boys from the age of three start preferring group to dyad-level activities and biases against members of other groups start to be displayed by the age of five years old (Benenson, 1993; Yee & Brown, 1992; Bernhard et al., 2006). Boys have also been reported to willingly integrate other boys in both cooperative and competitive contexts (Eder & Hallinan, 1978; Rogers et al., 1984). For adolescent boys, within group dominance starts to be established more on a recognition rather than physical strength basis (Savin-Williams, 1987).

On the other hand, research has provided evidence that girls preferentially engage in dyadic relationships, being more receptive of intimacy and solving other's problems and social conflicts (Benenson, 1993; Maccoby, 1998; Rose & Asher, 1999; Savin-Williams, 1987; Parker & Asher, 1993). There is also evidence that points out to women and girls being more sensitive to inequalities in their personal relationships and even towards women in general (Caldwell & Peplau,

1982). What can be acknowledged from the body of evidence discussed above, is that there is a tendency for women to develop relationships with higher emotional investments, leading to a preferential desire to have few high quality dyadic relationships rather than many low quality group relationships, possibly derived from the need to have support friendships with non-kin (Markovits et al., 2001). The maintenance of dyadic relationships entails both costs and benefits. The costs are that dyadic relationships are harder to maintain, and carry a high risk of defection and its effects, along with the potential for creating dense social cliques with few links to outside resources (Granovetter, 1983). On the other hand, dyadic relationships facilitate the negotiation of support in conflict and provide social and emotional stability (Taylor et al., 2000).

2.3.8.4 Competition via nature or nurture?

Above I discussed how physical dominance and notions of skill as a warrior are related to social status among men in many traditional societies (Chagnon, 1988) and how coalitional competition is endemic to most hunter-gatherer, horticultural, and agricultural societies (Ember, 1978) , but occurs less frequently in large-scale, industrialised societies (Keeley, 1996). I also emphasised how physical play, as well as physical aggression, are much more common among boys than among girls (Pietro, 1981; Maccoby, 1998). Anthropological (Chagnon, 1988), archeological (Keeley, 1996), and population genetics (Underhill et al., 2001) studies, as well as patterns of conflict in extant human populations (Horowitz, 2001), all point towards a long evolutionary history of coalitional and one-on-one male-male competition in humans. Many of the aspects of boys' social behaviour that are sometimes unfavourably compared to those of girls are a reflection of such history (Whiting et al., 1992). Nonetheless, cultural evolution is also responsible for many behavioural patterns. In the large-scale societies of today, behaviours are most of the times influenced by social strata, economic position, and upbringing among other factors.

2.4 Psychology and the Ontogeny of Spite

We have seen so far that evolutionary and socio-cultural mechanisms come together t0 shape how individuals compete and cooperate. It has also been explained that both genders' propensity for being competitive or cooperative is

based on a close intertwining of evolutionary acquired behaviours that boost survival, the cultural upbringing and reciprocal expectations on how each gender should behave. It was described how certain beliefs and "superstitions", such as the "evil-eye" can be interpreted as outcomes of a tendency for spiteful behaviour as an evolutionary and culturally significant strategy for both outcompeting and protection from being outcompeted by neighbours. Such beliefs, at first, seem rather irrational and would hinder the reasoning necessary to make decisions of competition or cooperation. However, taking the rationality approach exclusively is overlooking the effect that emotions play in such decisions, as the emotional side of the brain can be quite informative in such matters (Loch et al., 2006a).

Famous research done by neurologists Damásio (1994) and LeDoux (1996) has shown that making good decisions does not depend solely on reason detached from emotions. The account of individuals who, after suffering from brain damage in areas that deal with emotion processing (Damásio, 1994) without having their cognitive function impaired, showed severe decision-making difficulties and impressive lacks in social judgment abilities is evidence of the importance of emotional processing. In effect, emotions are a pre-requisite for making rational decisions in an agile manner. What most people define as "gut-feeling" is translated in Damásio's (1996) hypothesis for somatic markers. According to Damásio et al. (1996), somatic markers are the links between various reinforcing stimuli that will later induce an associated emotional state. These links can surface during decision-making and affect the cognitive process by biasing it. When facing a complex decision, the brain sums up all somatic markers and eventually forms what is called a net somatic state, that will essentially "direct" the brain on how to decide or act (Damásio, 2000). This direction allows for swifter detection of advantageous options, ultimately reducing the cognitive load to the brain by simplifying the decision process. In essence, emotions can shape cognition (LeDoux, 1996; LeDoux & Phelps, 1993; LeDoux, 1992).

Because the emotion processing sections of the human brain are much older (i.e., they evolved longer ago during evolution), they provide almost instant access to stimuli, making it possible for the brain to acknowledge a threat or any other fowl consequence even before it knows exactly what it is. In LeDoux (1992) groundbreaking study on fear, found that there are two essential pathways mediating between the senses and the consequent reaction (Figure 2.3). The sensory thalamus pathway is not able to make accurate distinctions between stimuli, however it sends the stimulus to the amygdala at least twice as fast as the more

accurate and fine sensory cortex pathway (LeDoux, 2003). In his own account, LeDoux (1996, p.163) explains that, "the thalamic pathway cannot tell the amygdala exactly what is there, but can provide a fast signal that something dangerous may be there. It is a quick and dirty processing system". As the cortex takes longer to accurately determine what a certain signal is, the amygdala provides an unfiltered, quicker way to respond to danger by evoking an emotional fear response. This proves to be essential as, "from the point of view of survival, it is better to respond to potentially dangerous events as if they were real than to fail to respond. The cost of treating a stick as a snake is less, in the long run, than the cost of treating a snake as a stick" (LeDoux 1996, p. 165). So here we see that emotional responses are essential from an evolutionary standpoint because they ready the organism to respond quickly to situations where there is no time for lengthy and complex cognitive and rational consideration (Ekman, 1992).

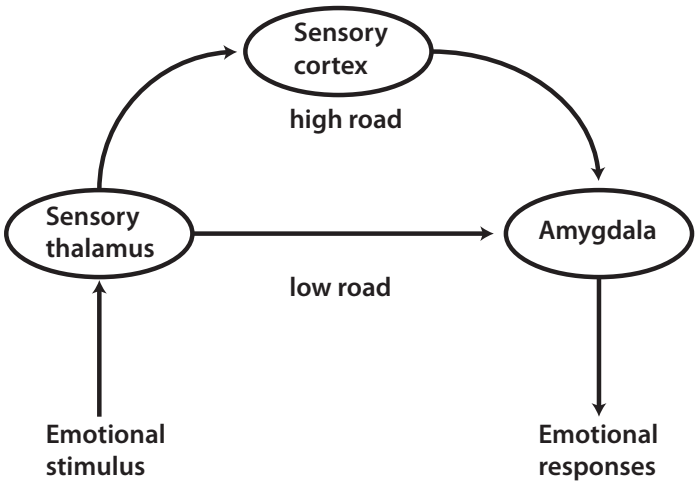

Figure 2.3: Exemplification of two separate pathways that mediate between sensory signals and fear reactions (*in* LeDoux 1992).

In the remainder of this section, I will discuss the psychological mechanisms that underlie the characteristics introduced above, mainly the adaptive importance of envy in resource competition and how spite is one of the behaviours it triggers in response to a situation where the scale of competition is reduced (i.e., in one-on-one competition). First I tackle the issue of the non-universality of emotions is tackled by arguing that it is not emotions themselves but emotional algorithms (emotional building blocks pertaining to four fundamental aspects of social life, affected by positive and negative feedback loops from each other) are in the basis of the tendency for spiteful behaviour. Next, I shall argue that envy forms the extreme part of an algorithm that deals with the strives to compete

and that spite is one of the behavioural applications of envy. I will also summarise the neurobiological basis of both envy and spiteful action and how they are connected to taking pleasure in punishing. Next I will explore the ontogenetic processes of spiteful behaviour and how they appear to arise with age. Finally, I will provide the evidence for spite among children in game theoretical experiments, which form the basis for the practical side of this thesis, and discuss how this evidence might be further explored.

2.4.1 Emotional Algorithms

Emotions are a fundamental characteristic of being human. However they are not all universal, as not all cultures recognise or conceptualise the same emotions (Elster, 1999; Elster, 2000). Moreover, emotions provide support for social norms but the behaviour they target can vary from population to population. However, an emotion not expressed does not equal to emotion not felt. It could rather mean it is repressed, taboo, sanctioned against or linguistically inexpressible. When an emotion is part of a cultural pattern, it is often the target for a prescriptive or proscriptive social norm, leading to either more or less occurrences of a certain emotion than might be expected if one does not take account of such sociocultural parameters (Elster, 1986). There are many cultural and social factors that could prevent emotional expression and even repress an emotion altogether. When a certain group endorses or condemns specific concepts or emotions it means that (i) individuals in that group have a common beliefs/values, concepts and norms; (ii) individuals of other groups lack said beliefs/values, concepts and norms. This would ultimately signify that these shared characteristics of individuals within a group are due to their upbringing and not to a human universal (Elster, 1986).

Emotional algorithms, however, represent a continuation of behavioural response processes coupled with an individual's subjective experience that includes a cognitive repertoire that is set in motion by both appraisal of a situation and emotional arousal (neurophysiological and motor expressions) (Loch et al., 2006a). There are several reasons why Emotional algorithms are proposed as universal. First they provide ultimate causation; secondly, they are akin to Damásio's (1996) somatic markers in that they are contained within modules in the mind; and finally, because they are adaptive in the sense of providing an evolutionary advantage (Loch et al., 2006a; Cosmides & Tooby, 2000).

There are four basic emotional algorithms as proposed by Loch et al. (2006a).

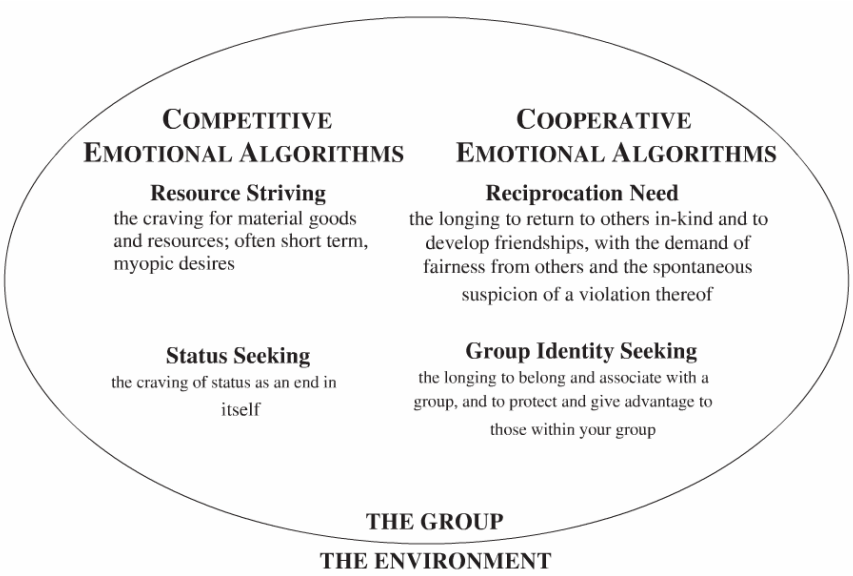

Figure 2.4: Emotional algorithms for competitive and cooperative scenarios. (*in* Loch 2006, p. 220)

These are: (i) *resource striving*; (ii) *status seeking*; (iii) *reciprocation seeking* and (iv) *group identity seeking*. These were synthesised by Loch et al. (2006a) reproduced here in Figure 2.4.

The emotional algorithm of interest here is *status seeking*. Although classic sociology has considered status as a good that has intrinsic emotional value (Veblen, 1994[1899]; Weber, 1948), status has recently been studied as means to an end in itself (Podolny, 2005) and can be underlined in the reciprocal gift giving systems discussed in section 2.3.2. Indeed, obtaining status has been described as a pleasure with physiological implications in the form of increasing serotonin levels (Booth et al., 1989).

Status striving seems to be hardwired in the brain as it elicits many basic emotions such as anger, sadness, happiness, disdain, pride, etc.[13], depending on the success or failure of status seeking endeavours (Loch et al., 2006a). This emotional algorithm, however, does not only elicit competitive outcomes. Status seeking can also be masked as altruistic acts (Loch et al., 2006a). It is this masking that is being argued here as spiteful. For example, it has been shown that Ache hunter-gatherers often pursue risky strategies in order to kill larger game, and sharing it mostly with non-kin (Buss, 2004). There are two things that stand out here. One, the hunter risks himself in a dangerous hunt that brings him no immediate advantage (as he will not even eat all the meat he obtains), thus he is paying a cost;

[13] As the reader will see in Chapter 3, these emotions will be used in the post game questionnaire.

two, he willingly shares the meat with non-kin in order to gain status from them and possibly a future return of such gifts, in a logic of agonistic gift (see section **??** (Sahlins, 1972; Buss, 2004; Loch et al., 2006a).

2.4.2 The Psychology of an Envious Algorithm

The emotional algorithm that deals with resource acquisition and competition (resource striving algorithm) drives the emotion that is known as envy (Hill & Buss, 2008). Envy is derived from the necessity for social comparison and self-evaluation. Given that the social landscape is composed of scarce resources, an individual's optimal strategy depends not only on how competent he or she is, but also on how competent his or her competitors are (Buunk et al., 2003). Social comparison is necessary in order to outcompete a rival without over-expenditure of effort (Hill & Buss, 2008). Adaptively, individuals should not focus only on bettering themselves overall, but better those they are competing with for the same resource (Frank, 1999; Hill & Buss, 2008). Humans are also very conscious of when there is a rank reduction on attributes that could influence reproductive success (Kalma, 1991; Mazur & Booth, 1999). This very human preoccupation has been synthesised by the strategic interference theory (Buss, 1989). According to this theory, upsetting emotional responses are highly adaptable as they serve very specific adaptive functions, namely,

> (1) temporarily screening out information that is less relevant to the adaptive problem being faced and focusing attention on the source of strategic interference, 2) prompting storage of the relevant information in memory, 3) motivating action to reduce the strategic interference, and 4) motivating action to prevent future such interferences (Hill and Buss 1989, p. 62).

The somatic markers (Damásio, 1994) associated with the interference at hand can explain the first point. By speeding up the interference recognition process, the individual is more capable of responding to said interference. The second point can be explained by what appears to be a physiological consequence for envy. In an experiment, individuals who displayed envy were not only more aware of what was happening but also were better at recalling information about the fictitious peers they were engaged with, when compared with a control group (Hill et al., 2011). The final two points, in my view, are related to behaviours that

could be classified as spiteful. This is because they concern motivating spiteful behaviour to effectively minimise the opponent's interference and finally reducing their payoffs to prevent future interferences.

Nonetheless, envy is an emotion highly repressed by society, as discussed in section 2.3.4. People go to many lengths in trying to avoid envying and avoid being envied. Elster (2000) provides an account on how the individual can delude herself by rationalising her envy. The first order cognitive assessment of envying something someone possess (the first somatic marker) screens out irrelevant information. The social *habitus* (Bourdieu, 1977) however, makes her feel ashamed of feeling envy, blocking the agent from acting towards it. However, the agent would feel the need to justify her feelings and prepare her for the actions needed to prevent interference to her success. This is where a revised cognitive assessment occurs where she tells herself a "story" about how the envied subject obtained the envied something by illegal means or at the expense of others. This is remarkably well explained by Elster in his work *Alchemies of the mind* (1999) with a schematic of this two-order cognitive assessment of envy (Figure 2.5).

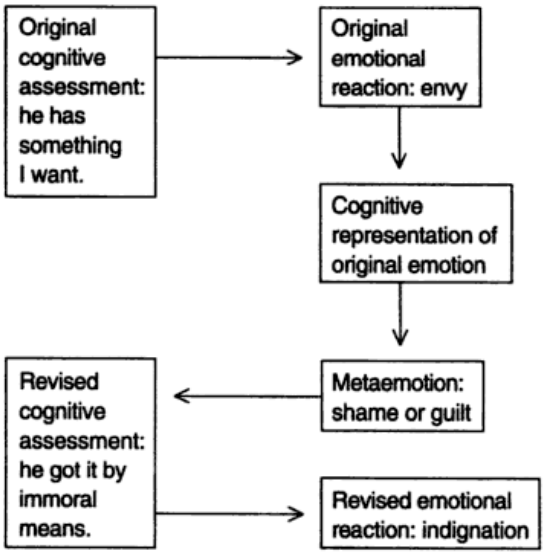

Figure 2.5: Two-order cognitive assessment of envy to justify feeling envious (*in* Elster 1999).

In fact, there is evidence that suggests people are less willing to report envy because it might reveal to others that they feel inferior (Fiske, 2012). According to this view envy is an emotion that enforces cultural control at both spectrums of a hierarchy (Fiske, 2012). As with the case of punishment (Fehr & Gachter, 2002; Elster, 1986), the mere threat of others expressing envy can elicit culturally appropriate behaviour (Fiske, 2012).

2.4.3 Neurobiology of Envy and Spite

Humans do not make decisions based on rationality alone, but decide with their emotions as well, especially when resource acquisition is concerned (Loch et al., 2006a; Damásio, 1994; LeDoux, 1992). If this is the case, what are the neurobiological foundations of these emotional processes? Let us again take the example of the ultimatum game. To remind the reader, this simple game implies giving a proponent a sum of money and splitting it with another person in any way she desires. The receiver then has the chance of accepting or rejecting the offer. If the receiver accepts the offer the money is then shared. But if she rejects, then both parties end up with nothing. The typical *Homo economicus* solution for the game is to offer the lowest amount possible if you are the proponent and accept any offer if you are the receiver, because something is always better than nothing (Sanfey et al., 2003) However, that is not what the evidence reports. The average offers are actually around 50% of the total sum and offers 20% or under have a 50% chance of being rejected (Camerer & Loewenstein, 2003; Roth, 1995), in multiple cultural contexts (Henrich & Boyd, 2001; Henrich, 2005).

The human brain is highly adapted to sociality (Dunbar, 1998). Networks in the brain devoted to processing social cognition, located in the medial prefrontal cortex (mPFC) not only get triggered when other people are encountered but also when considering their feelings and emotions (Amodio & Frith, 2006). Interestingly, there is evidence that others in social categories that provoke contempt or disgust to certain individuals will not fire up the mPFC (Mitchell, 2008). This means that there is a neurological predisposition in certain individuals to deny an out-group of typically human attributes such certain feelings and emotions (Fiske, 2012). In essence, this process is what is often called dehumanisation, or likening such out-groups with animals (Haslam et al., 2008). It has been found that people automatically engage in this sort of process (Haslam, 2006) and that people are more prone to attributing human characteristics to in-group members and primate emotions to out-group members (Leyens et al., 2003). What dehumanisation accomplishes, is to refuse acknowledging the inner complex experience of being human in others (Fiske, 2012; Haslam et al., 2008; Haslam, 2006; Leyens et al., 2003) When we think about dehumanisation in terms of the relatedness models presented in section 2.2, it is the ultimate form of negative relatedness. Individually, spite is advantageous in this type of context and usually is manifested by emotions of *schadenfreude* (a german word that means to be glad at the misfortunes of others) and aggression (Fiske, 2012; Trivers, 2005; Rózsa, 2009).

Schadenfreude is particularly elicited when envy is felt towards an individual that is in the same scale of competition (Van Dijk et al., 2006; Gardner & West, 2004a; West et al., 2006a).

2.4.4 Final Remarks

This section presented the findings that consider spite as a behaviour that is elicited when certain emotional algorithms are in place, and that these are highly influenced by both brain hardware and cultural software. The final section will now present a description of how game theoretical studies have been used in the social sciences, a primer in game theory and finally a discussion on how status competition and spite can actually be precursors to the evolution of cooperation in humans.

2.5 The sociology of spite

When addressing spite as a sociological phenomenon, the concept of status must be addressed. Status is one of the most important concepts in sociological studies and has proved rather helpful in understanding certain dynamics in social interactions (Podolny, 2005). From Weber (1948) to Merton (1968), many sociologists have found this concept key in explaining the actions of individuals in a very broad array of situations . Such as behavioural biologists have found that hierarchies influence individual behaviour (Martin & Bateson, 2010) and limit the extent of individual's actions, so to sociologists encounter the same issues (Swedberg, 2001). The location of an individual in the hierarchy shapes other's expectations for that individual's behaviour, which in turn limits the opportunities available for certain actions (Podolny, 2005).

Status is a universal biological and social fact. From primates to lions, to humans and their organisations, all of them are arranged in hierarchies (Fiske, 2012). Another individuals' dominance status it automatically judged in seconds using a plethora of subtle cues (Oosterhof & Todorov, 2008). Comparison and competition are ever present in any relationship, and people rank themselves relative to others (Todorov et al., 2008), ultimately leading to macro-level hierarchies such as class (Sidanius & Pratto, 2001).

It is well documented that human status and hierarchies are highly dependent upon interactions (Fiske, 2012) and can flow among individuals either through

exchange or deference (Dumont, 1982). Exchange relations are reciprocal in nature and imply that roles of giver and receiver alternate (Podolny, 2005). Not only exchanges of economical nature are involved but any type of association between individuals. Deference relations, however, imply that sides are unequal and one of them directs behaviour toward another (Willer, 2009). In this sense, spiteful behaviour is deferent in essence (Vickery et al., 2003). In the section arguing the spiteful nature of the kula and potlatch, one can understand how the reciprocal exchanges of items implies deference because the exchange is forced upon the receiver (Mauss, 2002[1954]; Leach & Leach, 1983). Nonetheless, this direction of behaviour need not be aggressive as deference might imply acknowledging another actor's status as higher than perceived by others (Podolny, 2005).

Association or exchange can mean that whenever there is a perceivable social interaction between individuals of unequal status there is a sort of bleeding effect whereas higher status individuals are perceived as losing, and lower status individuals are perceived as gaining status (Podolny, 2005; Elias & Scotson, 1994). Such type of interaction is patent in a study of social dynamics between established and outsider populations in an English Village. Here, newcomers into a "posh" neighbourhood affected the established people's reputations unless the "outsiders" behaved as expected during a certain 'probationary' period (Elias & Scotson, 1994). When two individuals engage in association, exchange or deference relations, and other individuals perceive that linkage; status flows accordingly through the links between the interacting nodes of a social network (Ridgeway, 2001; Fiske, 2012; Barabási, 2009). Higher ranked individuals will lose status and lower ranking individuals will gain it (Podolny, 2005).

Why is status so important and why do people constantly seek it? Primarily because status in a group will reflect on an individual's ultimate goal, which is to control more resources in order to gain a better chance of reproduction (Wrangham, 1980; Loch et al., 2006a; Fiske, 2012; Ridgeway, 2001). Status is a currency that is evaluated by other members of an individual's social group and the amount of value one has is determined solely by others' appreciations of an given hierarchy (Berger et al., 1972). Because of this, the group develops a silent consensus on the characteristics that are worth more status currency (Berger et al., 1972). While on hunter-gatherer societies, status was attributed to those with the best hunting skills (Ellis, 1994; Buss, 2004), on communal based agricultural societies (on which modern societies are based) those who show greater abilities for resolving a communal task, have strong altruistic demeanours or strong leadership skills can achieve higher standing (Berger et al., 1972; Hardy & Van Vugt,

2006; Ridgeway, 2001). There are many status benefits that come with selfless behaviour. In social dilemma studies, individuals who contribute larger sums for a communal fund are found to be more committed to the group and are awarded high status (Hardy & Van Vugt, 2006; Willer, 2009; Loch et al., 2006a). This means that individuals often engage in kula and potlatch type behaviour, i.e., competition over gift giving (Mauss, 2002[1954]; Malinowski, 1984[1922]). According to studies on modern day work organisations and universities, individuals were graded according to self and peer-ratings on how often they provided assistance to co-workers. The seemingly altruistic individuals, those who provided more help and also refused more help from others, were shown to be those more motivated for status seeking, strategically doing so by providing assistance (Flynn et al., 2006).

The concept of status flow is very much distinctive of the sociological view of status. Sociology has commonly perceived the expected gains and losses in status as qualitative in nature. Although qualitative interpretation of association exchange and deference relations does result in deeper data, the real costs and benefits of such interactions are very difficult to ascertain unless modelled through game theory and experimented in simple settings. In the following sections, an account of how game theory can be, and indeed has been used in sociological studies will be given, as well as a first introduction to how experimental game theory will be used throughout the remaining of the thesis.

2.5.1 Game theory as a sociological tool

Game theory has been in use in sociology ever since its beginnings (Neumann & Morgenstern, 1944), despite being considered a marginal work tool for most sociologists. It has shown a revival in interest in the 1980's until today (Swedberg, 2001). The pioneer in the use of game theory in sociology (and years ahead of her peers) was Jessie Bernard, whose work in *The Theory of Games* (1954) introduced sociologists to the use of games to analyse social problems. Bernard (1954) focused on studying social conflict and described game theory as a framework-building tool that allows narrowing sociological problems and their possible considerations. She was also important in bringing a social science perspective into game theory itself, arguing that sociologists should be brought into the conceptualisation of game theory and provide insight on how the object of study of sociology, such as institutions, changes the games people play (Bernard, 1954).

From the 1950's up till the mid 1970's, the use of game theory in sociology was highly focused on the development of theories of coordination. Scheff's (1967) attempt, much influenced by the work of Schelling (1980), at providing a theory of coordination that looked at social phenomena as games was considered by prominent social theorists such as Geertz (1983) as no more than a mere metaphor, brought about by influences from both philosophy and economics (Swedberg, 2001). However, it was during this time that laboratory experiments in game theory started to be conducted within the domain of sociology with the most prominent being the works of Bonacich (1972),and Bonacich (1976).

The sociologist that was most responsible for considering context in game theory was Erwin Goffman. The pioneering nature of Goffman's work was introducing the concept of strategic interaction to sociology (1969). Although it was to become a common concept in the coming emergence of Evolutionary Game Theory conducted by John Maynard Smith and George Price (1973), the use of strategies in everyday interactions was foreign to most social scientists concerned with the collective function of societies. Swedberg (2001) argues that the area of social life identified by game theorists was left out by most sociological studies, namely situations in which actors are aware of each other, their actions affect all actors involved and in which the decision one actor makes is highly dependent on what he or she thinks a second actor believes what the action is. However, Goffman (1969) was critical on the limitations of game theory in analysing empirical strategic interactions. He states that, in an empirical context,

> persons often don't know what game they are in or whom they are playing for until they have already played. Even when they know about their own position, they may be unclear as to whom, if anybody, they are playing against, and, if anyone, what his game is, let alone his framework of possible moves (...) these various difficulties can be dealt with by approximating the possible outcomes along the value and likelihood of each, and casting the result in a game matrix; but while this is justified as an exercise, the approximation may have (and be felt to have), woefully little relation to the facts. (Goffman, 1969, p.149-150)

However, much of this criticism was partly the consequence of the mathematical limitations of sociologists rather than the method itself (Swedberg, 2001). The post 1980's wave of sociological game theorists such as Heckathorn (1986) have embraced the notions of John Nash's (1950; 1953) game theoretical principles on

research into social dilemmas, mainly when there is a conflict between individual rationality (in the sense of payoff maximiser) and collective inherent rationality. This occurs when the individually dominant strategies converge toward a defective equilibrium (Kollock, 1998).

Game theory is in effect a useful tool to extract what is essential in a strategic interaction. A payoff matrix is an oversimplification of a social situation but it nevertheless highlights the implications of the various strategies it portrays (Blau, 1964). In summary, it has been a tool to investigate what the literature calls counterfactuals; it has greatly expanded the sociologist's research arsenal; as well as strengthen the analytical capabilities of sociological research itself, mainly by introducing an actor-based explanation of societal interactions, rather than one based on variables (Swedberg, 2001)

2.5.2 A primer in Game-Theory

Game theory as it is know today, was established by Von Neumann and Morgenstern in the 40's of the 20th Century (1944). What was initially developed as the mathematical formalisation for economic behaviour has now broadened to embrace many types of interactions between individuals. Nowadays, game theory is widely used to address the problem of cooperation and how it can emerge and be maintained in a population. Moreover, it is also used to address problems of conflict, competition and, what is important for this study, spite.

Because this study uses a 2-person game, a brief description of the main games used in game theory research will be given. This type of game considers two subjects that can interact with a set of rules that are common to both (Nash, 1953). The strategies being employed in the game can take multiple forms that range many types of behaviours. However, the outcome of the game is greatly contingent upon the presumption of rationality of its participants (Neumann & Morgenstern, 1944).

The common approach to game theory is highly based on the popular work of John Nash on game equilibria (1950). In his work, he explains that the rationality assumption of payoff maximisation inevitably leads to an equilibrium where a player's payoff cannot be higher should anyone change strategies unilaterally, a concept known as the Nash Equilibrium (Nash, 1950; Nash, 1953).

In this case, a social dilemma can be studied through a type of game where a

player's payoff is dependent not only on his action, but also on that of his partner. Because game theory is mostly used to study the problem of cooperation, the main three cooperation games will be explained here. Following will be an explanation of the game being used in this study.

The most famous social dilemma game is the Prisoner's Dilemma (PD), developed in the RAND Corporation by Flood and Drescher in the 1950's and later formalised by Tucker (Poundstone, 1992). The PD was described as a game where two prisoners were held for interrogation in separate rooms. The prisoners could either cooperate (C) (with each other) by not telling the police anything, or defect (D) and, "rat" on their "partner in crime" so to speak, impacting on how many years they each received for their crimes. For example, by staying quiet, both criminals would be kept under circumstantial evidence and get a couple of years each. By reporting to the police that their partner was the mastermind and they were coerced to participate in the crime, then the police would have evidence to lock up the partner for a long time. However, the opposite could also be true, hence the dilemma.

In this game a rational player should always defect, disregarding the other player's intentions and actions. When looking at the game by its usual 2x2 matrix (1), we can define it by its payoff hierarchy: $T = \prod(D, C) > R = \prod(C, C) > P = \prod(D, D) > S = \prod(C, D)$[14].

	C	D
C	R	S
D	T	P

Figure 2.6: Standard game theory payoff-matrix.

From this, we ascertain that the only Nash Equilibrium possible is (D, D), i.e., when both players defect.

The PD is considered the game where cooperation is more difficult to survive in and is the most studied in game theoretical literature. Areas like economics, politics, sociology and biology are therefore very keen on the study of the PD because of its applications to many real life situations (Kollock, 1998; Poundstone,

[14]The letters represent the payoff distributions: T is the temptation to defect, R is the Reward for being cooperative along with the other player, P is the punishment for another player for mutual defection and S is the Sucker's payoff, when a "sucker" cooperates and the other defects. Note that game theory is always referred to from the viewpoint of a single player and not both.

1992).

Another classic 2 x 2 game that has received nearly as much attention as the PD is called the Stag Hunt game (SH, also known as the assurance or the trust game) (Skyrms, 2003). This is in effect a game of coordination and its illustrative scenario is that of two individuals that have the option to cooperate and hunt a stag together, or defect and hunt a hare. Because the latter is a smaller animal, it can be caught alone, but the former requires the coordinative effort of both individuals. In this game, the payoff hierarchy is slightly different than from the PD: $R = \prod(C, C) > T = \prod(D, C) > P = \prod(D, D) > S = \prod(C, D)$. This causes the emergence of two equilibria, the Nash equilibrium of the PD (D, D) and a second Pareto efficient equilibrium (C, C), as it provides the highest payoff for both players. The solution for this dilemma is coordination as it is always better to do whatever the partner is doing. The Stag Hunt has been considered the most suitable game for studying biological interactions as most of the cooperative and competition problems in nature are more like a stag hunt than a prisoner's dilemma. Other two examples are the Snowdrift Game (Rapoport & Chammah, 1966), and the Harmony Game (Posch et al., 1999).

The game used in this study [15] is a dominance game because $R = \prod(C, C) > T = \prod(D, C) > S = \prod(C, D) > P = \prod(D, D)$, the player is always better off by playing C, making (C, C) the only Nash equilibrium. However, D is an unbeatable strategy in the sense that it guarantees that no payoff is greater than the actor's, even at the cost of own payoff. This in essence defines spiteful behaviour: paying a cost to guarantee that another, preferentially non-related individual, looses more than the actor (Hamilton, 1970; Wilson, 1975; Foster et al., 2001).

2.5.3 Motivations, rationality, and norms

Most sociological studies on strategic behaviour have focused on the motivations behind cooperation. One argument proposed by Jon Elster is that cooperation is not an irrational act but rather can be explained as a rational "consistent, future oriented and instrumentally efficient behaviour" (Elster, 1986). This specific case of rationality can be further distinguished as selfish and non-selfish. The selfish rationality concerns outcomes and process while non-selfish rationality concerns altruism on the positive side, and envy and spite on the negative

[15] see methodology chapter for more detail

side. Also, it is well known that classic sociology has established different types of rationality that can explain certain seemingly non-rational actions (Weber, 1948).

This means that selfish individuals do not always defect, but can cooperate as the more rational action. This description is akin to what theoretical researches are portraying as rationality. When the unit of selection is the gene and not the individual, then considering (even if unconsciously) the social group/family unit/-clan as the unit of selection is the rational choice (Dawkins, 1999[1976]; Fehr & Fischbacher, 2003; Fehr et al., 2002; Fehr & Gintis, 2007; Boyd & Richerson, 2009; Henrich, 2005). In this sense, altruism for example would be a purely psychological inclination. As discussed in the previous section, altruism could just be the reverse of spite (Bshary & Grutter, 2005). It feels good when something bad happens to x or y just as it feels good when something good happens (Trivers, 1971; Elster, 1986).

The problem with the concept of rationality is how rational choice theory is actually designed. This theory does not attempt at explaining what a rational individual does in a given situation (Elster, 1986). Rational choice theories are only concerned about the social outcome of individual interactions. The fact that an individual is rational in his or her decision does not mean that the outcome of said decision will be rational. As explained above, the outcomes of games can be stable equilibria where actors have no interest in changing their strategy given other individual's behaviours (Nash, 1953). This of course, can lead to less than desirable social outcomes.

Another possible criticism can be placed in assumptions on individual motivations. Most of rational choice theory considers individual beliefs (Bicchieri, 2003). Structural rational choice theorists regard both individual values and structural elements as equally important determinants of outcomes, but for methodological reasons their empirical applications typically place greater emphasis on social structural determinants (Goldthorpe, 1996). For this reason, rational choice explanations can be found among other general perspectives, such as structuralism and network analysis (Goldthorpe, 1996). A frequent outcome in experiments with games such as the prisoner's dilemma, is that individuals usually cooperate conditionally on another individual's choice in a previous round, rather than rationally consider the possible future benefits of a certain strategy choice (Semmann, 2012). This could mean two things, either that individuals are highly vindictive in their choices when engaging in game-theory experiments (Fehl et al., 2012) or that they are following social norms in the sense that individuals expect

a certain outcome and when that outcome is not what they expect they react by acting as punishers (Bicchieri & Chavez, 2010).

On the one hand we have thin rational choice models that disregard the particular values pursued by individuals (Elster, 1986). Such types of model base themselves in strong assumptions: (i) whatever an individual's values may be they must be stable and transitive (if someone prefers a to b, and b to c, they must prefer a to c) (Elster, 1986). Thin models, usually found in both economics and social choice theory, tend to be highly universalistic and akin to physics and biology theories concerning the optimal behaviour of atoms and organisms (Bicchieri, 2003). On the other hand, we have thick models of individual action. These are substantively richer, for they account for some aspects of intentionality (Hechter & Kanazawa, 1997). Individuals certainly have reasons for what they do, and their behaviour is only predictable if we know their underlying motivation (Fehr & Gintis, 2007). Thick models take into account an individual's values and beliefs. This is done by assuming that individuals will seek maximum quantities of exchangeable private goods be it wealth, power or prestige (Elster, 1986). With increasing group sizes, these idiosyncratic values tend to cancel each other out and in certain situations, the remaining common value permits quite accurate behavioural predictions at the collective level (Hechter, 1994).

Contrary to what some authors have proposed (England & Kilbourne, 1990) thick rational choice theories do not necessarily assume that individuals are selfish agents, but rather require they are self-interested (Friedman & Diem, 1990). The problem with adopting any sort of rational choice theory in the social sciences is that this approach seldomly provides demonstrable empirical payoffs. Occasionally, research on group processes has clear macro level implications. For example, the "cognitive miser" theory explains social welfare, order, and efficiency at the macro level by analysing dyadic interactions at the micro level (Orbell & Dawes, 1991). Here, intending cooperators are more likely to play dyadic Prisoner's Dilemma games than intending defectors, when they have the option not to play, a fact that has been attested by evolutionary game theorists in recent years when developing rules for the evolution of cooperation (Nowak, 2006b). Then the outcomes of most completed games are mutual cooperation, whereby the players enjoy its rewards and aggregate economic surplus at the macro level (Orbell & Dawes, 1991).

Another point that advocates for a thick or sociological mode of rational choice

theory is the problem of cooperation in public goods games. Unlike the usual n-person prisoner's dilemma games (Hamburger, 1973), the "volunteer's dilemma" game captures the problem of cooperation in situations where responsibility can be diffused (Diekmann, 1985; Diekmann, 1986; Diekmann, 1993). A single volunteer produces the public good in the volunteer's dilemma, and there is no pure dominant strategy. This means that one should defect if there is at least one cooperator, but should cooperate if there is none. In this case, a strictly game-theoretic solution, that of a mixed Nash equilibrium can lead to highly inefficient outcomes (Diekmann, 1993).

2.5.4 Spite, Punishment and the maintenance of cooperation

Punishment is a very effective tool in the emergence of collective action. As Olson (1965) describes in his seminal work the *The Logic of Collective Action*, one agent can withstand the full interest of a public good, but would risk being exploited by others. However, if a subset of agents is able to punish others, forcing them or inducing them to cooperate by providing negative or positive incentives contingent on the recipient's behaviour, then the free-rider problem tends to disappear. Punishments are linked to negative behaviour such as spite and positive incentives are linked to cooperative acts. Nonetheless the use of incentives can have strong or weak effects, which can make cooperation dominant or weak as an equilibrium strategy (Olson, 1965).

Reliance on positive incentives can imply a huge cost (Olson, 1965; Elster, 1986). Punishment, on the other hand, is a less costly and more efficient deterrent of defectors, as it works mainly by deterrence than secondly by administration (Casari, 2005). Despite this, individuals must be willing to pay this cost of punishment in order to enforce it in order for the benefits to be diffused among all members interested in the public good (Darcet & Sornette, 2008). Although options such as decentralised monitoring of a public good (such as modern institutions of government, courts, police, etc.) imply less costs and are selfishly rational, where these options are not applicable punishment is always a spiteful enterprise as the actor incurs a cost (punishing) to inflict a greater cost (punishment) to the defector (Cason et al., 2002). This will eventually benefit the group in the future, however there is no immediate gain for the punisher in doing such an act (Jensen, 2010) - and indeed future beneficiaries of the public good may free ride at the punisher's cost..

An optimal level of cooperation requires communication and coordination among actors, which is fostered by social norms (Diekmann, 1985). Experimental evidence shows that subjects do not employ strictly game-theoretic solutions (Diekmann, 1986; Diekmann, 1993) and are willing to punish even when there is no gain. This notion has been further explored by Dreber et al. (2008), in which they realised that, in a public goods experiment, costly punishment (another definition for what here is argued as spiteful punishment) increased levels of cooperation. This idea had already been widely discussed both in theoretical (Sigmund, 2007) and experimental studies (Yamagishi, 1986; Fehr & Gachter, 2002; Gurerk et al., 2006). Moreover, a clear advantage for the preference of punishment was found whenever defectors were eliminated and cooperation was the dominant strategy (Gurerk et al., 2006). However, Dreber and colleagues (2008) found that costly punishment did not increase the average payoff of the group. What is more interesting is that it was actually negatively correlated with total payoff and those with higher payoffs tended not to use it. According to the authors, punishment could have evolved for coercion and hierarchy establishment, however, no evidence has been put forward regarding this theory (Milinski & Rockenbach, 2008). Finally it must be clarified that not all punishment is costly, and non-costly punishment is neither spiteful nor altruistic in nature.

2.5.5 How spiteful strategies can lead to the emergence of fairness and altruism

In a recent article, Forber & Smead (2014) set out to understand the occurrence of spiteful responses in games such as the ultimatum game. It arose from the common premise that, the responder being rational, she should aim at maximising pay-off, therefore accepting any offer greater than 0 and that the proposer acting according to the same principle should always try to demand as much as possible. (Forber & Smead, 2014; Henrich, 2005). Previous studies have always linked the evolution of fair behaviour to altruism, given that fair behaviour implies sacrifice (Gintis et al., 2003; Tomasello & Vaish, 2013). However, Forber & Smead (2014) discovered that this is not entirely accurate when we considered assortment, or whom one chooses to play the game with. They claim that positive assortment drives the evolution of altruism because altruists would preferentially engage in sociality with each other frequently, avoiding free-riders (Hamilton, 1964a; Trivers, 1971). On the other hand, negative assortment would drive the evolution of spite because spiteful individuals would frequently harm others

not like them (Hamilton, 1970; Smead & Forber, 2013).

The model put forward by Forber & Smead (2014) shows that positive assortment has little effect, while negative assortment tends to aid the evolution of fair behaviour. Introducing mutations even increased the effect of spiteful strategies in the evolution of fairness, destabilizing the equilibria that consisted only of fairness with the emergence of a stable equilibrium that consisted in a mix of spite and fair behaviour (Forber & Smead, 2014; Smead & Forber, 2013). The authors' model fits well with the predictions of Hamilton (1964a) in that small populations usually generate this sort of negative assortment. Moreover, considering that small groups were probably the norm in early human populations (Dunbar, 2008), intragroup evolutionary pressures could have been driven by effects of negative assortment of strategies, causing the typical parochialist behaviour where in-group is sanctified and out-group is demonised (Bernhard et al., 2006)

2.6 Conclusion

From what has been described in this chapter, there is a single thread: spite as a defence against out-groups, negative reciprocity against non-kin, amoral familism, small populations. The common theme of spiteful strategies is that of parochialism. Although spite is truly hard to find in animals, it has been extremely important in building human societies. By being spiteful in the correct situations, sense of fairness evolves within the group. It has also been shown that feelings that provoke spiteful behaviour are hard-wired in our brains, quite as much as feelings of cooperation. We are built to compare with others and spite can provide a means to get ahead. We are also built to cooperate and coordinate and attain goals. And the former can actually help the latter.

Now that the what and the why of this thesis has been explained, it is time to answer the how. The next chapter will explain all the methodology used in this thesis in order to achieve the goals I have set out in the introduction.

3

Materials and Methods

3.1 The Model: spiteful practices as status competition

Before undertaking experimental research, a visual model was devised to portray how interactions could take place. As described in the theoretical background, spiteful behaviour seems to occur in a variety of social and cultural contexts, (mainly regarding beliefs in the evil-eye). Taking into account this premise, this thesis proposes that spite is a behaviour elicited by negative emotional algorithms engrained in the individual and social psyche, and triggered by events of status competition. For example, when an individual has an opportunity of engaging in a social dilemma where disregarding his opponent's choices is the better option, he/she instead prefers competing, causing harm to the opponent but also harm to him or herself. Even though this process is costly it confers individuals with an edge in highly competitive environments. It is also proposed that this process is ontogenic, i.e., it develops with age, with children showing less spiteful inclinations than adults.

If this is the case, then spiteful inclinations should be stronger in face-to-face interactions rather than anonymous interactions, as the stimulus for competition is increased. Here, individuals would likely be more inclined to compare their relative payoffs when they can see their opponent.

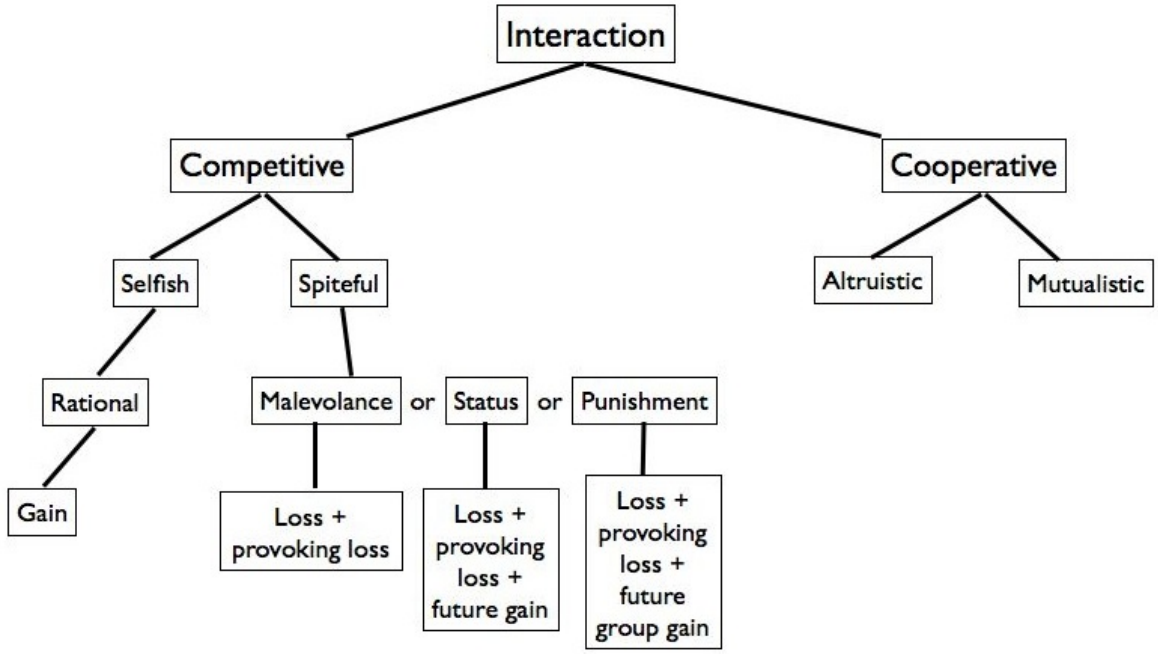

Figure 3.1: Flow chart of the theoretical model on how spite may occur

In order to test this model three main methodologies will be used. The first is through a series of game theory experiments, performed with students of a Portuguese school. These will be a two-player social dilemma game with spiteful strategies and a dictator game based on the study of Hager (2010) with spiteful and altruistic strategies. A post-game interview will also be made to the students in order to understand their psychological framework while engaging in the experiment. Finally, semi-structured interviews with teachers and school staff will be performed to understand how the children behave in their daily school life, covering topics that range from status seeking behaviour, to establishment of hierarchies in group tasks and development of parochialist competition with other groups of students.

3.2 Experimental Game Theory methodology

The methodology is based on a game theoretical experiment with a modified dominance game (Myerson, 2013) with two strategies: max (a dominant strategy that represents a Nash equilibrium (Nash, 1950; Nash, 1953), and min which is considered here as spiteful non-Nash equilibrium. The game is designed such

that rational maximisers will choose the max strategy; risking having a pay-off lower than the opponent; alternatively, spiteful players will choose the min strategy, reducing their payoff but still reducing opponent payoff even more.

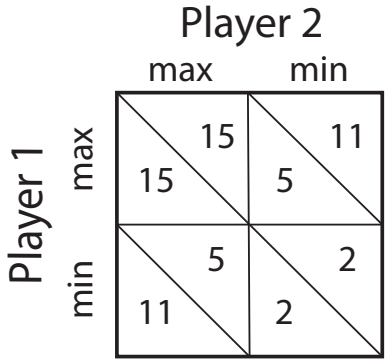

Figure 3.2: The Spite Game payoff matrix. Here payoffs are displayed for each pair of decisions. Left for player 1 and Right for Player 2.

3.2.1 Much or more (Azores) Study

3.2.1.1 Subjects

Subjects were 398 children from 5th to 11th grades from 6 different schools in the island of São Miguel in the Azores Archipelago, Portugal. Grades 6, 9 and 11 were discarded from analysis because sample sizes were too small and grade 6 did not play one of the variants (we required a minimum of 15 sessions in each game in a given grade to consider it). After removing these subjects from the sample, our study comprised 350 children in 175 sessions, as each person participated only once.

3.2.1.2 Experimental Protocol

The participation of each student was strictly voluntary but was presented to the students as an opportunity to develop a taste in mathematical and economical issues. The study was performed outside normal lecture period. No personal information was requested either from the students or teachers other than the date of the experiment, age and class year of the participants. We presented the teachers with the tools to perform the experiments, which they ran from March to June 2010. Authorisation was given by the school boards, directors of study and teachers.

Each player was given a "Red" backed and a "Black" backed card from normal playing decks. These correspond to max and min in our payoff matrix, respectively. It is important to note that the terminology "max" and "min" was never used in training or the experiments. In each class, schoolteachers randomly divided the children into two groups: A and B. Each of the pairs would play the game corresponding to their group letter in the experiment for five rounds after they were read the instructions and clarified any questions regarding the procedure. Children chose their cards underneath the table and simultaneously disclosed their choice after the teachers command. After the results were recorded the students could then play another round. After the game was played, prizes were given according to the following paying scheme: In Treatment A, a piece of candy was given for every 25 points accumulated by either player, meaning that each player could earn a maximum of 3 pieces of candy. In Treatment B, the child with the most points of the pair would win a high value chocolate with a monetary value to approximate to 3 pieces of candy. In case of a tie, the chocolate was split in half.

After appointing each pair of children to their respective group, the teacher handed each of them a score sheet with the payoff matrix (which means students had access to it during the entire duration of the experiment). The following information was recorded on a score sheet:

1. Ages of each participant;
2. School year of each participant;
3. What card was played by which student in rounds 1 through 5;
4. Score of each student after each round and total score.

In order to insure impartiality, teachers attributed a third student to each pair that would act as a referee and was responsible for filling the information on the score sheet. The referee only registered the game points on the record sheet and announced the result after each round. He had no other participation in the experiments. No communication was allowed between the players themselves and between the players and the referees.

After all students and their referees sat down, the teachers read aloud the following information:

- All players have the same rights and duties;

- Each player receives one red and one black card
- For game A: The prize will be proportional to the number of points obtained by each player at the end of the game.
- For Game B: The prize will be given to the player with the highest score.

After this information was given, the teacher explained the procedure of the experiment:

1. Each player chooses either the Black or the Red strategy
2. The referee requests the strategies be shown
3. The referee records the participant's strategies and resulting points in the provided experimentation score sheet.
4. Items 1 to 3 are repeated a further four times.
5. After everyone in the class played, the teacher wrote the total scores for game type in the board and proceeded with attributing the prizes.

The prizes were attributed in the following manner:

- Game A: the prize is given proportional to the points obtained by each player with 15 points equaling 1 piece of candy.
- Game B: the prize is given to the player with the highest score. The payoff consists of a small, but high valued chocolate (with a proximate monetary value of three candies).

After this information was given and when there were no doubts regarding procedure of the experiment, the game began. The recording sheet is provided in Appendix A

3.2.2 Computer based experiments

3.2.2.1 Subjects and Location

In the anonymous experiments, subjects were 220 children from 7th to 12th Grade and were students in the Camilo Castelo Branco School in Carnaxide.

Face-to-face experiments were run as a control and comprised 24 children from the same school. The experiments were conducted in the School's library (see Figure 3.3) as it provided a total of 12 computers connected to the same internet hub, which was necessary in order to run the server used in the experimental procedure. Students were randomly divided into groups of 12 at the teacher's discretion, which were then selected by myself for Treatments A and B respectively. The reason for choosing such a low number of children for the face-to-face computer experiments was mainly logistic, as most classes had an uneven number of students that could be paired with the computers available. For example, whenever a class had 30 students, 12 were put in Treatment A and 12 in Treatment B, while the remaining six students were placed in the face-to-face experiments as anonymity could not be guaranteed. The same was true when the available parents's authorisations equated to six or less students.

Figure 3.3: Computer experiments' main location.The study was conducted in the Library of the Camilo Castelo Branco School. The library was chosen not only for its technological capabilities, but also to provide students with a familiar environment in which to perform the study.

Carnaxide is located in the municipality of Oeiras with an Area of 6.63 km^2 and a population of 21,353 according to the 2001 population census and a density of: 3,200 per km^2. The Camilo Castelo Branco school is the hub of the Carnaxide School Mega-Group which comprises six other schools (JI Nossa Senhora do Amparo arnaxide; EB1/JI São Bento alejas; EB1 Antero Basalisa arnaxide; EB1 Sylvia Philips - Carnaxide; EB23 Vieira da Silva arnaxide; and ES Camilo Castelo

Branco.). The total number of students registered in the school are 720 according to the school's official website. The total sample used in this study comprises 33.8% of the total school population (CMO, 2009; CMO, 2011).

3.2.2.2 The EconPort platform

Experiments were run via the EconPort (Chen et al., 2003) platform. EconPort (Chen et al., 2003) is an Open Archives Initiative (OAI)-compliant collection on several educational materials for the teaching and learning of Microeconomics, and instructions on game-theoretical issues, coupled with software for running experiments. The platform is run and maintained by the Experimental Economics Center of Andrew Young School of Policy Studies in Georgia State University,USA

This software allows for game-theory experiments to be conducted either over the internet, or acting as a server where computers in a network can remotely connect to, offering multiple matching methods for users and forms for experiments. The computer based experiments were designed using the NFG (Normal Form Game template) from the EconPort (Chen et al., 2003) platform. For Game type, the setting Payoff game was chosen. Here, a standard payoff table was presented to the player with each cell displaying the Row player payoff first and the Column player payoff second Figure 3.4. In this form, players accumulated points during the sessions.

The "Session Parameters" tab allowed for changing experimental settings in three groups: match settings, player pairing, and client display. Match settings allows controlling the settings for:

- **Max number of players**: Specifies the maximum number of players to be allowed in the session. It is not required to set the maximum number of players to run the software. For this setting 12 players were chosen as this was the number of computers available.

- **Match clock**: The value shown in this field will define how much time a player has for making selections during the course of one match. The match clock was set to zero which meant that students had as much time as desired to make a decision.

- **Number of matches**: Specifies the number of matches in an experiment.

Figure 3.4: Game Board template window for the NFG. The board was customised for the study and actual board game is shown below. (*in*: EconPort website)

- **Conversion factor**: Allows the moderator to give a point conversion factor for reporting the player final balance.
- **Match end condition**: This option controls the number of rounds in each match. This condition varies depending on whether a payoff or probability game is specified.

For player matching options only two were used in this study:

- **Constant Pairing**: A non random pairing method where subjects are paired as they connect to the server. Each independent pair automatically begins its first match. Subjects maintain the same opponent in all subsequent matches. This pairing was used for the Face to Face experiments.
- **One-time random pairing**: After connecting to the server, players are randomly matched before beginning. Subjects maintain the same opponent in all subsequent matches. This pairing option was used for the anonymous experiments. The game was limited at 20 rounds.

After the configuration of the experiment, a server was setup with a username and a password which were kept hidden from the students to avoid unwanted

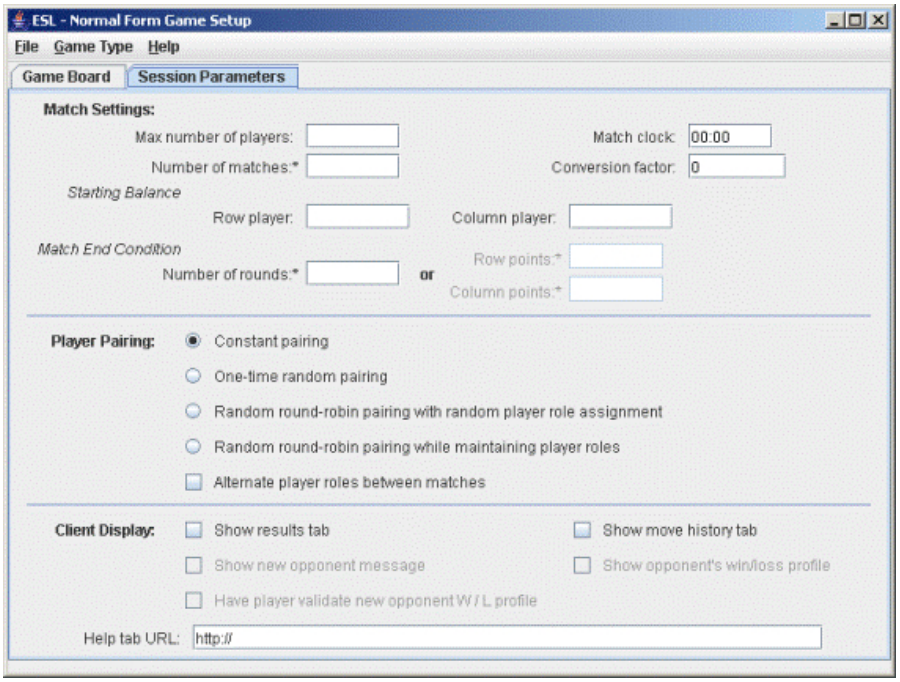

Figure 3.5: Session parameter window (*in*: EconPort website)

access after the experiment was over. For each session, a different instance of the server was run and named after the treatment, grade and class. Start server mode was set to manual. This allowed the experimenter to control the start of the experiment after everyone logged in (Figure 3.6).

3.2.2.3 Experimental Protocol

The experiment was divided into two treatments A and B, and two variants, a non-anonymous and an anonymous. Both were played with the EconPort (Chen et al., 2003) platform with the difference being that the non-anonymous experiments were setup with a constant pairing mode and students were told beforehand who their opponents were. On the other hand, the anonymous experiment was setup with a random pairing mode and students only knew they were playing against one of their colleagues but not which one specifically.

After setting up the server and before students were called in, each of the computers was assigned a random letter from A to Z, printed on a piece of paper and placed on the desktop machine. At every session the letters were randomly re-arranged. After the letters were placed the students were called in and asked to pick a computer at random and sit down. Communication was allowed specifically so that informal observation of the students attitudes prior to the game

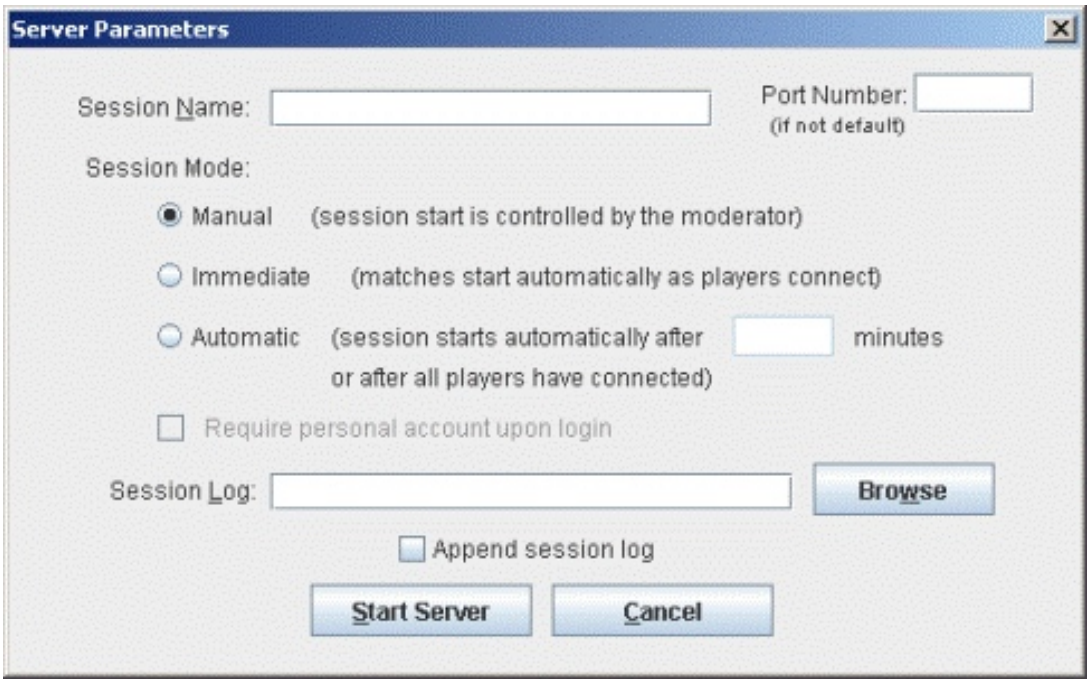

Figure 3.6: Server setup window (*in*: EconPort website)

could be made. After they sat down, an instruction sheet was given that contained the explanation of the game, the rules, the prize attribution system and how to play. This sheet was originally presented in portuguese (see Appendix A section A.1 for original version) and stated the following in english:

Treatment A

- Hello and welcome to this experiment!
- You are going to take part in an economic game that will allow you to win a prize. Your prize in this variant will be awarded according to the following rule:

  You will win 0.05 EUR for every 30 points that you accumulate in a ticket that you can exchange in the school's cafeteria
- Your prize will depend on your choices. You have only two options: strategy **M** and strategy **R**. Each round you will accumulate points that will depend not only on the strategy you choose, but also on the strategy your opponent chooses.
- When you start this experiment you will see the window in Figure 3.7:

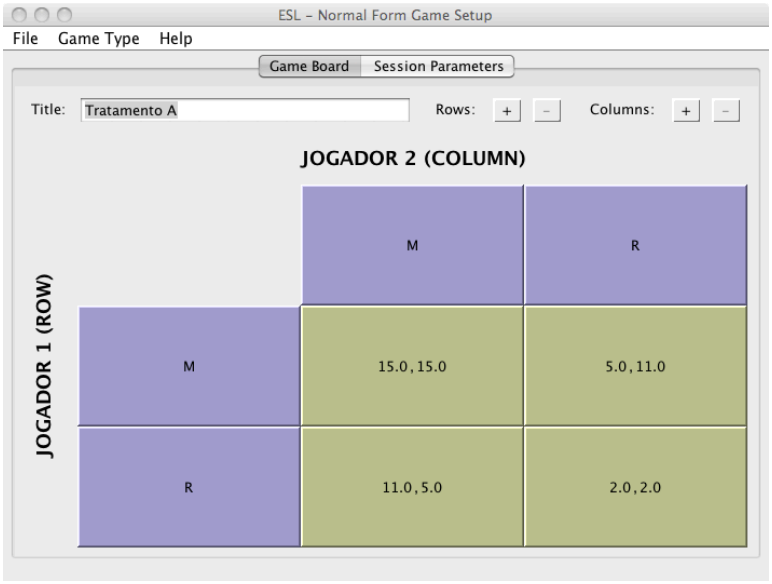

Figure 3.7: Game Template for the Computer Experiments

- This is the game matrix. The computer will let you know which player of the players you are. If it says you are the row player, it means you are player 1 and that your points are at the left of the comma; if it says you are the column player, then you are player 2 and your points are on the right of the comma.

- When the experiment begins, you will be able to click on strategy **M** or strategy **R**. You can take as long as you like to decide, but pay attention, as the choice is final and you can not go back! After you and your opponent have chosen, the computer will send a warning and you can click "continue" to proceed to the next round.

- You can always check how many points you have and what has been played by both of you in the previous rounds by clicking the "history" window

- How do the points work?

  For example, if both of you play **M**, then you each win 15 points (15.0, 15.0). If you play **R** and your opponent plays **M**, then you will win 11 points and your opponent 5 (11.0, 5.0). When you finish playing the game, click on the internet icon to answer a quick questionnaire. After that you can get your prize next to the researcher!

- Please pay attention: do not discuss the results of the experiments nor your username to your colleagues so not influence their decisions! This is very important for the results of this experiment.

- Thank you!

For Treatment B, the same text was presented with the students with one exception:

Treatment B

- Hello and welcome to this experiment!
- You are going to take part in an economic game that will allow you to win a prize. Your prize in this variant will be awarded according to the following rule:

  The player with the most points wins 0.50 EUR in a ticket exchangeable in the school's cafeteria.
- (...)

Following the reading of the instructions, a brief explanation of game theory was given. The concept of dilemma was introduced to the students by explaining famous games such as the Prisoner's Dilemma (Poundstone, 1992), the Stag Hunt (Skyrms, 2003) and the Snow Drift (Rapoport & Chammah, 1966). This helped in the children's comprehension of the experiment they were participating in and what it was for. After all explanations were given students were explained the following rules:

- Please log in to the server with your computer's letter and class identifier (e.g. A-8G; B-10D, etc.).
- Stay quiet during the experiment and keep still until every student has finished playing the game.
- Any questions raise your arm.
- A window just like the one in the instructions sheet will appear in the computer. After you decide what strategy to play click the square with your strategy choice.
- After your opponent has played, a Continue button will appear on the screen. Press the button to continue to the next round.
- repeat the procedure until the game over screen appears.
- After you have finished playing the game, please go to you web browser and fill in the questionnaire. After you answered all questions press submit.

3.2.3 The Dictator game experiment

3.2.3.1 Subjects and Location

The participants of this study were 54 children from 1st to 3rd grade with ages from 6 to 8 years old from the Sylvia Philips Basic School in Carnaxide. Of these, 27 participated has dictators and the other 27 participated as receivers.

3.2.3.2 Experimental Protocol

This part of the study consists in an experiment designed to understand whether children in earlier stages of development understand different strategies when give the opportunity maximise their absolute payoff or maximise the maximum payoff difference relative to an opponent. More accurately, it is a dictator game where a child chooses one out of two prize allocations: In Choice A, he/she wins three "candies" and gives seven to his/her classmate. In Choice B, he/she gets two pieces of candy and only gives one to his/her classmate. This choice is made anonymously so the neither the child who is allocating the prizes knows who he/she is allocating them to, nor does the receiver know who is giving them the candy. This is to control for the fact that children's everyday social relations influence natural choice making. As can be seen from the prize allocation, option A confers the dictator more payoff for being altruistic and option B confers the dictator less payoff but more than the receiver's.

Firstly, the students were instructed on what the game is, what they are distributing and how to proceed during the experiment. The experimental setup will be displayed to the students as a pre-test and the prize allocation set on the table. The student will sit facing the candy he/she is keeping, and with the candy being given away on the opposite side, as can be seen in Figure 3.8.

This table was shown to all participant students. After they examined the table, each student was asked whether they understood how many pieces of candy they got and how many pieces of candy their colleague got. Next, they were asked if they understood that in option A they could obtain more candy for them but less than their colleague, and on the other hand, if they understand that in option B they would get less candy for them but more than their colleague. After the preliminary sections, each student was given a pre-test and allowed to choose either option. After students made their choice, each will was asked individually how many pieces of candy they and their opponent got on the option

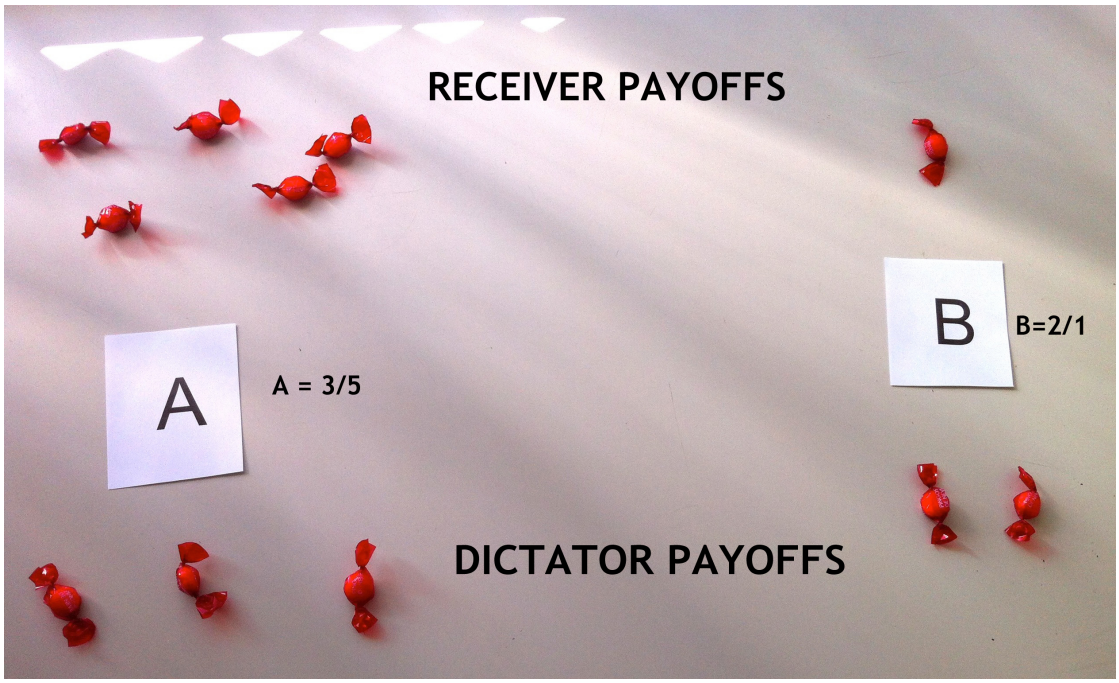

Figure 3.8: Experimental setup for the dictator game

of their choice. Only the students that answered correctly were chosen for the experimental stage.

After all pre-tests were made, students were paired into their dictator/receiver pairs. Children randomly pulled out of a black bag a set of numbers and letters that identified them. Each number and letter had a matching other (known only to the experimenter) to identify pairs of students. This method assured that no personal information would be collected by the experimenter and that the child's anonymity would be maintained throughout. After the children picked their identifiers, they were instructed to keep it secret from their colleagues.

Following this procedure, the experiment was made. Each of the students in the class were lead to a room where the experimental setup was mounted with the candy in full view of the child (Figure 3.8). The following rules were explained to the student:

- You can only choose once and the choice will be final. After you choose we will ask you if you are certain of the choice you made. Only then can you change your mind. After you accept your choice you cannot change it anymore.
- After you made your choice you can collect your candy. Your colleague will receive his/her candy after the game is over.
- You cannot tell your classmates about the choice you made until everyone has

played and received their candy.

- After you made your choice and collected your candy, I'm going to ask you some questions ok?
- Have you got any questions? (give the child some time to reflect) O.K., so let's begin!

After the child made a choice and removed his/her candies, the opponent's candies were placed in an envelope with letter and number corresponding to the dictator that just played. Then, the following questions were asked to the student in portuguese (see Appendix A section A.3 for the original portuguese version) were asked to the child:

1. Why did you choose that way?
2. (If A was chosen) Did you feel you were being nice to your classmate? or did you want more candy for yourself?
   - Fair to my classmate
   - I wanted more candy for myself
   - Both
3. (If A was chosen) Do you think it was fair that for just one extra candy your classmate gets to keep that many?
   - Yes
   - No
   - Other
4. (If B was chosen) Did you pick only two candies instead of three because you wanted to have more candy than your classmate?
   - Yes
   - No
   - Other

5. (If B was chosen) Were you happier that both of you got few candies rather than your classmate having many and you only having three?

- Yes
- No
- Other

After answering the questions, the student was then led back to his class and another student with the dictator role was chosen at random.

After all students finished their choices, the children who were in the receiver role were individually called and their candy was distributed. After they received the candy, they were asked how they felt for having received that amount of candy and if they would reject the offer if they could.

3.3 Statistical Analysis

3.3.1 Binomial Probabilities

3.3.1.1 Binomial Test

The binomial test is an exact test to find the statistical significance of deviations from an expected distribution of observations in two categories, making it especially suitable to test two-strategy game theoretical data. Because the null hypothesis in such a game is that the two strategies are as equally likely to occur, the binomial test is highly suitable. The reason for choosing this rather than the more common Pearson's chi-squared test or the G-test is that the approximation by convenient continuous distributions in large samples breaks down when considering smaller samples, leaving no alternative to the binomial test (Howell, 2007).

3.3.1.2 Binomial Distribution

Assuming the null hypothesis is "players do not play differently Treatments A and B" calculations are made for probability p, in the worst possible scenario, that this hypothesis is confirmed.

Consider that in Treatment A, a given player played strategy max N_A and in Treatment B, the same player played N_B times the strategy max. For simplicity, assume in both cases, a set of N trials. Assume, furthermore, that this player is a q strategist, where q is a number in the interval [0,1], meaning that it plays strategy max with probability q. Therefore, in Treatment A, where the best strategy is given by the strategy $q = 1$, the probability that a better result is obtained with the strategy q is given by

$$F_A(q, N_A, N) = \sum_{i=N_A}^{N} Niq^i(1-q)^{N-i} \cdot \tag{3.1}$$

For game B, where $q = 0$ gives the best strategy, the probability of obtaining a better result with strategy q is given by.

$$F_B(q, N_B, N) = \sum_{i=0}^{N_B} Niq^i(1-q)^{N-i} \cdot \tag{3.2}$$

The probability to have better result in both games is given by the product of F_A and F_B. Finally, P is defined as the maximum, over all possible values of q, of the product of F_A and F_B. Therefore, P is the maximum probability to attain a result as good as the one observed using the same strategy for both Treatments. We consider that the null hypothesis is rejected if $P < .05$.

3.3.2 Binomial Probit Regression Model

A probit model is a type of regression where the dependent variable can only take two values. In this case, the max and min strategies in the game theoretical experiment. The purpose of the model is to estimate the probability that an observation will fall into a specific one of the categories. A probit model is a specification for a binary response model by employing a probit link function estimated using the standard maximum likelihood procedure. The response variable Y is binary, that is it can have only two possible values. We also have a vector of regressors X that are assumed to influence the outcome Y. Here, it is assumed the model takes the form

$$Pr(Y = 1 \mid X) = \Phi(X'\beta), \tag{3.3}$$

where Pr denotes probability, and Φ is the Cumulative Distribution Function

(CDF) of the standard normal distribution with the β parameters being estimated by Maximum Likelihood. Given that data set $y_i, x_i\}_{i=1}^n$ contains n independent units corresponding to the model , then their joint log-likelihood function is

$$\ln \mathcal{L}(\beta) = \sum_{i=1}^{n} \Big(y_i \ln \Phi(x_i'\beta) + (1 - y_i) \ln(1 - \Phi(x_i'\beta)) \Big) \tag{3.4}$$

The equations and description above are based on (Albert & Chib, 1993; Agresti, 2002).

3.3.3 Pearson's Chi-square test

Pearson's chi-squared test (χ^2) is a statistical test applied to sets of categorical data to evaluate how likely it is that any observed difference between the sets could have occurred by chance. It tests a null hypothesis by observing whether the frequency distribution of certain events observed in a sample is consistent with a given theoretical distribution. The events must be mutually exclusive and have total probability of 1. This test is commonly used when comparing categorical variables. For example, comparing the frequency of gender in each of the experiments Treatments. The value of the test-statistic is

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \tag{3.5}$$

χ^2 is Pearson's cumulative test statistic, which asymptotically approaches a χ^2 distribution. O_i is an observed frequency; E_i is the expected frequency as expected by the null hypothesis; and n is the number of cells in a contingency table.

The chi-squared statistic can be used to calculate a P-value by comparing the value of the statistic to a chi-squared distribution. The number of degrees of freedom is equal to the number of cells n, minus the reduction in degrees of freedom, p.

The result form the numbers of degrees of freedom is valid when the original data are multinomial and hence the estimated parameters are efficient for minimising the chi-squared statistic (Greenwood, 1996).

The equations and description above are based on (Greenwood, 1996; Albert & Chib, 1993; Agresti, 2002; Howell, 2007).

All statistical analysis were performed with Microsoft Excel 2011® for Mac

and IBM SPSS 21® for Mac.

3.3.4 Post-Game Interview

The following post game interview was given to the students using the google docs(TM) platform in the portuguese language. After the game was played, students were given a link to the questionnaire and identified themselves via the username given to them when logging on to the EconPort Server (Chen et al., 2003). The interview questions were based on the perception of feelings as described by Jon Elster (1999) in his book *Strong Feelings: Emotion, Addiction and Human Behavior* and the theory of emotional algorithms (Loch et al., 2006a) as explained earlier in Chapter 2 (See Appendix A section A.2 for original portuguese version).

Now that you have finished playing, please answer these questions. After youe chosen all your option, click submit at the end. After that you can collect your prize- Thank You!

- Q1: How old are you?
- Q2: What's your school grade?
- Q3: Are you a?
  1. Boy
  2. Girl
- Q4: Which of the Treatments did you play?
  1. A
  2. B
- Q5: What was your username?
- Q6: When playing, did you think only about the points you were winning or also about your opponent's points?
  1. Only about my points

2. About mine and my opponent's points

- Q7: When playing, did you prefer winning many points, or beat your opponent, regardless of the number of points you won?

  1. I preferred to win many points
  2. I preferred to beat my opponent regardless of the number of points I won

- Q8: When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round?

  1. Always
  2. Never
  3. Occasionally

- Q9: When you won more points than your opponent what did you feel?

  1. Pride
  2. Joy
  3. Justice
  4. Victory
  5. Regret
  6. Shame
  7. Nothing

- Q10: When your opponent won more points than you, what did you feel?

  1. Envy
  2. Sadness
  3. Shame
  4. Contempt
  5. Defeat

6. Justice
7. Resignation
8. Nothing

- Q11: When both you and your opponent won many points together, what did you feel?

1. Envy
2. Sadness
3. Pride
4. Joy
5. Injustice
6. Justice
7. Nothing

- Q12: Did you understand which strategy to play in order to win a prize?

1. Yes
2. No

- Q13: If you knew who your opponent was, would you play the same way? (Ignore if playing face-to-face game)

1. Yes
2. No

- Q14: What was your motivation for participating in the experiment?

1. Win a prize
2. I wanted to participate to know if I could beat my classmates
3. I wanted to participate to please my classmates
4. I wanted to participate to please the teacher

5. I wanted to participate to show that I can win

6. I wanted to participate to occupy my free-time

This study, methodology and application tools were approved by the Portuguese Ministry of Education, Science and Technology's board for Monitoring Research in School Environments with authorisation code 213934500-MIME on 19th of April 2013. Data was collected from 20th of April 2013 through 10th of April 2014. All participating children submitted a consent form signed by their parents or guardians to their director of studies. These documents were passed from the directors of studies to the school board directly and I had no access to them at any time.

4

Much or More: Experiments of rationality and spite in school children

4.1 Introduction

There are many ways to be competitive (as there are many ways to be cooperative, too). The most studied one, both theoretically and empirically, is called "rationality" (maximisation of self-interest). The term rationality traditionally refers to individuals acting towards the maximisation of their own selfish interests, measured by the "pay-off" concept originally introduced in game theory (Neumann & Morgenstern, 1944; Tversky & Kahneman, 1986). In a sense, one compares his/her fate in all possible scenarios and chooses the best possible outcome. However, in most real situations of experimental interest, people compete against each other. Taking as an example an experimental game, where each of two individuals has two strategic possibilities and pay-off functions associated with all possible combinations, a simple maximisation of one's pay-off says nothing about the effect of this decision to the direct competitor's pay-off. If a strategic decision maximises one's pay-off but results in an even higher pay-off for the opponent, then this may be a wrong decision in an environment of direct competition. In fact, mathematical models along these lines are considered the

starting point of the studies of cooperation, as the benefit of one is also a benefit for the other (Chalub et al., 2006; Falk et al., 2005; Hamilton, 1970; Leimar & Hammerstein, 2001; Santos & Pacheco, 2005; Santos et al., 2006; Trivers, 1971). Evolutionary psychology has further explored this by studying the impact that neurological and emotional processes related to altruism and cooperation have on the survival and spread of individuals (Van Lange, 1999; Van Lange et al., 1997; Waal, 1996).

Defined as an act that causes loss of payoff (or any other type of cost) to the opponent, spite may be advantageous in a competitive scenario given certain precise conditions. We will not specify here the full set of conditions that make spite advantageous; we stress however, that rationality (maximisation of own's payoff) and spite (minimisation of other's payoff) are not mutually exclusive.

Humans display many behaviours that could be classified as spiteful and spite is often linked with negative emotional responses to inequity such as envy and jealousy (Berke, 1989; Dufwenberg & Güth, 2000; Salovey & Rothman, 1991; Smith, 1991). Although apparently maladaptive, these behaviours are suited to certain competitive contexts. By comparing payoffs directly with another individual, one could be empowered with the means of assessing the best strategy for obtaining a payoff. Some authors have suggested that this would elicit an "out-compete your neighbour" decision process that would allow exerting just the right amount of effort to succeed in outcompeting rivals (Hill & Buss, 2008). In economics, the process of dumping (where a firm decreases the price of its product, possibly below cost price, intending to drive competitors out of the market) is such an example (Winters, 1991). Humans also commonly display what is known as "last-place aversion". In this case individuals prefer to minimise the probability of being last (for example, in a ranking of income distribution), rather than maximising their own pay-off (Kuziemko et al., 2011). Spiteful behaviour has also been identified in a study where higher-ranking individuals are more likely to spite lower ranking individuals than their peers (Fehr et al., 2008b).

For this study, the starting point was to understand if the propensity for spiteful behaviour was present in children along with the propensity for rationality, or if children displayed these propensities at different stages of their development, ultimately comparing the motivations and the ability of children and teenagers to react to stimuli that induced behaviour in one or the other direction. Namely, the propensity for acting rationally or spitefully was quantified according to age. Spiteful choices (as described above) were reported to arise spontaneously in

about 22% of subjects between 3 to 6 years old in an anonymous ultimatum game ((Fehr et al., 2008a; Fehr et al., 2013) and appeared more often than chance at ages 5 to 8 in a face-to-face experiment designed to replicate studies of altruism in chimpanzees (House et al., 2012). Using the dictator game, other studies reported that younger children tended to be more selfish and that pro-social choices increased as children became older (Fehr et al., 2008a; Harbaugh et al., 2003; Hook & Cook, 1979). In the dictator game, the proponents were assumed to be interested in maximising their own pay-off; however, their observed behaviour frequently contradicted this assumption. One possible explanation was that participants took into account other's pay-offs (Camerer, 2003). This was confirmed by the studies of Benenson et al. (2007) and Knight & Kagan (1977), where competitive behaviour among children arose substantially by 9 years of age. It was suggested that children with better fluid cognitive skills were more likely to be spiteful (Bügelmayer & Spieß, 2011). These findings can also be argued as likely related to the improvement in children's ability of calculating proportionality (Kagan & Madsden, 1972; Streater & Chertkoff, 1976; Toda et al., 1978), a reasoning that echoes Piaget's work on child developmental stages (Piaget, 1965 (1932)).

In this sense, the present chapter aimed at comparing strategic choices in children within a competitive scenario. Unlike most studies that focused on spite (Foster et al., 2001), comparing this behaviour with that of altruism, this chapter presents a comparison of spite and rationality (in the sense of pay-off maximisation) in a competitive environment. For that effect, a face-to-face game was used to assess how children behaved competitively when presented with the following dilemma: (i) maximising pay-off and incurring in the risk of having a pay-off lower than the opponent, or (ii) deciding not to maximise pay-off while, on the other hand, guaranteeing that it is not smaller than the opponent's pay-off. The game was presented in two treatments. In the first one (A), a prize was given to both players, proportional to their accumulated pay-off; in the second one (B), a prize was given to the player with the highest pay-off. Therefore, the optimal strategy was different in each treatment; in the first case the rational strategy maximised the expected value of the prize, while, in the second, this was obtained by the spiteful strategy.

Psychological research on motivation tends to be made via eliciting responses from subjects to questions raised by researchers. Despite this, economics research tells us that individuals might not be properly motivated to provide accurate responses without material incentives (Fan, 2000). In this sense, the stimuli for the children behaviour, spiteful or rational, in this experiment, was assumed to be a

consequence of the material incentive (although its monetary value was largely symbolic).

The game was designed such that rational players would choose the maximising strategy; nonetheless, they risked having a pay-off lower than that of the opponent. Alternatively, spiteful players would choose the spiteful strategy, reducing their own payoff but still managing to reduce opponent payoff even more. We expected that players would learn the best strategy and converge to the Nash equilibrium (Nash, 1950) in Treatment A (both players playing rationally) and to the non-Nash (spiteful) equilibrium (both players playing spitefully) in Treatment B, ultimately playing different strategies in Treatments A and B. It was also predicted that older children would be better at devising the optimum strategy than younger children.

4.2 Materials and Methods

4.2.1 Participants

In order to remind the reader, a summarised version of the materials and methods will be given in this section. Participants were 350 children and teenagers that played the spite game throughout 175 sessions, as each individual participated only once (See Table 4.1 for descriptive frequencies).

Each session was composed of a 5-round game with the payoff matrix in Figure 3.2 explained in Chapter 3. Students participated voluntarily and no personal information was collected either from students or teachers other than date of the experiment, age and class year of participants. To ensure that the children did not feel any pressure towards a certain action due to the presence of university researchers, we presented the teachers with the tools to perform the experiments. For that purpose, the teachers of 6 schools were given a crash course in game theory history, economic experiments and the practical execution of the experimental protocol during March 2010. The schoolteachers then chose the appropriate date to run the experiments, which ranged from March to June, 2010[1]

The experiment required 4 playing cards per student, two with red backs and

[1]The basis for this decision was mainly logistical, as the availability of students and teachers was not known until very close to the date of the experiment itself due to time constraints from teachers and students alike.

Table 4.1: Descriptive frequencies. Frequencies described are after participants removal

Treatment		Frequency	Percent
	A	178	50.9
	B	172	49.1
	Total	350	100
Age			
	10	13	3.7
	11	5	1.4
	12	88	25.1
	13	96	27.4
	14	44	12.6
	15	49	14
	16	51	14.6
	17	4	1.1
	Total	350	100
Grade			
	5th Grade	20	5.7
	7th Grade	150	42.9
	8th Grade	94	26.9
	10th Grade	86	24.6
	Total	350	100
School			
	Ribeira Grande	258	73.7
	Roberto Ivens	16	4.6
	Laranjeiras	42	12
	Lagoa	8	2.3
	Antero de Quental	26	7.4
	Total	350	100

two with black backs. Each student received one card of each colour. Red corresponded to max and black to min in the payoff matrix. It is important to note that the terminology max and min was never used during the training or during the experiments. In each class, the schoolteachers divided the children into A and B. Each of the pairs in these groups played the game corresponding to their group letter in the experiment for five rounds. After each pair of students went to their respective group, the teacher handed each of them a score sheet with the payoff matrix and their respective cards (see chapter 3 for details)(which means students had access to it during the entire duration of the experiment).

As was stated previously, the prize in Treatment A was given proportionally to the points obtained by each player with 15 points equaling 1 piece of candy. On the other hand, in Treatment B the prize was given to the player with the

highest score. The payoff consisted of a small, but high valued chocolate (with a proximate monetary value of three candies), which was split in half in case of a tie.

After this information was given and when there were no doubts regarding procedure of the experiment, the game began.

4.2.2 Statistical analysis breakdown

Statistical analysis in this experiment was made via binomial distribution probabilities, binomial tests and Probit regressions. For the binomial distribution probabilities, the null hypothesis was "players do not play differently in Treatments A and B", and probability P was calculated to confirm or disprove this hypothesis. We referred to the strategies of a given player in a given treatment by a number q in the interval [0,1], if, in that game, he/she played strategy max with probability q. Furthermore, we called N_A the number of times that a given player played strategy max in Treatment A and N_B the number of times the same player played strategy max in Treatment B. The total number of trials was given by N. (In this sense, he or she played strategies N_A/N and N_B/N, for treatments A and B, respectively). P was defined as the maximum, over all possible values of q, of the product of F_A and F_B. Therefore, P was the maximum probability of attaining a result as good as or even better than the one observed using the same strategy for both Treatments (see chapter 3 for equations and further detail).

After this analysis, the strategies being played in each Treatment were tested via binomial tests to assess if children were trying to maximise the absolute or relative pay-off (i.e., if they were playing as rational or spiteful players) and rounds were combined to analyse differences in total min and max plays between the two different Treatments. Afterwards, Probit Regression analysis was made on each round as a dependent variable in order to understand whether children were making their decision based on their age, grade, school, previous rounds and payoffs and relative payoffs.

4.3 Results

In the first analysis, the results showed seven significant cases, four of which with $P < .01$. 5th graders played different strategies in Treatments A and B in the first round; 8th graders played different strategies in rounds 1, 3 and 4 with

a probability greater than chance and 10^{th} Graders played different strategies in rounds 1, 3 and 4 with a probability greater than chance. In Table 4.2 players were considered to adopt the same strategy in both Treatments (H_0). Here, maximum probability that, under the H_0, a better result is obtained in both Treatments is shown (note that it is always possible, under the H_0, to obtain a better result in at least one Treatment). Bold text denotes significant results. Despite these results not showing which strategy was used for each Treatment, they suggested that older children understood better that each one induced strategic differences.

Table 4.2: P-values of the Binomial cumulative distribution for both games simultaneously. Exact P-values are displayed. Bold denotes significant results.

	Round 1	Round 2	Round 3	Round 4	Round 5
5th Grade	**0.018**	0.58	0.34	0.18	0.45
7th Grade	0.16	0.53	0.63	0.08	0.89
8th Grade	**0.05**	0.25	**0.04**	**0.05**	0.28
10th Grade	**0.006**	0.07	**0.004**	**0.004**	0.31

The following question was whether or not children were playing the correct strategy for each Treatment. Therefore, probability p_A of playing optimum strategy max in Treatment A and probability p_B of playing optimum strategy min in Treatment B was computed(see Table 4.3). Here, 5th and 8th graders correctly played the max strategy in round 1 of Treatment A, but only 8th graders played the correct strategy min in round 3 of Treatment B. Children in the 10th grade played the correct strategy max in rounds 1 and 3 of Treatment A and the correct strategy min in round 4 of Treatment B. Results were not conclusive, but indicated that rational behaviour was more easily understood than spiteful behaviour.

Although most cases did not show that children played different strategies significantly, a binomial test was applied to all years and rounds to understand what strategies were being played in each occasion. For Game A, 5th Grade children played max (with probability p_{max}; we also define $p_{min} = 1 - p_{max}$ the probability that the children play min) more often than chance in Round 1 ($N = 46, P < 0.01$), 78% of the time, while the rest of the rounds were non-significant (Round 2, $p_{max} = 0.48$; Round 3, $p_{max} = 0.37$; Round 4, $p_{max} = 0.39$; Round 5, $p_{max} = 0.52$). Seventh Graders had two rounds where they played max more often than chance: Round 1 ($N = 78, P < 0.01$), 67% of the time and Round 5 ($N = 78, P < 0.05$) 64% of the time. The remaining rounds were non-significant

Table 4.3: Probabilities of Playing (max) in Treatment A (p_A) and (min) in Treatment B (p_B). Bold text denotes significant results for the binomial test of each Treatment

Grade	Round	p_A	p_B
5th	1	**0.92**	0.5
8th	1	**0.57**	0.56
	3	0.5	**0.64**
	4	0.57	0.56
10th	1	**0.77**	0.45
	3	**0.7**	0.55
	4	0.57	**0.76**

(Round 2, $p_{max} = 0.51$; Round 3, $p_{max} = 0.47$; Round 4, $p_{max} = 0.44$). 8th Graders had no significant results (Round 1, $p_{max} = 0.57$; Round 2, $p_{max} = 0.52$; Round 3, $p_{max} = 0.50$; Round 4, $p_{max} = 0.57$; Round 5, $p_{max} = 0.50$). 10th Graders played max more often than chance in two rounds: Round 1 ($N = 44, P < 0.01$), 78% of the time and Round 3 ($N = 44, P < 0.05$) 70% of the times. Remaining results were non-significant (Round 2, $p_{max} = 0.50$; Round 4, $p_{max} = 0.57$; Round 5, $p_{max} = 0.48$).

For Game B, 5th graders also played max (the incorrect strategy) more often than chance in Round 1 ($N = 88, P < 0.01$), 73% of the time, with the remaining rounds being non-significant (Round 2, $p_{max} = 0.55$; Round 3, $p_{max} = 0.60$; Round 4, $p_{max} = 0.56$; Round 5, $p_{max} = 0.45$). Nonetheless, there are more max than min plays for this year, indicating a preference for maximisation regardless of the type of game being played. For the 7th Grade, we also see the same trend as the previous result with Round 1 with children playing max more significantly than by chance 63% of the time ($N = 72, P < 0.05$) and remaining rounds non-significant (Round 2, $p_{max} = 0.57$; Round 3, $p_{max} = 0.44$; Round 4, $p_{max} = 0.56$; Round 5, $p_{max} = 0.53$).

Eight Graders ($N = 88$) also maintained the trend of non-significant results seen for game A, although there was a tendency towards playing more min than max strategies (Round 1, $p_{max} = 0.44$; Round 2, $p_{max} = 0.50$; Round 3, $p_{max} = 0.36$; Round 4, $p_{max} = 0.44$; Round 5, $p_{max} = 0.42$).

For the 10th Grade, there is only one significant result where players played min more often than chance in Round 4 ($N = 42, P < 0.01$), 76% of the time. None the less, this year continues the same tendency as the 8th Grade, with all other rounds (with the exception of round 1) having more min than max strategies played (Round 1, $p_{max} = 0.55$; Round 2, $p_{max} = 0.38$; Round 3, $p_{max} = 0.45$;

Round 5, $pmax = 0.48$).

The next set of results aimed at understanding which factors influenced children's decisions. For that effect, Probit regressions were calculated where each round was the dependent variable, followed by a Type III intercept model with Age, Grade and School as constant independent factors and each round adding the previous round and payoffs as factors. For Treatment A, min was modelled as the response category and max as the reference category. For Round 1 of Treatment A, Age, Grade or School did not influence children's min responses. In Round 2, Round 1 and Payoffs of Round 1 influenced children's min responses (Round 1 Wald's chi$_{(1)}$ = 7.949, $P < 0.05$; Payoff 1 Wald's chi$_{(1)}$ = 3.611, $P < 0.05$). For Round 3 both Round 1 and Round 2 proved to influence children min responses, (Round 1 Wald's chi$_{(1)}$ = 7.133, $P < 0.05$; Round 2 Wald's chi$_{(1)}$= 4.835, $P < 0.05$). For Round 4, payoffs of Round 1 and 2 influenced children's min responses significantly (Payoff Round 2 Wald's chi$_{(1)}$ = 12.032, $P < 0.01$; Payoff Round 2 Wald's chi$_{(1)}$ = 10.396, $P < 0.01$). Finally for Round 5, only min plays in Round 1 influenced children's behaviour (Wald's chi$_{(1)}$= 4.466, P < 0.05). For Treatment B, the same procedure was used but instead, max was modelled as the response and min as the reference category. Here, very few significant influences were found. For Round 1, an influence of Grade in the max responses to min plays was found (Wald's chi$_{(3)}$ = 6.905, $P < 0.05$). In Round 3, School influenced the max responses (Wald's chi$_{(3)}$ = 9.658, $P < 0.05$), however, this result can be readily explained by the skewness of the sample with one school clearly dominating. Finally, Round 4 presented an influence of the Payoff of Round 1 in max responses (Wald's chi$_{(3)}$ = 4.036, $P < 0.05$).

After this analysis, only absolute and relative payoffs were considered as factors. Interestingly, the results were unexpected as Treatment A revealed that relative payoffs were a major influence in children's decisions, especially in rounds 2 and 3 (see Table 4.4).

Table 4.4: Azores Treatment A Probit regression. Wald Chi Square and P-values for relative and absolute payoffs with rounds as dependent variables

Dependent	Factors	Wald's Chi square	df	P
Round 2	Rel. payoff Round 1	7.473	2	0.024
Round 3	Rel. payoff Round 1	11.896	2	0.003
	Rel. payoff Round 2	11.108	2	0.004
Round 4	Abs. payoff Round 1	4.277	1	0.039
Round 5	Rel. payoff Round 4	9.777	2	0.008

For Treatment B on the other hand, only two significant results were obtained (Round 4 as dependent and Payoff of Round 1 as factor:Wald's chi$_{(1)}$= 7.171, $P <$ 0.05; and Round 5 as dependent and Payoff of Round 3 as factor Wald's chi$_{(1)}$ = 3.988, $P <$ 0.05). Finally, the overall trend in min and max plays was determined. For that effect all rounds were combined into a single variable and a bar chart was plotted (Figure 4.1) that shows total min and max plays separated by Treatment and binomial proportions were calculated to understand if the differences between max and min were significant.

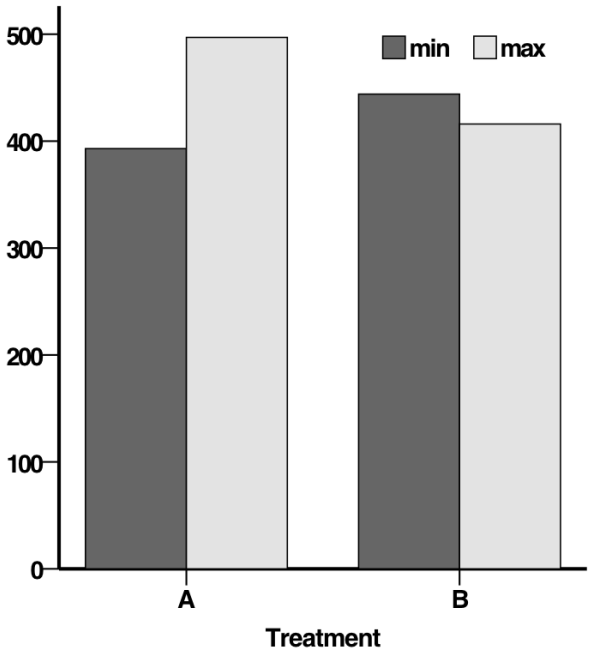

Figure 4.1: All rounds combined max and min plays for Treatments A and B. Binomial tests Treatment A: max proportion = 0.56, min proportion = 0.44, $P <$ 0.001; Treatment B: max proportion = 0.48, min proportion = 0.52, $P = n.s.$

4.4 Discussion

At first glance, the results showed that younger children did not understand that there were strategic differences in the Treatments as overall they seemed to adopt the exact same strategy in both, despite not being in their own interest to do so; while older children understood that both Treatments had different strategies. The data also pointed towards younger children (5th to 7th grade) tending to play rationally more than spitefully and teenagers (10th Graders) tending towards rationality when it was best for them and for spiteful strategies when the latter were more advantageous.

We also found that more children played max in Round 1 of Treatment A then slowly reversed their strategy, and that fewer children started with min in Round 1 of Treatment B then slowly increased this strategy. However, Probit analysis revealed that spiteful strategies were more common when they were not advantageous. This could mean that the children perceived treatment A across all grades as a collaborative effort, and min responses triggered reciprocal behaviour, maybe as punishment for a non-collaborative action or simply as a spiteful action, where a child preferred to win against the other at the cost of points that could result in fewer candies. In fact, we found similar patterns between what children played in our experiment and the strategy of win-stay lose-shift Nowak1993. Despite the max strategy being the rational one, probability of playing min in any Round was highly influenced by both min plays and payoffs of previous Rounds. This effect could be explained by a feeling of envy towards the other player's pay-off or some other effect that drove children to reduce the effective max plays after they started playing correctly. This explanation relates to previous findings that claim that socialisation practices that affect human altruistic and competitive behaviour impact at similar ages and that the circumstances that drive each of these behaviours are learned with age (Benenson et al., 2007). In Treatment B, grade was influential in the decision of playing max in the first round, meaning that older, more rational children were better at a competitive game than younger children. In this Treatment, reciprocal behaviour was not observed apart from Round 4 with a minor influence from the Payoff of Round 1.

4.5 Conclusion

It is clear that children responded to other's pay-offs in different ways in each Treatment. Inequity aversion played a bigger role in Treatment A, with children that had negative relative payoffs retaliating in the following rounds with spiteful strategies. Our results point toward spiteful preferences being present when children directly played against each other. Psychologically, spite is often linked with negative emotional responses to inequity such as envy (Ben-Ze'ev, 1992; Salovey & Rothman, 1991; Smith, 1991). Envy and spite are negatively charged concepts that have been considered maladaptive (Hamilton, 1970; Hill & Buss, 2008). However, these responses to inequity might play an important role in human development. In this sense, spiteful participants could be better equipped to cope with competitive environments, especially when pitched against efficiency-minded and inequality-averse participants as was shown by Balafoutas et al.

(2012). Nonetheless, it must be acknowledged that other effects might have influenced the children behaviour. One possibility is that the participants' gender might have impacted on how teenagers played. Also, despite the original design comparing behaviour in two competitive environments, children's desire to fight for status and reputation might have been different in both Treatments, against initial assumptions.

After the preliminary results of the Azores experiment, the influence of anonymity and location will be considered in the next chapter. A post-game questionnaire will also be conducted in order to understand children's thought processes during the experiment and hopefully better explain the results at hand[2].

[2]This chapter is a modification of the paper published in *North American Journal of Psychology*, (2014), Vol. 16, No.1, 163-178 by André F. d'Almeida, Ricardo C. Teixeira and Fabio A. C. C. Chalub

5

Anonymous Computer experiments

5.1 Introduction

The results presented in the previous chapter were the prequel of this thesis, so to speak. The Azores study laid the foundation for considering the spite game as a novel premise in experimental game theory. The main conclusions were that younger children preferred to play max strategies in both treatments and that older children understood (albeit not clearly) that they should use different strategies for each treatment (d'Almeida et al., 2014). However, as it was seen, the methodological approach needed extensions mainly when considering the amount of variables to be considered in analysis.

This new chapter proposes just that. Firstly, applying a computer based approach rather than a pen-and-paper approach not only brought the study closer with most experimental game theory research, but also made it easier to replicate. Secondly, increasing the amount of variables being analysed - for example including gender and also the children's own opinion on how they felt when they were playing and why they were playing a particular way - increased both the quality and interpretative power of the data.

5.2 Methodological Breakdown

Because the statistical tests used are many and complex, the reader would certainly have a difficult time remembering all that was explained in the methodology section. For that reason, this section provides a breakdown of the methods used in this chapter. The following subsections will provide a brief description of what each test is analysing and why. At the end of the section, a flow chart (Figure 5.1 will be provided for easy reference.

5.2.1 Descriptive statistics

This test will provide the frequencies of the sample, means and standard deviations. It will be divided by Treatment, Grade, Age and Gender. These data will be compared with the municipalities official statistics on the school population and will be presented through tables and histograms.

5.2.2 Binomial tests

The binomial tests will be performed on the following data: i) binomial test per grade, per round; ii) binomial test per age, all rounds combined; iii) binomial test per grade, all rounds combined; iv) binomial test per gender, all rounds combined .

5.2.3 Line plots and bar charts

In order to better visualise trends in the data, line plots and bar charts were plotted on how each grade, age and gender performed during the 20 rounds, comparing each of the categories within these variables.

5.2.4 Probit model analysis

As referred in section 3.3 of the materials and methods chapter, Probit regression models test the probability of a certain variable predicting one of two binomial responses. This is useful as it describes how certain variables may influence how children play. In order to do that, a test variable is selected. In this case,

each round was selected as the dependent variable because I wanted to understand whether I could predict a certain strategy play given children's age, gender, grade, strategy play in the previous round, and both payoff and relative payoff of the two previous rounds. This allowed understanding whether it is possible to predict a player's move based on the previous rounds strategies or if there are other variables at work swaying a child's strategy choice. The reason for only considering the two previous rounds is because adding parameters would mask each individual factor or covariate's influence, under-representing their weight in the model

5.2.5 Previous round analysis

This analysis aims at identify how children respond to both their opponent's and their own strategy choice in the previous round. First, I coded the responses of each individual to their opponent's choice in the previous round and performed a χ^2 test on all three categories to understand if the results were random (H_0) or if there was a significant deviation from a random distribution (H_1).

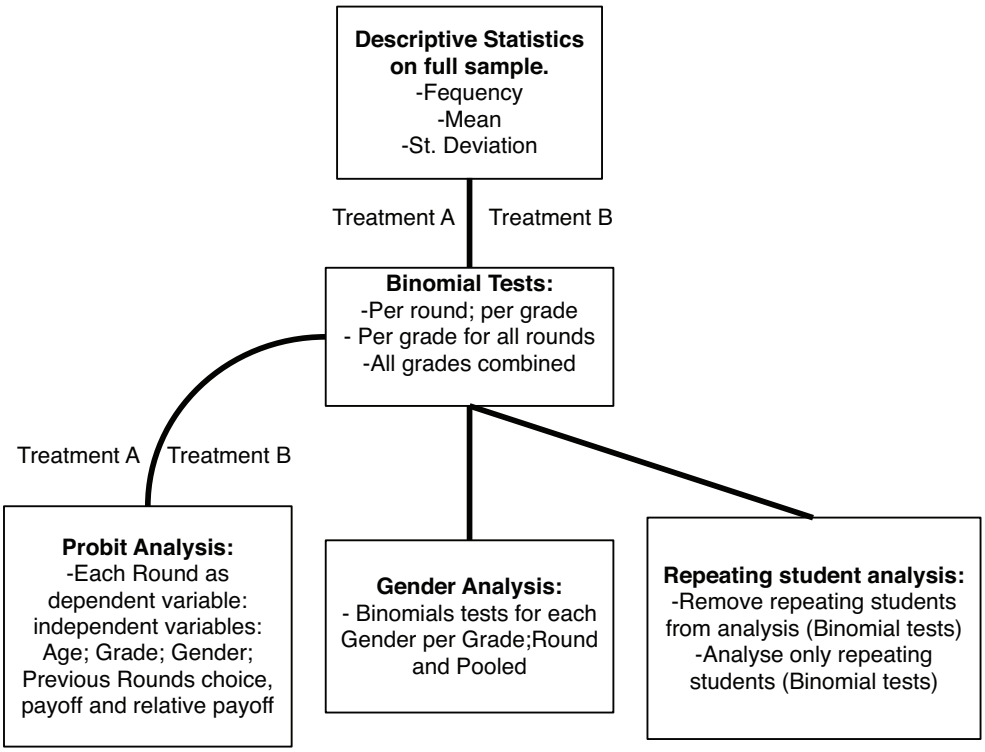

Figure 5.1: Methodology flow chart.

5.3 Results: Sample frequencies

Table 5.1: Anonymous experiment frequency table. Total frequencies and percentages for both treatments, Gender, Age and Grade.

Treatment		Frequency	Percent
	A	116	52.7
	B	104	47.3
	Total	220	100
Gender			
	Female	104	47.3
	Male	116	52.7
	Total	220	100
Age			
	11	2	0.9
	12	19	8.6
	13	32	14.5
	14	42	19.1
	15	36	16.4
	16	31	14.1
	17	23	10.5
	18	20	9.1
	19	10	4.5
	20	4	1.8
	22	1	0.5
	Total	220	100
Grade			
	7	40	18.2
	8	30	13.6
	9	40	18.2
	10	54	24.5
	11	34	15.5
	12	22	10
	Total	220	100

The total sample size for the anonymous experiment comprised 220 students divided into two treatments A and B(table 5.1, with 52.7% and 47.3% respectively. Comparing with the school's total population, the anonymous sample used in this study comprises 30.55% of the total school population. In terms of gender, the distribution is similar to that reported by the Oeiras municipality demographic handbook (CMO, 2011) with 52.7% Males and 47.3% Females. When looking at age distributions (Figure 5.2), the data fit a poisson curve with a median=15. The Median presented in this study is similar to what is reported in

the Oeiras municipality demographic handbook (CMO, 2011). When looking at the distribution of grades, we see that there is a greater representation of 7th, 9th and 10th Grade students, comprising 18.2%, 18.2% and 24.5% of the sample, respectively.

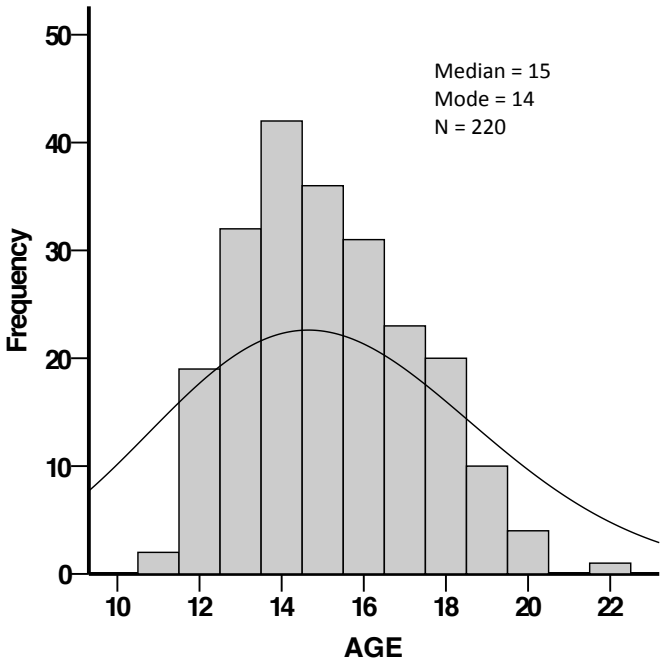

Figure 5.2: Age distribution histogram for the anonymous study sample. The sample presents a poisson distribution curve with Median = 15, Mode = 14, Skewness = 0.417 and St. Error of Skewness = 0.164.

5.4 Results: Treatment A

5.4.1 Binomial tests per grade

In this section I analysed how children responded in Treatment A. As the reader may be reminded, both children needed to play strategy max in order to maximise their probability of winning a prize in this treatment. In this context the max strategy is in essence mutualistic[1], as it involves two individuals aligning their selfish interests with each other.

Here rounds were separated into variables and binomials calculated for each grade with random threshold set at 0.5. Table 5.2 below, summarises the results

[1]Note that a mutualistic interaction is not to be confused with a cooperative action, as in the former there is no loss of payoff, or "sacrifice" for the benefit of a third-party.

of the binomial tests. Here, children responded well to this treatment across all grades, with the exception of the 8th, 9th and 12th Grades. Nonetheless, it is noteworthy that all grades played significantly more max above the random threshold in the first Round of the game (7th Grade N=20, max prop.= 0.90; 8th Grade N=12, max prop.= 0.83; 9th Grade N=22, max prop.= 0.73; 10th Grade N=30, max prop.= 0.77; 11th Grade N=22, max prop.= 0.73; 12th Grade N=10, max prop.= 0.90). This means that in this Round, children were not playing randomly as their strategy choices were significantly different from the random test proportion of 0.5.

Table 5.2: Treatment A Binomial test exact *P* values. Bold denotes significantly more max plays, asterisks denote significantly more min plays

	7th	8th	9th	10th	11th	12th
Round 1	**P = 0.000**	**P = 0.039**	**P = 0.052**	**P = 0.005**	**P = 0.052**	**P = 0.021**
Round 2	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 3	*n.s.*	*n.s.*	*n.s.*	**P = 0.099**	*n.s.*	*n.s.*
Round 4	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 5	*n.s.*	*n.s.*	*n.s.*	*n.s.*	**P = 0.052**	*n.s.*
Round 6	*n.s.*	*n.s.*	*n.s.*	**P = 0.043**	*n.s.*	*n.s.*
Round 7	**P = 0.041**	*n.s.*	**P = 0.017**	*n.s.*	*n.s.*	*n.s.*
Round 8	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 9	**P = 0.041**	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 10	**P = 0.041**	*n.s.*	*n.s.*	*n.s.*	*n.s*	*n.s.*
Round 11	*n.s.*	*n.s.*	*n.s.*	**P = 0.099**	*n.s.*	*n.s.*
Round 12	**P = 0.041**	*n.s.*	*n.s.*	*n.s.*	*n.s.*	**P = 0.021**
Round 13	*n.s.*	P = 0.039*	*n.s.*	*n.s.*	*n.s.*	**P = 0.021**
Round 14	**P = 0.012**	P = 0.039*	*n.s.*	*n.s.*	**P = 0.004**	*n.s.*
Round 15	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 16	**P = 0.012**	*n.s.*	*n.s.*	**P = 0.099**	**P = 0.052**	*n.s.*
Round 17	*n.s.*	*n.s.*	*n.s.*	*n.s.*	**P = 0.052**	*n.s.*
Round 18	**P = 0.041**	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 19	*n.s.*	*n.s.*	*n.s.*	*n.s.*	**P = 0.04**	*n.s.*
Round 20	**P = 0.003**	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*

7th graders were the overall best performers on this treatment playing max in nine out of twenty rounds (N=20, Round 1: max prop.=0.90; Round 7: max prop.=0.75; Round 9: max prop.=0.75; Round 10: max prop.=0.75; Round 12: max prop.=0.75; Round 14: max prop.=0.80; Round 16: max prop.=0.80; Round 18: max prop.=0.75; and Round 20: max prop.=0.85) significantly different from random. 8th graders on the other hand did not fair as well, with only three rounds with significantly different from random strategy plays, playing more min than

max strategies on two of them (N=12; Round 1: max prop.=0.83; Round 13: min prop.=0.85; Round 14: min prop.=0.85. 9th graders also followed this trend and only played correctly in two rounds (N=22, Round 1: max prop.=0.73; Round 7 max prop.=0.77).

10th graders also performed relatively well with five Rounds having significantly more max plays (N=30, Round 1: max prop.=0.77; Round 3: max prop.=0.67) than random, along with 11th graders with seven rounds with max plays above the random threshold (N=22, Round 1: max prop. 0.73; Round 5: max prop.=0.73; Round 10: max prop.= 0.52; Round 14: max prop.=0.82 ;Round 16: max prop.=0.73; Round 17: max prop.=0.73; Round 19 max prop.=0.82). Finally, 12th graders only displayed 3 Rounds where strategy plays were significantly different from random , albeit proportion of max plays was very high ($N = 10$, Round 1: max prop.= 0.90; Round 12: max prop.=0.90; Round 13: max prop.=0.90).

5.4.2 Binomial tests per grade and per year, all rounds combined

For this analysis, I wanted to understand the trend in overall max plays for each grade and age. For that, I performed a binomial test on the total amount of max and min plays for each grade and age and plotted a line graph with the proportion of max plays in the Y axis and grade in the X axis (Figure 5.3), and one with age (Figure 5.4) on the X axis, correcting differences in sample size.

In Figure 5.3), we see the same trend as in the round separation analysis. The best performers were 7th graders (N=400, P<0.001) playing max 69% of the time. There is a drop in performance with 8th graders (N=240, $P = n.s.$) and 9th Graders (N=440, $P = n.s.$) playing max 56% and 55% of the time respectively. Finally, 10th (N=640), P<0.001, 11th (N=440, P<0.001) and 12th Graders (N=200, P=<0.05) performed relatively well playing max 60%, 67% and 61% of the time.

A similar pattern emerges in Figure 5.4, but now it is possible to pinpoint the ages responsible for the performances in their respective grades. Twelve year olds played max strategies 69% of the time (N=120, P<0.001) while thirteen year olds played max 67% of occasions (N=320, P<0.001). Fourteen year olds choices were non-significant and fifteen year olds chose it 56% of the time (N=480, P<0.05). Sixteen (N=340, P<0.001), seventeen (N=260, P<0.001) and eighteen (N=260, P<0.001) year olds also behaved more often than random as maximisers, with 64%, 65% and 61% of max plays, respectively.

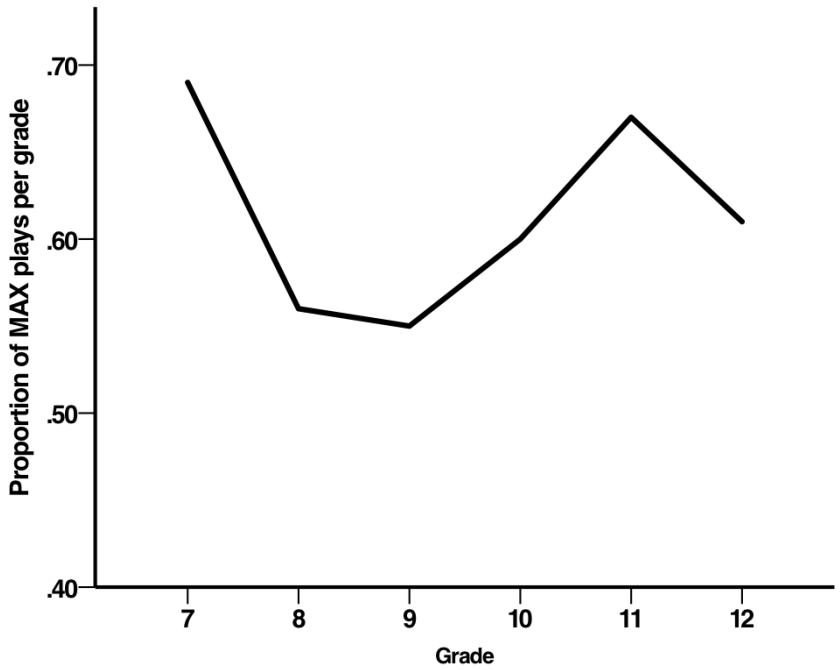

Figure 5.3: Proportion of total max plays per grade, Treatment A.

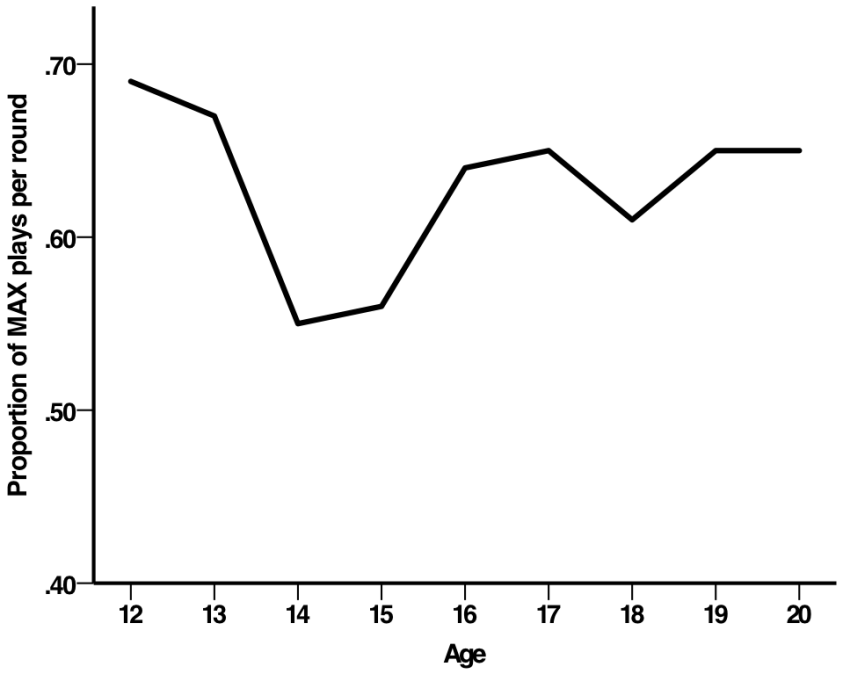

Figure 5.4: Proportion of total max plays per age, Treatment A.

5.4.3 Overall strategic behaviour per round, all players combined

In the previous subsections I analysed the behaviour of each grade and year group and found that, overall, students behave as expected in Treatment A. None the less, another question remained as how they behaved throughout the 20 rounds when all plays were considered. Figure 5.5 below shows that the majority of students start out playing max, but then the amount of plays plunders (although never below 50%). However, it remains fairly stable throughout the 20 rounds (with the exception of Round 13) only varying between 5 and 10%, always above the 50% threshold. In Round 20, a phenomenon typical in game theoretical studies (Axelrod & Hamilton, 1981) can be seen with last round effects pushing the amount of max plays to 67%.

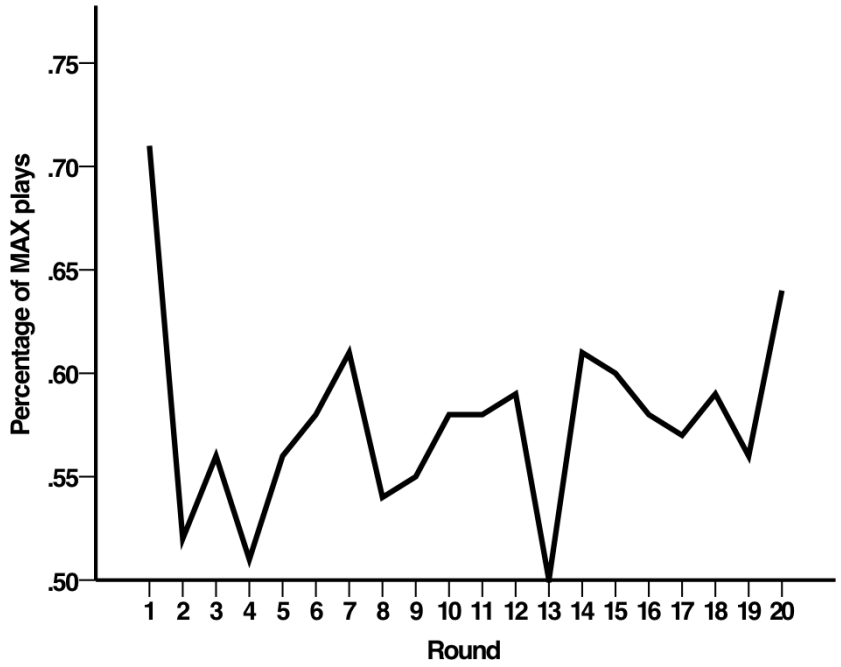

Figure 5.5: Percentage of total max plays during 20 Rounds. Y axis starts at 50% threshold for random playing. Binomial P levels: R1- P<0.001; R2- $P = n.s.$; R3- $P = n.s.$; R4- $P = n.s.$; R5- $P = n.s.$; R6- P<0.05; R7- P=0.001; R8- $P = n.s.$; R9- $P = n.s.$; R10- P<0.05; R11- P<0.05; R12- P<0.05; R13- $P = n.s.$, R14- P=0.001; R15- P<0.05; R16- P<0.05; R17- P<0.05; R18- P<0.05; R19- $P = n.s.$; R20- P<0.001.

5.4.4 Binomial tests for total strategy plays

The last analysis made clear that children comprehended the logic behind the max game in that a large proportion of students played this strategy non-randomly. When combining all grades and all rounds and analysing the total

number of moves played by all students in this treatment, it is clear that students played max 61% of the time above the random threshold with $P < 0.001$ (Figure 5.6). This means that, of the 2360 plays in Treatment A, 1445 were max. Overall, children responded very well to this Treatment and played the correct strategy more often, which shows that there was a clear comprehension of the game's instructions and objectives.

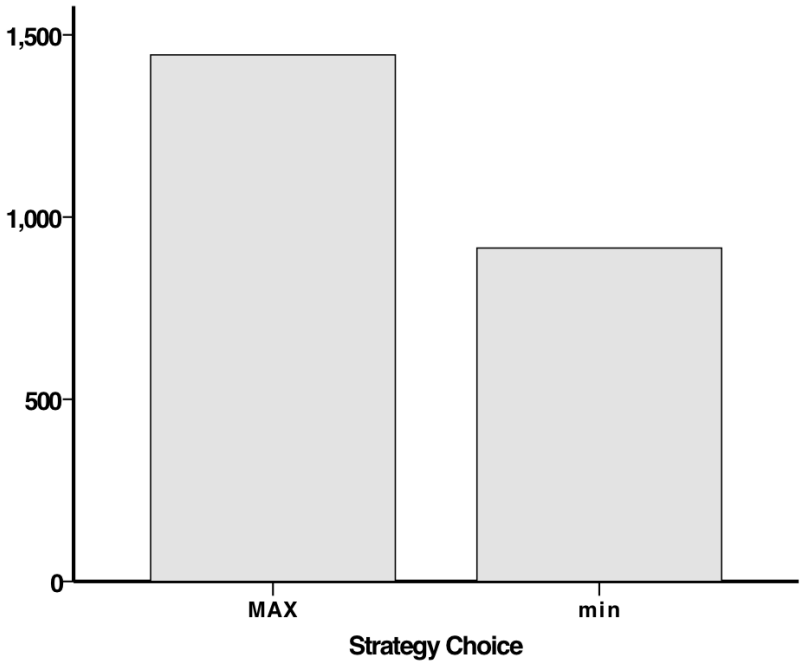

Figure 5.6: Total number of max and min plays for Treatment A, all rounds combined.

5.4.5 Probit model analysis

The overall trend of student's behaviour for Treatment A was analysed in the previous subsections. It was found that, overall , students were behaving as maximisers, as predicted by the hypothesis [2]. For this next analysis, I wanted to find out what was the underlying quantifiable motivations that led students to change their behaviour from one round to the other. By calculating a probit regression model, one can examine the variables, and parameters therein, that have an influence on a student's choice. For the tables below, I calculated β values for each of the test variables' influence on the probability of choice in each Round (dependent variable). The β values in the table identify the change in z-scores of the

[2]except for the 8th and 9th grades, which will be discussed when considering the results for Treatment B

dependent variable for one unit's increase in each of the independent variables. Results were divided into four tables to facilitate comprehension.

Table 5.3: β values for Probit Regressions in Treatment A. Rounds 1-5. Independent Parameters are established in rows while the dependent variable (each round) is displayed as columns. Italic text equates to covariates while normal text equates to categorical factors. †Bayesian Information Criterion. *P<0.05; **P<0.001: Wald's Chi Test

	Dep. Variable				
Parameters	**Round 1**	**Round 2**	**Round 3**	**Round 4**	**Round 5**
AGE	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GENDER	*n.s.*	*n.s.*	*n.s.*	*n.s.*	0.639*
GRADE 7	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 8	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 9	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 10	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 11	*n.s.*	*n.s.*	*n.s.*	*n.s.*	-1.24*
GRADE 12	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 1	.	-1.178*	*n.s.*	.	.
Round 2	.	.	*n.s.*	-0.827*	.
Round 3	.	.	.	0.766*	*n.s.*
Round 4	.	.	.	.	0.791*
Payoff 1	.	*n.s.*	*n.s.*	.	.
Payoff 2	.	.	0.01**	*n.s.*	.
Payoff 3	.	.	.	*n.s.*	0.079*
Payoff 4	.	.	.	.	*n.s.*
Relative Payoff 1	.	*n.s.*	*n.s.*	.	.
Relative Payoff 2	.	.	*n.s.*	*n.s.*	.
Relative Payoff 3	.	.	.	*n.s.*	*n.s.*
Relative Payoff 4	.	.	.	.	*n.s.*
BIC*	100.043	155.133	172.123	207.297	220.853

In the first table (5.3), it can be see that none of the variables considered for analysis had an influence in students behaviour in the first round. This is interesting as this was the round where most student's played the max strategy, meaning that neither age, gender nor grade could explain this behaviour. When looking at round 2, students were clearly influenced by strategy choice in the previous round as each min play, when compared to max plays, meant a negative impact on z-scores (Wald's chi test$_{(1)}$=7.844, P<0.05). Round 3 on the other hand, showed plenty of variables that can explain children's behaviour. Here, Age (Wald's chi test$_{(1)}$=8.534, P<0.05), Grade 7 (Wald's chi test$_{(1)}$=6.494, P<0.05) and Grade 8 (Wald's chi test$_{(1)}$=12.033, P<0.05) were significant , as well as Gender and the choice of Round 2 (Wald's chi test$_{(1)}$=12.0337, P<0.001 and Wald's chi

test$_{(1)}$=0.107, P<0.001, respectively).

Table 5.4: β values for Probit Regressions in Treatment A: Rounds 6-10. Independent Parameters are established in rows while the dependent variable (each round) is displayed as columns. Italic text equates to covariates while normal text equates to categorical factors. †Bayesian Information Criterion. *P<0.05; **P<0.001: Wald's Chi Test

	Dep. Variable				
Parameters	**Round 6**	**Round 7**	**Round 8**	**Round 9**	**Round 10**
AGE	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GENDER	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 7	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 8	2.080*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 9	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 10	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 11	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 12	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 4	*n.s.*	.	.	.	.
Round 5	0.817*	*n.s.*	.	.	.
Round 6	.	*n.s.*	*n.s.*	.	.
Round 7	.	.	*n.s.*	*n.s.*	.
Round 8	.	.	.	*n.s.*	*n.s.*
Round 9	.	.	.	.	-0.863*
Payoff 4	*n.s.*	.	.	.	.
Payoff 5	*n.s.*	*n.s.*		.	.
Payoff 6	.	*n.s.*	*n.s.*	.	.
Payoff 7	.	.	*n.s.*	*n.s.*	.
Payoff 8	.	.	.	*n.s.*	*n.s.*
Payoff 9	.	.	.	.	*n.s.*
Relative Payoff 4	*n.s.*	.	.	.	.
Relative Payoff 5	*n.s.*	*n.s.*	.	.	.
Relative Payoff 6	.	*n.s.*	*n.s.*	.	.
Relative Payoff 7	.	.	*n.s.*	*n.s.*	.
Relative Payoff 8	.	.	.	*n.s.*	*n.s.*
Relative Payoff 9	.	.	.	.	*n.s.*
BIC*	235.901	181.144	192.473	200.185	189.843

We see that the choices in Round 4 were also affected by the choices made both in Round 2 and 3 (Wald's chi test$_{(1)}$=6.664, P<0.05 and Wald's chi test$_{(1)}$=5.411, P<0.05 respectively). In Round 5, student's behaviour could be explained in terms of gender (Wald's chi test$_{(1)}$=3.953, P<0.05), being on Grade 11 (Wald's chi test$_{(1)}$=4.218, P<0.05), the previous choice in Round 4 (Wald's chi test$_{(1)}$=6.026, P<0.05) and the Payoff of Round 3 (Wald's chi test$_{(1)}$=5.151, P<0.05). The second part of the results, shown in Table 5.4 present a lesser number of significant results which could be a reflection of the slight fluctuation in the middle rounds shown

in Figure 5.5 above. In Round 6, Grade 8 (Wald's chi test$_{(1)}$=6.296, P<0.05) and strategy choice in Round 5 (Wald's chi test$_{(1)}$=5.168, P<0.05) were significantly influencing the student's strategy option.

Table 5.5: β values for Probit Regressions in Treatment A. Rounds 11-15. Independent Parameters are established in rows while the dependent variable (each round) is displayed as columns. †Bayesian Information Criterion. *P<0.05; **P<0.001: Wald's Chi Test

	Dep. Variable				
Parameters	**Round 11**	**Round 12**	**Round 13**	**Round 14**	**Round 15**
AGE	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GENDER	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 7	*n.s.*	*n.s.*	*n.s.*	-2.206*	*n.s.*
GRADE 8	*n.s.*	*n.s.*	2.079*	-2.475*	*n.s.*
GRADE 9	*n.s.*	*n.s.*	*n.s.*	*n.s.*	-0.746*
GRADE 10	*n.s.*	2.089*	*n.s.*	*n.s.*	*n.s.*
GRADE 11	*n.s.*	1.576*	*n.s.*	*n.s.*	*n.s.*
GRADE 12	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 9	*n.s.*	.	.	.	.
Round 10	*n.s.*	*n.s.*	.	.	.
Round 11	.	*n.s.*	*n.s.*	.	.
Round 12	.	.	*n.s.*	*n.s.*	.
Round 13	.	.	.	*n.s.*	-0.942*
Round 14	.	.	.	.	*n.s.*
Payoff 9	*n.s.*	.	.	.	.
Payoff 10	*n.s.*	*n.s.*	.	.	.
Payoff 11	.	*n.s.*	*n.s.*	.	.
Payoff 12	.	.	*n.s.*	*n.s.*	.
Payoff 13	.	.	.	-0.081*	*n.s.*
Payoff 14	.	.	.	.	*n.s.*
Re. Pay. 9	*n.s.*	.	.	.	.
Re. Pay. 10	*n.s.*	*n.s.*	.	.	.
Re. Pay. 11	.	*n.s.*	*n.s.*	.	.
Re. Pay. 12	.	.	*n.s.*	-0.131*	.
Re. Pay. 13	.	.	.	*n.s.*	*n.s.*
Re. Pay. 14	.	.	.	.	*n.s.*
BIC*	188.487	184.253	191.485	169.469	191.580

Once again, it can be see that results in the previous round influence behaviour on the following Round. The following three rounds did not yield any significant results and Round 10 was influenced by, yet again, the choices of the previous Round (Round 9: Wald's chi test$_{(1)}$=8.102, P<0.05). Round 11 on the other hand did not present any effects, while Round 12 and 13 were affected by being in Grade 10 and 11(Wald's chi test$_{(1)}$=7.329, P<0.05 and Wald's chi

test$_{(1)}$=4.171, P<0.05, respectively) in the former and Grade 8 in the latter (Wald's chi test$_{(1)}$=5.748, P<0.05).

Table 5.6: β values for Probit Regressions in Treatment A. Rounds 16-20. Independent Parameters are established in rows while the dependent variable (each round) is displayed as columns. †Bayesian Information Criterion. *P<0.05; **P<0.001: Wald's Chi Test

	Dep. Variable				
Parameters	**Round 16**	**Round 17**	**Round 18**	**Round 19**	**Round 20**
AGE	*n.s.*	*n.s.*	*n.s.*	-0.323*	*n.s.*
GENDER	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 7	*n.s.*	*n.s.*	*n.s.*	-1.942*	-1.856*
GRADE 8	*n.s.*	1.186*	*n.s.*	*n.s.*	*n.s.*
GRADE 9	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 10	*n.s.*	1.1*	*n.s.*	*n.s.*	*n.s.*
GRADE 11	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 12	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 14	*n.s.*	.	.	.	.
Round 15	0.897*	*n.s.*	.	.	.
Round 16	.	*n.s.*	*n.s.*	.	.
Round 17	.	.	*n.s.*	*n.s.*	.
Round 18	.	.	.	*n.s.*	*n.s.*
Round 19	.	.	.	.	*n.s.*
Payoff 14	*n.s.*	.	.	.	.
Payoff 15	-0.071*	*n.s.*	.	.	.
Payoff 16	.	*n.s.*	-0.073*	.	.
Payoff 17	.	.	*n.s.*	-0.064*	.
Payoff 18	.	.	.	*n.s.*	*n.s.*
Payoff 19	.	.	.	.	*n.s.*
Relative Payoff 14	0.103*	.	.	.	.
Relative Payoff 15	*n.s.*	*n.s.*	.	.	.
Relative Payoff 16	.	*n.s.*	*n.s.*	.	.
Relative Payoff 17	.	.	*n.s.*	*n.s.*	.
Relative Payoff 18	.	.	.	*n.s.*	*n.s.*
Relative Payoff 19	.	.	.	.	*n.s.*
BIC*	174.634	199.696	188.366	184.026	183.585

Finally, looking at the results from the last rounds (Table 5.5 and 5.6), it is possible to see a trend of previous rounds decisions and/or payoffs and relative payoffs having an influence on a student's choice. In Round 15 decisions were influenced by strategy plays in Round 13 (Wald's chi test$_{(1)}$=8.668, P<0.05) and in Round 16, choices were influenced by decisions in Round 15 (Wald's chi test$_{(1)}$=6.308, P<0.05), Payoff in Round 15 (Wald's chi test$_{(1)}$=2.030, P<0.05)and Relative Payoff of Round 14 (Wald's chi test$_{(1)}$=5.312, P<0.05). Round 17 was

influenced by students being in Grade 7 and 9 (Wald's chi test$_{(1)}$=4.151 , P<0.05 and Wald's chi test$_{(1)}$=8.196, P<0.05, respectively). Round 18's choices were influenced by Payoff of Round 16 (Wald's chi test$_{(1)}$=5.833, P<0.05), while round 19's behaviour could be predicted by Age (Wald's chi test$_{(1)}$=4.404, P<0.05), Being on Grade 7 (Wald's chi test$_{(1)}$=8.791, P<0.05) and Payoff of Round 17 (Wald's chi test$_{(1)}$=4.391, P<0.05). Finally, and in accordance with the typical last round effects, Round 20 was only influenced by being on Grade 7 (Wald's chi test$_{(1)}$=4.576, P<0.05). It is interesting to understand that many of the choices in each round were influenced by what was happening in the previous rounds. This is a result common in both theoretical and experimental game theory for games such as the Prisoner's Dilemma, where Tit-for-Tat is one of the recurring strategies (Axelrod & Hamilton, 1981) alongside win-stay-loose-shift (Nowak & Sigmund, 1993). However, the spite game designed for this thesis was not aimed at provoking said behaviour as it was in the student's best interest to keep playing the same strategy. In the following section, I analysed how children responded to the previous rounds.

5.4.6 Response to previous round

The Probit analysis results above showed a particular trend where students were responding to events in the previous rounds. This is interesting as the prize system of Treatment A meant that the children should have ignored the previous rounds and only be interested in maximising their gain. Were the students responding to their opponents choices and payoffs and relative payoffs resulting thereof, or were they influenced by their own choices in the previous rounds? Are they coordinating to attain a better result rather than being absolute maximisers? In order to answer this question, each transition in strategy was coded and a chart made on how the students were responding to previous rounds. Since there were two strategies, only four possible transitions occurred: i) opponent played min in previous round, player plays max in current round; ii) opponent played max in previous round, player plays max in current round; iii) opponent played min in previous round, player plays min in current round and finally; iv) opponent played max in previous round and player plays min in current round.

When looking at Figure 5.7, it is possible to see that a high percentage of students copied the opponent's strategy in the previous rounds, while many of the other choices were either as predicted by randomness or below it. χ^2 tests

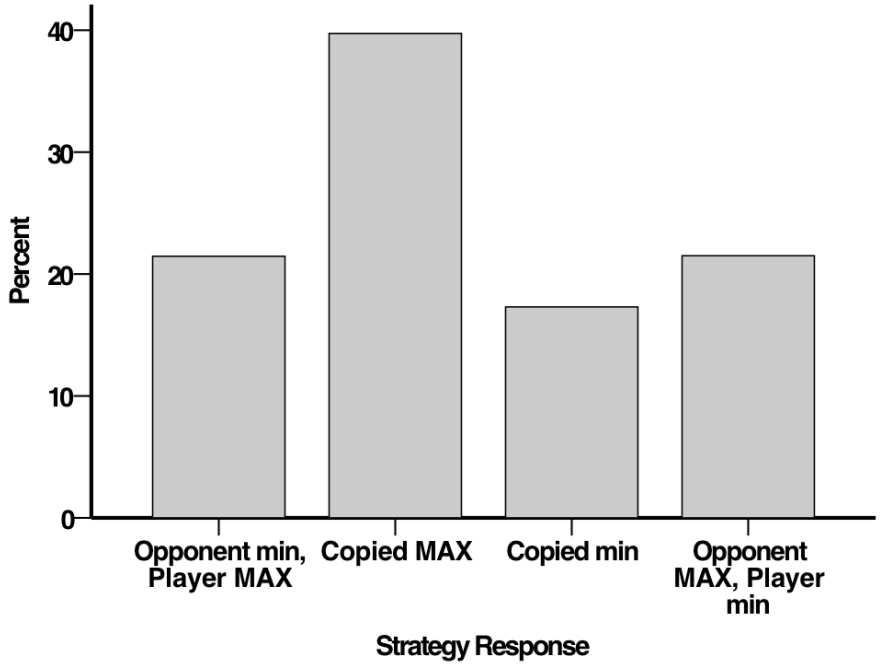

Figure 5.7: Percentage of responses to opponent's plays in the previous rounds, all grades pooled.

showed that the disparity of these percentages is significantly different from random (H_0), (N=2358, $\chi^2_{(3)}$=284.100, P<0.05), with a residual of 347.5 counts above the expected value (589.5). Another point of concern was which grades were most responsible for this behaviour.

In Figure 5.8 it is possible to see that the grades that most closely followed this pattern were 7th, 10th and 11th. This is expected as grades 8, 9 and 12 did not play different strategies above a random threshold according to their binomial test scores (see Table 5.2). What this result suggests, is that students seem to be coordinating in a game where they should be disregarding their opponent altogether and only playing according to their own interest.

After acknowledging that behaviour in a certain round was mostly caused as a response to the opponent's previous choice, I also wanted to understand if the same occurred in relation to a player's own previous move. Again only four possible transitions occurred: i) player played min in previous round, player plays max in current round; ii) player played max in previous round, player plays max in current round; iii) player played min in previous round, player plays min in current round and finally; iv) player played max in previous round and player plays min in current round.

Although not as pronounced as in the previous analysis, student's also seem

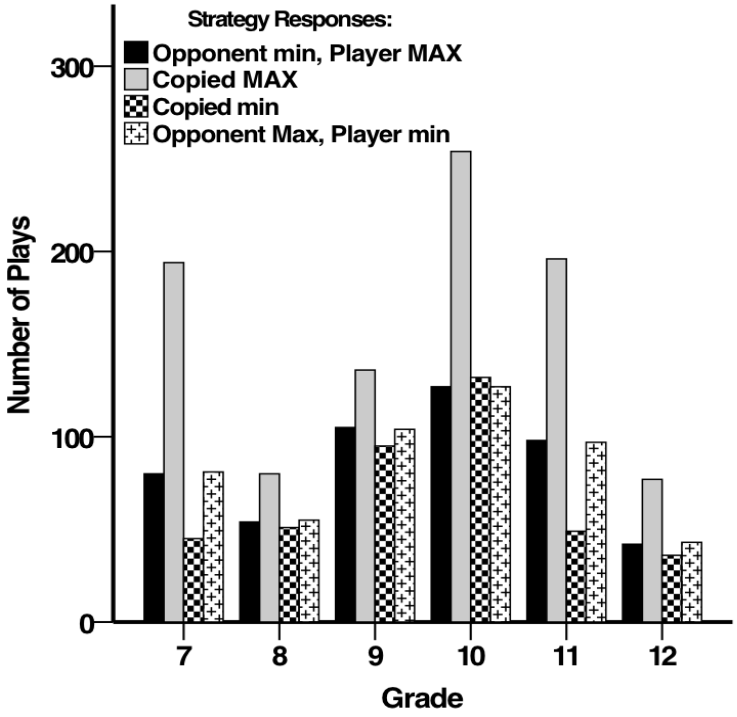

Figure 5.8: Percentage of responses to opponent's plays in the previous rounds per grade.

to follow a max choice with another max choice, more often than they do for any other strategy with a residual of 243.3 over the expected value (589.8) (N=2359, $\chi^2_{(3)}$=241.361, P<0.05). Student's also appeared to change strategy in the following rounds more often than when responding to the opponent. Although continuing to play max was the most common choice, it seemed children shifted from max to min on their own rather than as a response to the opponent. This should be highlighted as it seems that students in this treatment not only behaved as maximisers, but also switched from a maximising to a spiteful strategy more often than they did the other way around. This is another evidence for the win-stay-lose-shift type strategies (Nowak & Sigmund, 1993) seen in the Azores experiment.

After discussing the results in treatment A, it was clear that children responded well as maximisers, with the only surprising result being that the children in the 7th grade performed very well when compared with older children. Another interesting result was that students often reciprocated the opponent's max plays but not min, and often preferred to continue to play max. Interestingly though, they switched plays from max to min more often than any other switch. Next, the results for Treatment B will be explored. The analysis will be a repetition from the one above so the same structure will be applied.

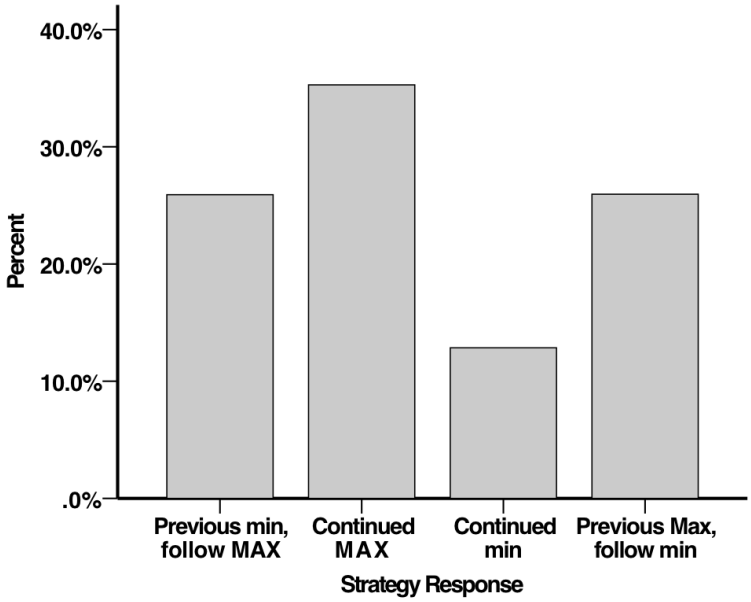

Figure 5.9: Frequency of player's response to their own decision in the previous rounds, all grades pooled.

5.5 Results: Treatment B

5.5.1 Binomial tests per grade

Treatment B was designed so that acting spitefully would make the student win a prize. In essence, min was an unbeatable strategy in the sense that it was the only strategy that would not only allow obtaining more points than the opponent but also guarantee never loosing the game. Because the winner was the student with the most points in the end of the experiment, min was the optimum strategy. Again rounds were separated into variables and binomials calculated for each grade with random threshold set at 0.5. Table 5.7 below, summarises the results of the binomial tests.

Table 5.7: Treatment A Binomial test exact P values. Bold denotes significantly more max plays, asterisks denote significantly more min plays

	7th	8th	9th	10th	11th	12th
Round 1	*n.s.*	**P = 0.008**	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 2	*n.s.*	*n.s.*	*n.s*	*n.s.*	*n.s.*	*n.s.*
Round 3	*n.s.*	**P = 0.096**	*n.s*	*n.s.*	*n.s.*	*n.s.*
Round 4	*n.s.*	*n.s.*	*n.s*	*n.s.*	*n.s.*	*n.s.*
Round 5	*n.s.*	*n.s.*	*n.s*	*n.s.*	**P = 0.006**	*n.s.*
Round 6	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 7	*n.s.*	**P = 0.031**	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 8	*n.s.*	*n.s.*	P = 0.096*	*n.s.*	*n.s.*	*n.s.*
Round 9	*n.s.*	**P = 0.031**	P = 0.031*	*n.s.*	*n.s.*	*n.s.*
Round 10	*n.s.*	*n.s*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 11	*n.s.*	*n.s*	P = 0.096*	*n.s.*	*n.s.*	*n.s.*
Round 12	*n.s.*	*n.s*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 13	*n.s.*	**P = 0.031**	P = 0.031*	*n.s.*	P = 0.039*	*n.s.*
Round 14	*n.s.*	*n.s*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 15	*n.s.*	**P = 0.001**	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 16	*n.s.*	*n.s*	P = 0.096*	*n.s.*	*n.s.*	*n.s.*
Round 17	*n.s.*	**P = 0.096**	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 18	*n.s.*	*n.s*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round 19	*n.s.*	**P = 0.096**	P = 0.008*	*n.s.*	*n.s.*	*n.s.*
Round 20	*n.s.*	**P = 0.001**	*n.s.*	**P = 0.064**	*n.s.*	*n.s.*

The first point to be highlighted is that there are fewer significant results than in the previous treatment. 7th graders did not play either min or max significantly above the random threshold. 8th graders on the other hand, surprisingly played max more often than random in 9 out of 20 rounds (N=18, Round1 max prop.=0.83; Round 7 max prop.=0.78; Round 8 max prop.=0.78; Round 12 max; Round 14 max prop.=0.89; Round 20 max prop.=0.89). 9th Graders on the other hand, were the student's who behaved more as relativists (spiteful behaviour) with six out of twenty rounds with significantly more min plays than random (N=18, Round 8: min prop.=0.72; Round 9: min prop.=0.78; Round 11: min prop.=0.72; Round 13: min prop.=0.78; Round 16: min prop.=0.72; Round 19 min prop.=0.83). Finally, only three other significant results occurred. In the 10th Grade's last round (N=24) students behaved more as maximisers than relativisers (max prop.=0.71) and in 11th Grade, Students behaved more as maximisers in Round 5 (N=12, max prop.=0.92) and more as relativisers in Round 13 (min prop. =0.83). It was expected that younger children did not perform as well in the spite treatment than older children, explaining the results from the 7th and 8th grades.

9th graders behaved better as relativisers while older students seemed to play randomly.

5.5.2 Binomial tests per grade and per year, all rounds combined

After learning that students did not respond too well during the 20 rounds to a spiteful stimuli, it was important to know how did each grade and age behaved overall. Again, I performed a binomial test on the total amount of max and min plays for each grade and age and plotted a line graph with the proportion of min plays in the Y axis and grade in the X axis (Figure 5.10), and one with age (Figure 5.12) on the X axis, correcting differences in sample size. Considering Figure 5.10), 7th graders did not present significant results.

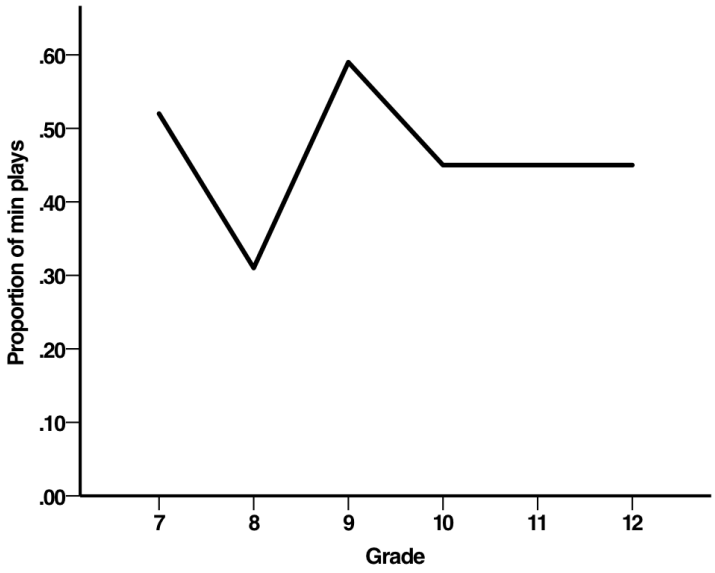

Figure 5.10: Proportion of total min plays per grade, Treatment B.

For the 8th grade, students played max 69% of the time (N=360, P<0.001, which is expected considering the round analysis above (Table 5.7). Students in the 9th grade were the best performers also when rounds were combined and min comprised 59% of total strategy plays in treatment (N=360, P=0.001). 10th graders on the other hand played max 55% overall, a difference not attainable by chance alone due to the higher sample size (N=480,P<0.05). Finally 11th and 12th graders played max non-significantly. Students in the 9th grade chose spiteful strategies significantly more often. What can be seen is that when separating each age (see 5.12, none of the age groups significantly played min more often than max. In the cases of 13, 15 and 22 year students, these chose max significantly

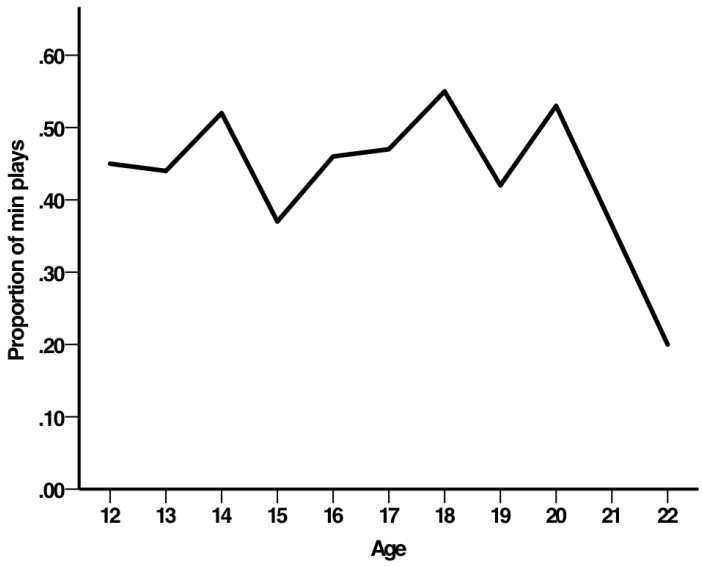

Figure 5.11: Proportion of total min plays per age, Treatment B.

more often than min (13 year olds: N=320, max prop.=0.56, P<0.05; 15 year olds: N=260, max prop.=0.63, P<0.001; 22 year olds N=20, max prop.=0.80, P<0.05).

5.5.3 Overall strategic behaviour per round, all players combined

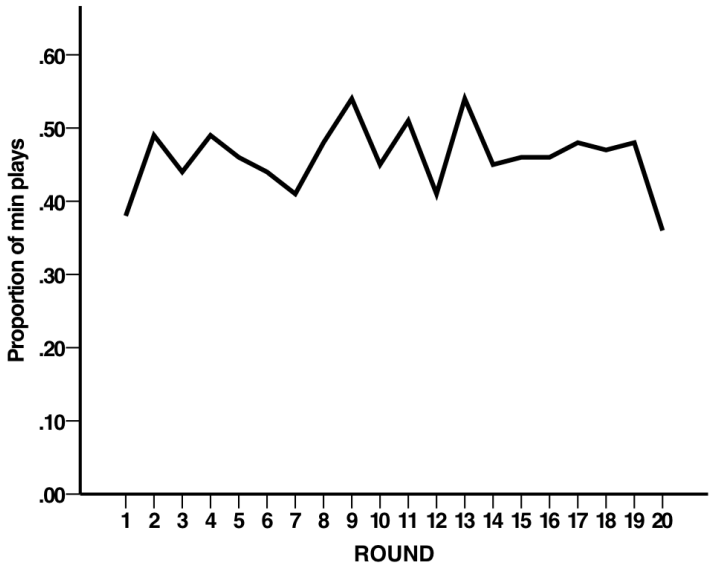

Figure 5.12: Proportion of total min plays per round, Treatment B.

In the previous analysis it was seen that only 9th graders responded properly to the the stimulus presented to them. The following question was what pattern emerged from pooling all years and analysing the evolution of plays during the

20 rounds. In Figure 5.12 it is possible to see that there is not much variation in min plays throughout the 20 rounds. The only two significant results occurred in the 1st and 20th Rounds, but with more max than min plays, which means that, overall, children started out as maximisers and played it 62% of the time (N=104, P<0.05) and finished as maximisers playing max 67% of the times (P<0.05).

5.5.4 Binomial tests for total strategy plays

When pooling all grades and all rounds and analysing the total number of moves played by all students (Figure 5.13), it is further clarified that the subjects did not fair as well in this treatment. However, there were more overall min plays when comparing with the previous treatment which meant that of the 2080 strategies played by every subject, max equated to 1121 (54%) and min equated to 959 (46%). (Binomial test: P<0.001).

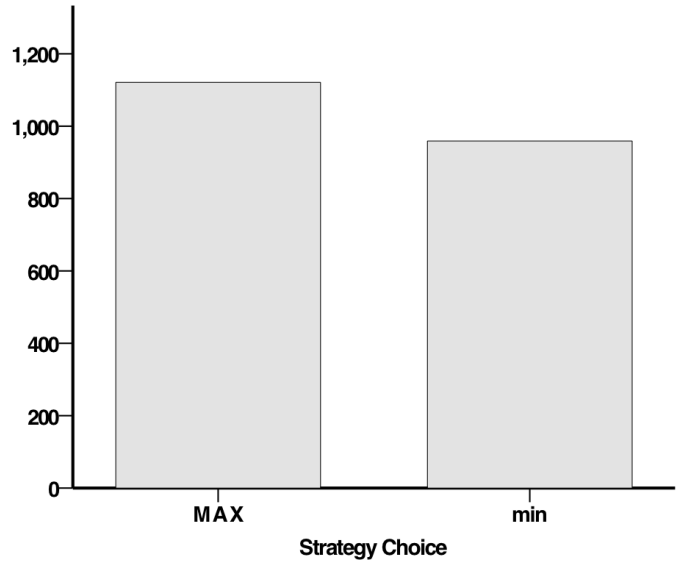

Figure 5.13: Total number of max and min plays for Treatment B, all rounds combined

5.5.5 Probit model analysis

In the previous analysis it was shown that, except for the 9th grade, students seemed to respond less favourably to a game where the prize was won via a spiteful strategy. This is result is somewhat contrary to those obtained in the Azores where older children seemed to understand that they needed to adopt a different Nash equilibrium (min, min) in order to make sure they did not lose. Did students play strategies close to random? Were they influenced by the same

variables as in Treatment A? To answer these questions, a probit regression was also run for this treatment.

Table 5.8: β values for Probit Regressions in Treatment B. Rounds 5-9. Independent Parameters are established in rows while the dependent variable (each round) is displayed as columns. †Bayesian Information Criterion. Values displayed are significant for Wald's chi test (P<0.05)

	Dep. Variable				
Parameters	**Round 5**	**Round 6**	**Round 7**	**Round 8**	**Round 9**
AGE	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GENDER	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 7	*n.s.*	1.852	*n.s.*	*n.s.*	*n.s.*
GRADE 8	*n.s.*	1.699	*n.s.*	*n.s.*	*n.s.*
GRADE 9	*n.s.*	*n.s.*	*n.s.*	*n.s.*	-1.792
GRADE 10	*n.s.*	1.476	*n.s.*	*n.s.*	*n.s.*
GRADE 11	1.367	1.207	*n.s.*	*n.s.*	*n.s.*
GRADE 12	.	.	.	.	.
Round 4	-15.589	*n.s.*	.	.	.
Round 5	.	*n.s.*	16.262	.	.
Round 6	.	.	-15.390	-17.040	.
Round 7	.	.	.	*n.s.*	*n.s.*
Round 8	.	.	.	.	-22.226
Payoff 4	1.180	.	.	.	.
Payoff 5	.	.	-1.203	.	.
Payoff 6	.	.	1.239	1.280	.
Payoff 7	.	.	.	-2.096	*n.s.*
Payoff 8	.	.	.	.	1.64
Relative Payoff 4	-1.863	*n.s.*	.	.	.
Relative Payoff 5	.	*n.s.*	*n.s.*	.	.
Relative Payoff 6	.	.	-1.482	*n.s.*	.
Relative Payoff 7	.	.	.	*n.s.*	*n.s.*
Relative Payoff 8	.	.	.	.	-2.670
BIC†	179.544	174.846	168.481	163.369	176.383

Examining Table 5.8 it is noticeable that, for the first four rounds, students were not influenced by any of the factors or co-variates chosen for analysis. However, the following rounds saw major influences of previous round, payoff and relative payoff in the z-scores of each dependent variable.

Table 5.9: β values for Probit Regressions in Treatment B. Rounds 11,12, 15 & 16. Independent Parameters are established in rows while the dependent variable (each round) is displayed as columns. †Bayesian Information Criterion. All values displayed are significant for Wald's chi test (P<0.05)

	Dep. Variable			
Parameters	**Round 11**	**Round 12**	**Round 15**	**Round 16**
AGE	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GENDER	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 7	*n.s.*	*n.s.*	-2.169	*n.s.*
GRADE 8	*n.s.*	2.056	*n.s.*	*n.s.*
GRADE 9	*n.s.*	*n.s.*	*n.s.*	-1.697
GRADE 10	*n.s.*	*n.s.*	*n.s.*	*n.s.*
GRADE 11	*n.s.*	*n.s.*	-1.248	*n.s.*
GRADE 12	.	.	.	.
Round 10	-17.068	*n.s.*	.	.
Round 11	.	*n.s.*	.	.
Round 12	.	.	.	.
Round 13	.	.	*n.s.*	.
Round 14	.	.	*n.s.*	*n.s.*
Round 15	.	.	.	*n.s.*
Payoff 10	1.352	.	.	.
Payoff 11	.	*n.s.*	.	.
Payoff 12	.	*n.s.*	.	.
Payoff 13	.	.	*n.s.*	.
Payoff 14	.	.	*n.s.*	*n.s.*
Payoff 15	.	.	.	*n.s.*
Relative Payoff 10	-2.075	.	.	.
Relative Payoff 11	.	*n.s.*	.	.
Relative Payoff 12	.	*n.s.*	.	.
Relative Payoff 13	.	.	*n.s.*	.
Relative Payoff 14	.	.	*n.s.*	*n.s.*
Relative Payoff 15	.	.	.	*n.s.*
BIC†	173.684	171.972	181.894	178.287

Round 5 for example, was influenced by a decrease of -16 in z-scores for every min choice in Round 4 (Wald's chi test$_{(1)}$=3.994, P<0.05). It was also influenced by both payoff (Wald's chi test$_{(1)}$= 4.358, P<0.05) and relative payoff (Wald's chi test$_{(1)}$=4.306, P<0.05) of round 4. Round 6 was influenced by Grade with being on Grade 7 (Wald's chi test$_{(1)}$=3.923, P<0.05), 8 (Wald's chi test$_{(1)}$=3.905, P<0.05), 10 (Wald's chi test$_{(1)}$= 5.971, P<0.05) and 11(Wald's chi test$_{(1)}$=3.802, P<0.05) causing an influence in max responses to the min reference category. Round 7 on the other hand was heavily influenced by previous plays in rounds 5 (Wald's chi test$_{(1)}$=3.890, P<0.05) and 6 (Wald's chi test$_{(1)}$=3.721, P<0.05) and also by payoff

of the same rounds (Payoff 5: Wald's chi test$_{(1)}$=3.620, P<0.05; Payoff 6 Wald's chi test$_{(1)}$=4.170, P<0.05) and relative payoff of Round 6 (Wald's chi test$_{(1)}$=3.617, P<0.05). Choice in Round 8 was influenced by choices in Round 6 (Wald's chi test$_{(1)}$= 4.233, P<0.05) and by payoff of Round 6 (Wald's chi test$_{(1)}$=4.131, P<0.05) and 7 (Wald's chi test$_{(1)}$=4.338, P<0.05). Finally, Round 9's strategy choices were influenced by being in the 9th Grade (Wald's chi test$_{(1)}$=5.554, P<0.05), choices in Round 8 (Wald's chi test$_{(1)}$=7.292, P<0.05), Payoff of Round 8 (Wald's chi test$_{(1)}$=6.966, P<0.05) and relative payoff of Round 8(Wald's chi test$_{(1)}$=2.670, P<0.05).

The last four rounds where significant results occurred are presented In Table 5.9 below. Here, choices of Round 11 followed the same pattern as the previous results, being influenced by not only the choices in Round 10 (Wald's chi test$_{(1)}$=4.184, P<0.05), but also Payoff (Wald's chi test$_{(1)}$=4.464, P<0.05), and relative payoff (Wald's chi test$_{(1)}$=4.166, P<0.05) of Round 10.

Finally, the last Rounds that presented significant results seemed to be influenced only by Grade with Round 12 influenced by being in Grade 8 (Wald's chi test$_{(1)}$=4.822, P<0.05), Round 15 influenced by being on Grade 7 (Wald's chi test$_{(1)}$=5.744, P<0.05) and Grade 11 (Wald's chi test$_{(1)}$=4.206, P<0.05) and lastly Round 16's choices influenced by being on Grade 9 (Wald's chi test$_{(1)}$=4.985, P<0.05).

5.5.6 Response to previous round

The probit regressions above clarified that, although students did not behave spitefully more often than random, their choices were highly influenced by what happened in previous rounds. These were also influenced by relative payoffs and payoffs more often than in Treatment A.

After plotting the analysis of how subjects reacted to their opponent's moves (Figure 5.14), the same pattern seen in Treatment A emerges. Student's more often followed an opponents max choice with a max choice in the next round (656), although this time, the residual is not as high as in Treatment A (N=2078, $\chi^2_{(3)}$=48.864, P<0.001, Residual=136.5). Another evidence is that responding to the opponent with a different strategy was close to the expected value and therefore is behaviour that could have occurred merely by chance.

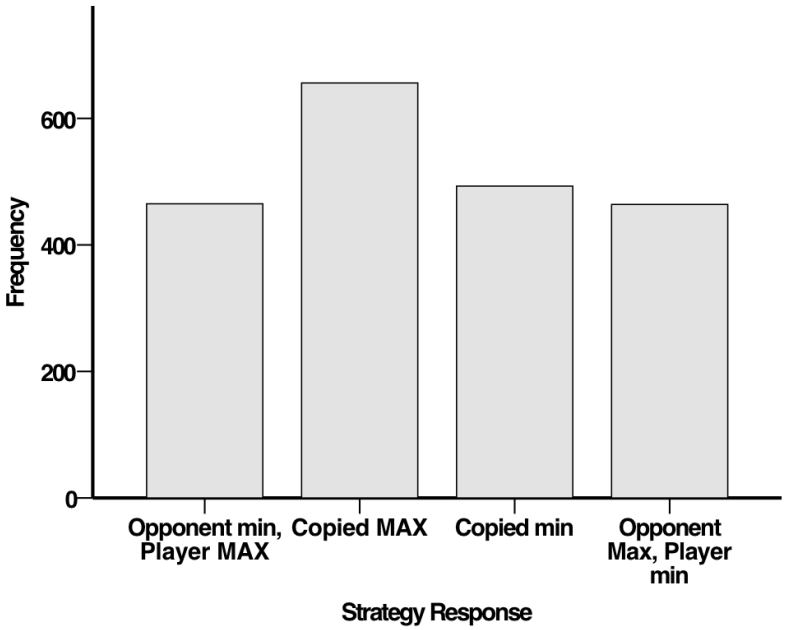

Figure 5.14: Frequency of responses to opponent's plays in the previous rounds, Treatment B. All grades pooled.

When looking at the response behaviour of each grade, the results for the binomial tests above (Table 5.7) are now better understood, with both 8th and 10th graders replying to their opponent's max choices with a max choice in the following round. Not surprisingly, 9th graders behaved in a similar way, but with more min replies to min, which means these students were replying to spiteful strategies by also behaving spitefully more often than chance.

On the other hand, when we analyse how players followed their own choices in the previous round(Figure 5.16), the differences in response frequencies are not as clear as in the previous analysis. Although students still preferentially continued playing the same strategy as the previous round, they did so less frequently than before (N=2079, Residual 76.3) and the amount of times they changed strategy also increased (Residual 5.3), close to expected value. Interestingly, students less frequently followed up a min strategy in a previous round with one in the following round (Residual -86.8, $\chi^2_{(3)}$=25.772, P<0.001).

Examining how each grade responded to their own previous round (Figure 5.17), it is possible to see that the patterns that were seen above for responses to the opponent's choices do not occur. Grades 7, 10 and 11 continued playing a max strategy in a following round. For every other grade, switching either from max to min or vice-versa was more common than to continue playing min.

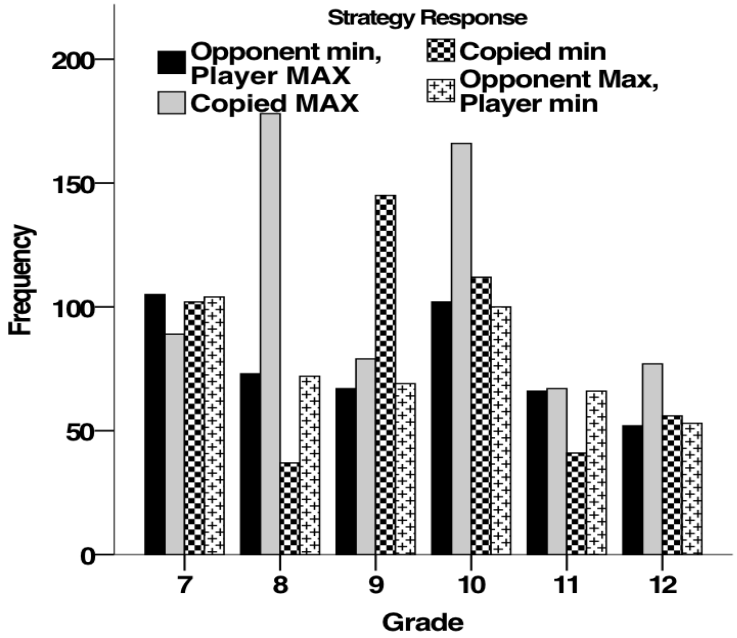

Figure 5.15: Frequency of responses to opponent's plays in the previous rounds per grade, Treatment B.

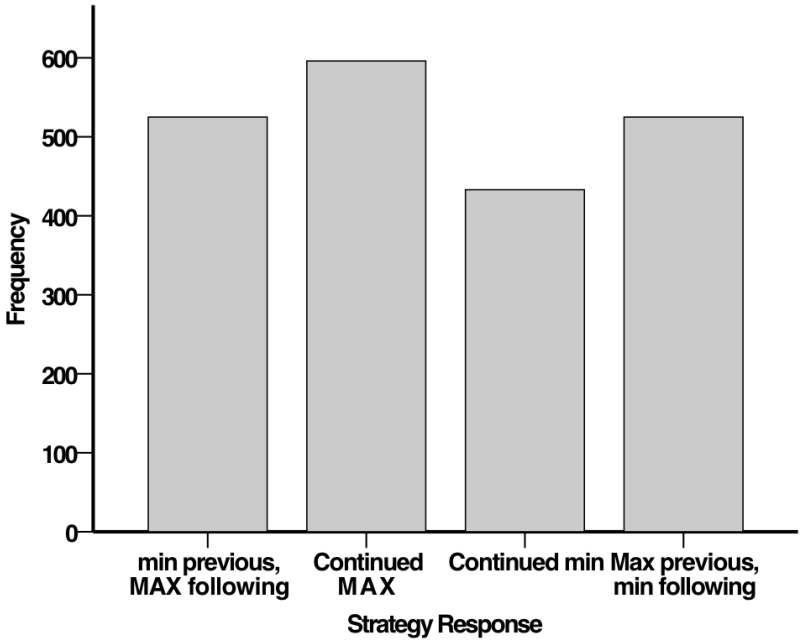

Figure 5.16: Frequency of responses to own strategy in the previous rounds. All grades pooled.

9th graders were clearly responding to their opponent's moves as keeping to a min strategy after playing one was less common than any of the other 3 outcomes.

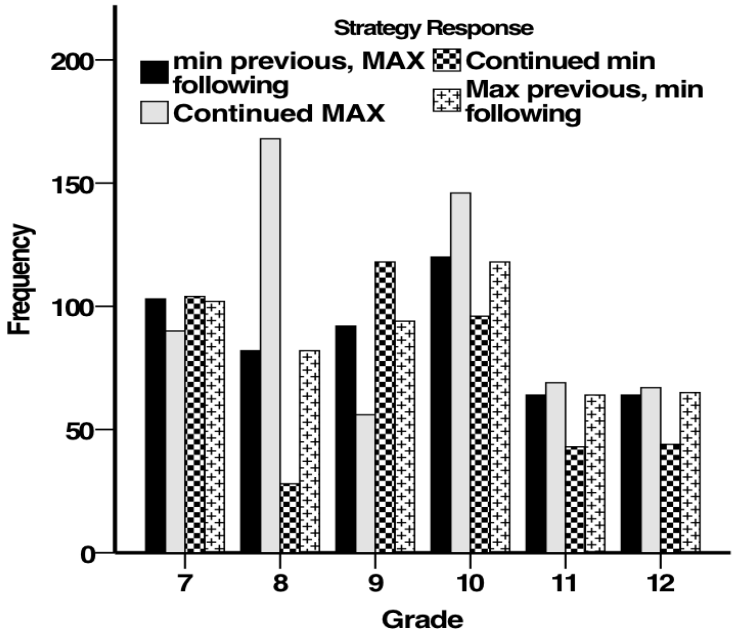

Figure 5.17: Frequency of responses to own strategy in the previous rounds per grade, Treatment B

5.6 Results: Comparing Treatment A & B

The results above showed us that overall, students responded better to the stimuli provided by Treatment A, and that they followed a win-stay-lose-shift type of strategy (Nowak & Sigmund, 1993). Treatment B on the other hand showed us that only 9th graders understood that the spiteful strategies were the only ones capable of providing them with a prize. However, it did show also that opponent's decisions in the previous round were highly taken into account in a more tit-for-tat like mechanisms.

Summarising students decisions in both Treatments (Table 5.10, we have that only 9th graders acted accordingly to each of them, while all other grades were far better at being maximisers than being spiteful. The reader must not forget, however, that children and teenagers may have perceived Treatment A has a coordination game (Skyrms, 2003) rather than a dominance game (Myerson, 2013).

Table 5.10: Binomial tests for all grades and Treatments with pooled rounds. Exact *P*-values are shown.

		Treatment					
		A			**B**		
	Strategy	N	Obs Proportion	Significance (2-tailed)	N	Obs Proportion	Significance (2-tailed)
7th Grade	MAX	275	0.69	**P = 0.000**	193	0.48	n.s.
	min	125	0.31		207	0.52	
8th Grade	MAX	135	0.56	**P = 0.061**	250	0.69	**P = 0.000**
	min	105	0.44		110	0.31	
9th Grade	MAX	240	0.55	**P = 0.063**	148	0.41	P = 0.001*
	min	200	0.44		212	0.59	
10th Grade	MAX	381	0.6	**P = 0.000**	266	0.55	**P = 0.002**
	min	259	0.4		214	0.45	
11th Grade	MAX	293	0.67	**P = 0.000**	133	0.55	n.s.
	min	147	0.33		107	0.45	
12th Grade	MAX	121	0.61	**P = 0.004**	131	0.55	n.s.
	min	79	0.39		109	0.45	

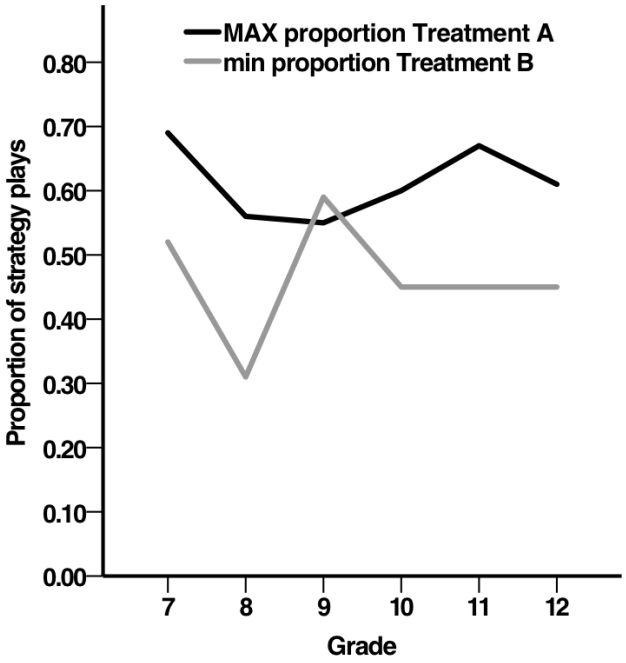

Figure 5.18: Proportion of max plays in Treatment A and min plays in Treatment B per grade

When joining Figures 5.2 and 5.3 with Figures 5.10 and 5.11, (Figure 5.18 and Figure 5.19) we can further see that students were playing preferentially as maximisers. Although there is a high percentage of min plays, students were overwhelmingly more adept at performing as expected in Treatment A than in Treatment B.

However, it should be noted that level of min plays were relatively stable for the latter grades, and this could mean that spiteful preferences were showing up after adolescence (Knight and Kagan 1975, Trivers 2005) but were expressed more heavily in its onset.

One of the shortcomings of the Azores study was that gender was not registered as a control variable when performing the study, as it was not collected as a parameter of analysis. In the next section, gender differences in behaviour will be analysed and described.

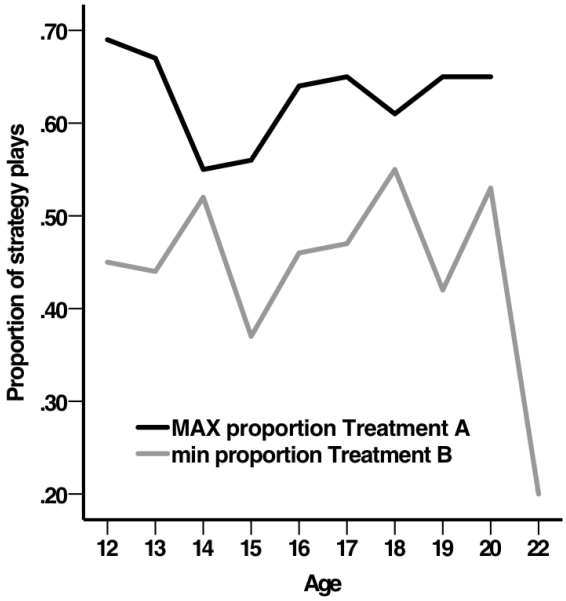

Figure 5.19: Proportion of max plays in Treatment A and min plays in Treatment B per age

5.7 Results: Gender behaviour in Treatments A & B

In the Theoretical Background, gender differences in competition and cooperation were described in both an evolutionary and cultural perspective (section 2.3.8.1). This description identified that boys were more likely to cooperate in groups that had already established a solid hierarchy and were more likely to compete with out-group individuals rather than in-group individuals. Girls on the other hand, were described as being better at cooperating with close friends rather than maintaining cooperation in larger groups. It was also discussed that boys were overall more competitive than girls (Fiske, 2012). The next analysis compared male and female behaviour in both Treatments.

When looking specifically at how each gender played during the 20 rounds we can see that in Treatment A, male students were more consistent in their strategy choices while female students started out better, but then were less consistent throughout the 20 rounds (Figure 5.20).In Treatment B on the other hand, female students behaved spitefully slightly more often the male students, although differences were never above the random threshold (Figure 5.21).

From what can be understood from table 5.11, boys behaved as maximisers more often than random in each of the 20 rounds when compared to girls, but

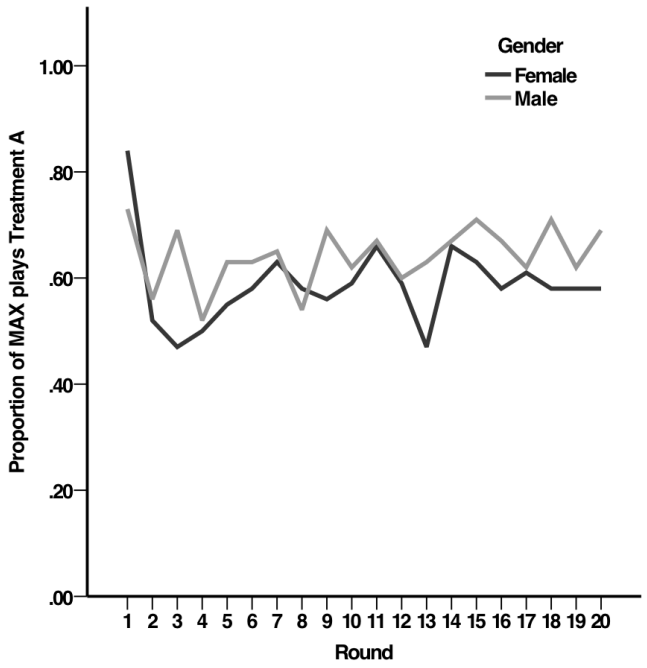

Figure 5.20: Percentage of Male and Female max plays in the 20 rounds of Treatment A. All grades pooled.

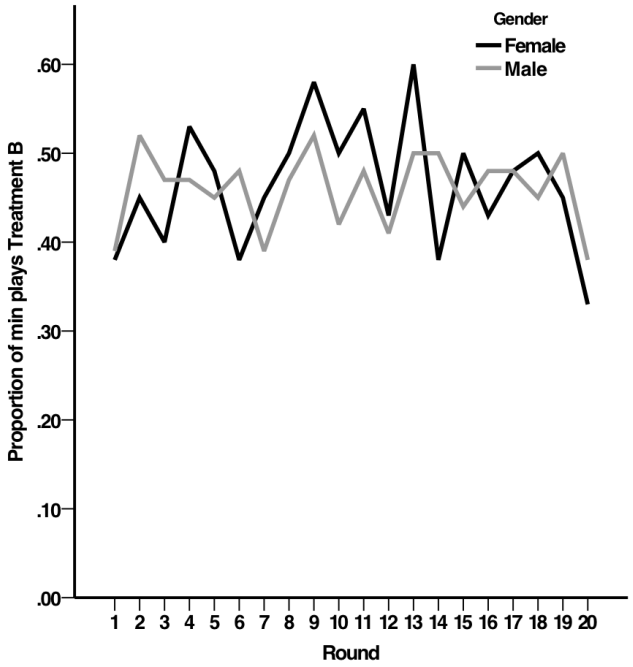

Figure 5.21: Percentage of Male and Female min plays in the 20 rounds of Treatment B. All grades pooled.

behaved equally less often as relativisers when compared with girls in Treatment, B. This result agrees with what was discussed in the theoretical background on boys being more readily available to coordinate with unknown parties as long as the goal does not involve a fight for hierarchy (Geary et al., 2003).

Table 5.11: Binomial test results for male and female behaviour in both treatments. Bold denotes significantly more max than min choices.

Treatment:	**A**		**B**	
	Male	**Female**	**Male**	**Female**
Round1	**P = 0.001**	**P = 0.000**	*n.s.*	*n.s.*
Round2	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round3	**P = 0.008**	*n.s.*	*n.s.*	*n.s.*
Round4	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round5	**P = 0.07**	*n.s.*	*n.s.*	*n.s.*
Round6	**P = 0.07**	*n.s.*	*n.s.*	*n.s.*
Round7	**P = 0.036**	**P = 0.06**	*n.s.*	*n.s.*
Round8	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round9	**P = 0.008**	*n.s.*	*n.s.*	*n.s.*
Round10	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round11	**P = 0.018**	**P = 0.017**	*n.s.*	*n.s.*
Round12	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round13	**P = 0.07**	*n.s.*	*n.s.*	*n.s.*
Round14	**P = 0.018**	**P = 0.017**	*n.s.*	*n.s.*
Round15	**P = 0.003**	**P = 0.06**	*n.s.*	*n.s.*
Round16	**P = 0.018**	*n.s.*	*n.s.*	*n.s.*
Round17	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round18	**P = 0.003**	*n.s.*	*n.s.*	*n.s.*
Round19	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Round20	**P = 0.008**	*n.s.*	**P = 0.06**	**P = 0.038**

When looking at spiteful behaviour in Treatment B, it was found that a similar proportion of female and male students played min strategies (females students played min 47% of the time, while male students played max strategies 46% of the time). When specifically looking at the 9th grade, where most students behaved spitefully, the proportion of male and female students was not equal, with 72.2% male students and only under 27.8% of female students, meaning that behaviour in this grade was clearly gender-biased. These results point towards there being actual gender differences in competitive and cooperative behaviour among children and teenagers when playing the spite game.

5.8 Results: Repeating students analysis

During the experiments, many teachers voiced their concerns over having many repeating students in their classes and whether they would make the effort of taking the game seriously. This question arose during data analysis and I decided to both remove the repeating students from the sample (by removing anyone who was not in the correct age spectrum for each grade) and only analyse the behaviour of repeating students. This is relevant because a student who flunks will be put in a class where other children have already formed bonds from previous years and could either cause the older student to impose himself in terms of status or cause him to be left out by others in the class.

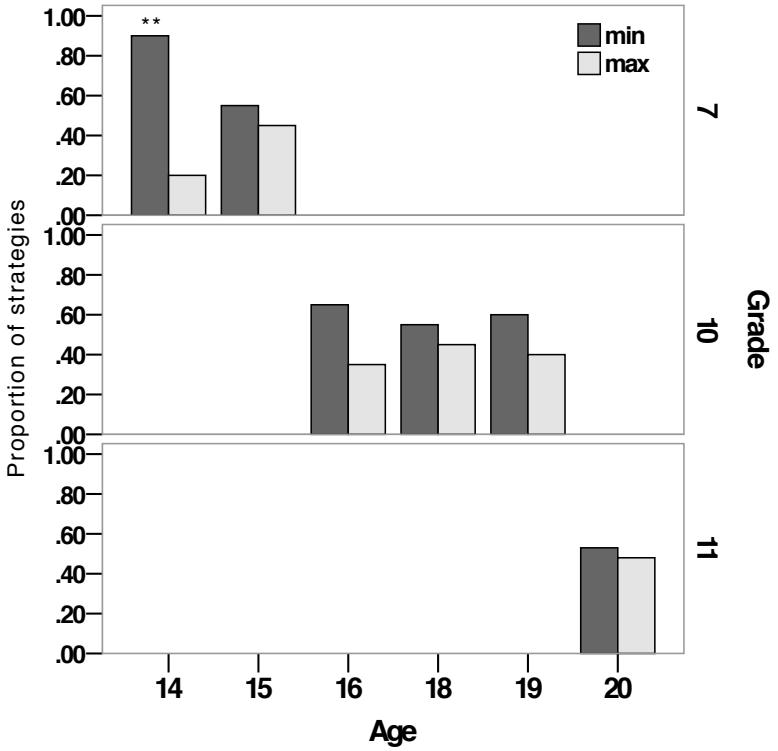

Figure 5.22: Proportion of repeating student's min and max plays in Treatment B. Here age is set on the X axis while each subgraph represents the grade these students are repeating. **denotes P<0.001

Removing repeating students had no effect in overall max and min strategy choices either in Treatment A (N=2020, max prop.=0.60, P<0.001) or Treatment B (N=1700, min prop.=0.46, P=0.001). This is especially clear when looking at the non repeating students behaviour during the 20 rounds of each session (see Figures A.3 and A.4 in appendix 1).

However, something very different occurred when looking at only the repeating students. By analysing every choice of only the repeating students in regards to their age and grade, we see that overall, repeating students chose min strategies more often than max strategies in Treatment B. In Figure 5.22 we can see that repeating students in the 7th grade chose significantly more spiteful strategies than the random threshold.

From the analysis made on the students behaviour, it is possible to understand that students acted more as maximisers than as relativisers. It was also shown that one of the reasons why students were better at Treatment A was that they copied their opponent's choice in the previous round more often than any other strategic transition. Another surprising result was that only one grade acted spitefully in Treatment B and that repeating students were more spiteful than students in the correct grade for their age.

While the previous sections studied the statistical patterns behind students' behaviour in both Treatments, the next section will analyse the students' responses to the questionnaire presented to them after the game.

5.9 Results: Post-game interview analysis: Responses per Treatment

Students behaviour in the previous sections was analysed in terms of underlying statistical patterns. However, input from children in regards to how they felt when playing is also needed. The questionnaire aimed at understanding whether children's opinions on their feelings when playing the game equated to their strategy choices.

First, students were asked if they retaliated to spiteful strategies (Figure 5.23). Here students were not too differentiated in their answers but in Treatment B students seemed to claim they always retaliated (which means they were choosing the optimum strategy) rather than never retaliated or sometimes retaliated. However, it is noteworthy to mention that students recognised their retaliatory behaviour, as seen by the Probit analysis above.

When looking at students feelings when playing, the obvious and most common choice was nothing. Although this variable could have been removed altogether, it seemed truer to provide students with this option as most of them would actually not have any particular feelings of playing what they probably

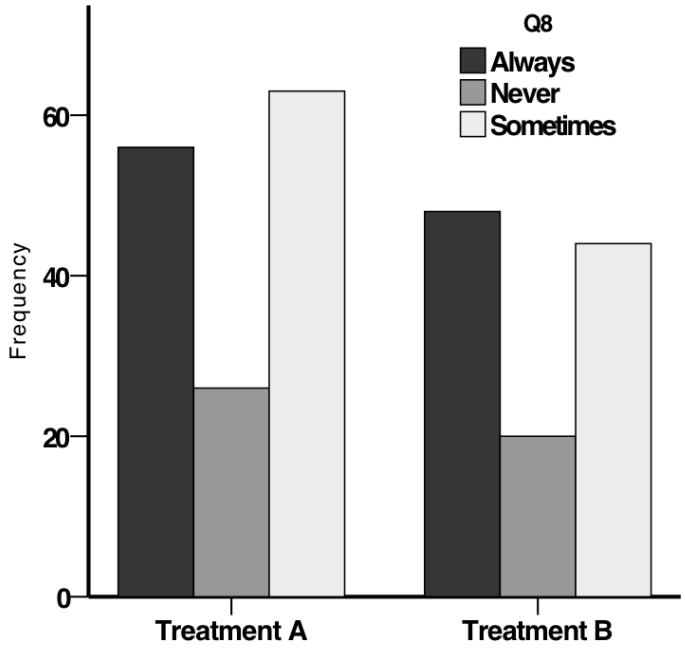

Figure 5.23: Answers to question: When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round? per Treatment

considered a very simple "computer game" with a colleague. However, some feelings were expressed by students when asked how they felt about winning *more* points than their opponent. Here students could answer with 4 positive and two negative "emotions"/ "feelings"

Across both treatments (Figure 5.24) there were not many differences in response rate, however there were slightly more regret and shame responses in treatment A, as well as slightly more Pride answers in treatment B. When looking at how students felt when their opponents won more points than them (Figure A.5 in appendix 1), Envy and Disdain were not as differentiated as expected in Treatment B, and the only differences between treatments lied in students who felt resigned and sad more often in Treatment A than in B. The interesting differences occurred when asking students how they felt for both of them winning points together (Figure 5.25). Here the response would clarify if students were acting as coordinators or not. Clearly, more students felt happy by coordinating with their partner in Treatment A than in Treatment B. However, envy was felt by a few subjects in Treatment A and none in Treatment B. This means that some students were actually behaving spitefully in the maximising game, sacrificing their own prize money so that their opponent won less for themselves.

When asking students if they understood what to do in order to win a prize,

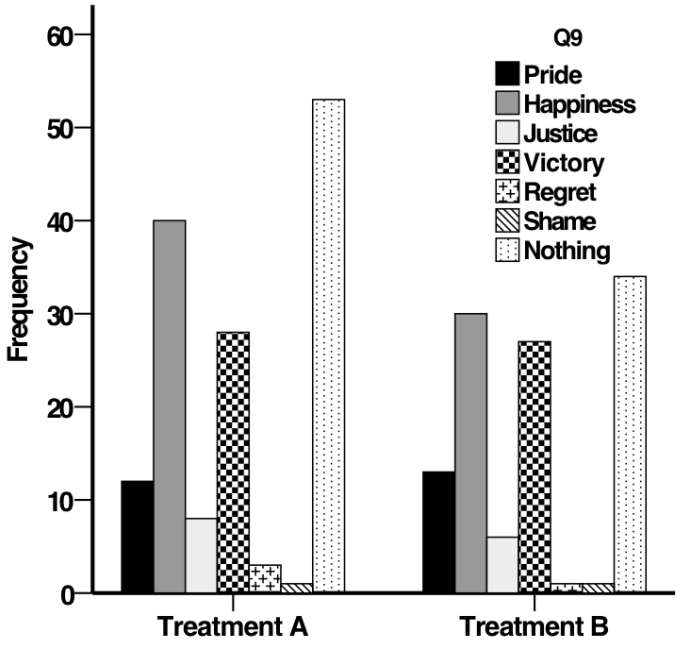

Figure 5.24: Answers to question: When you won more points than your opponent what did you feel? per Treatment

answers were similar for both treatments (Figure A.6 in appendix 1). Finally, most children answered they participated to win a prize (which shows their eagerness to compete, although many of them answered they were testing their winning skills specifically against others (Figure A.7 in appendix 1).

5.10 Results: Post-game interview analysis: Responses per Grade

The next step was to analyse how grades differentiated in their responses to the questionnaire. For question 8, the explanation of why 9th graders behaved spitefully more often than any other grade in Treatment B was clearly given here. Most 9th graders replied that they always retaliated to a spiteful strategy more than any other of the possible answers, and more than any other grade. 8th graders behaviour can also be somewhat explained here as more students either never or sometimes retaliated more than always, with the other grades not having a sufficiently different frequency of answers.

For question 8 there were no real perceivable differences in answer frequencies except for the fact that some students in grades 8, 10 and 11 expressed negative

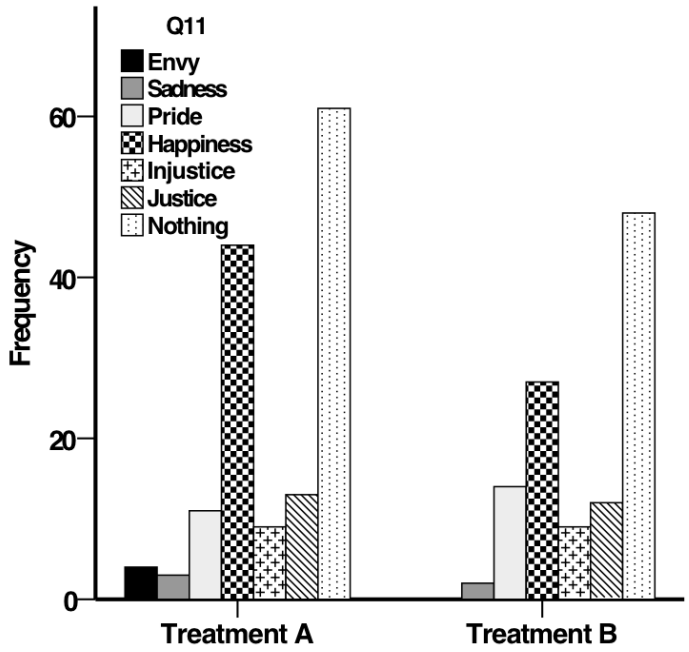

Figure 5.25: Answers to question: When both you and your opponent won many points together, what did you feel? per Treatment

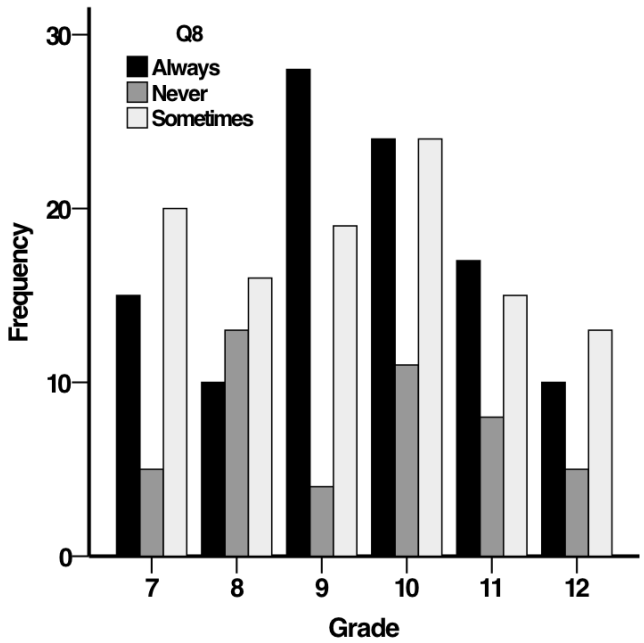

Figure 5.26: Answers to question: When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round? per Grade

feelings while most others did not (see Figure A.8. Also, 9th graders expressed more sentiments of happiness and victory than others.

Regarding question 10, there is a clear feeling of defeat demonstrated by 9th graders when confronted with loss of payoff. This suggest these students were knowingly comparing their points and felt the effects of loosing points more than other students (Figure 5.27). Older students (10th and 11th graders) also claimed to feel defeated by loosing points to their opponent, albeit not as much as 9th graders.

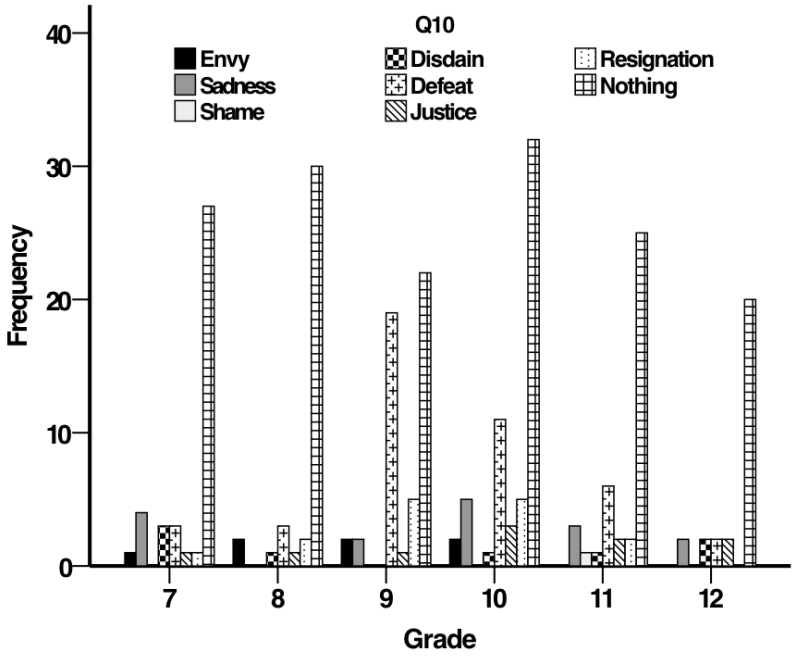

Figure 5.27: Answers to question: When your opponent won more points than you, what did you feel? per Grade

In Question 11, most students felt happy to be winning points with their colleagues across all grades. A small number of 9th graders answered they felt envy, although not significantly (See Figure A.9 in appendix).

Finally, Figure 5.28 shows students' responses to the question: what was the motivation for participating in the experiment. The answers chosen were aimed at identifying if their motives were purely rational[3] (win a prize) or competitive (wanted to beat others); if their aim was status competition (to show that I can win); or if they were altruistic or other-regarding (to please my colleagues or to please the teacher). As expected, most students replied in a rational way as they wanted to win a prize. The most competitive students were 9th graders, which

[3]Here, the term rational is used in the classic economical sense of maximising gains

could explain their high prevalence of spiteful behaviour. Interestingly, more 12th graders reported they had competitive motivations than 12th graders who had rational motivations, a behaviour which was not reflected by their game results. However, this reflects the fact that 12th graders replied they did not understand what to do in order to win a prize more often than any other choice (Figure A.10 in Appendix 1).

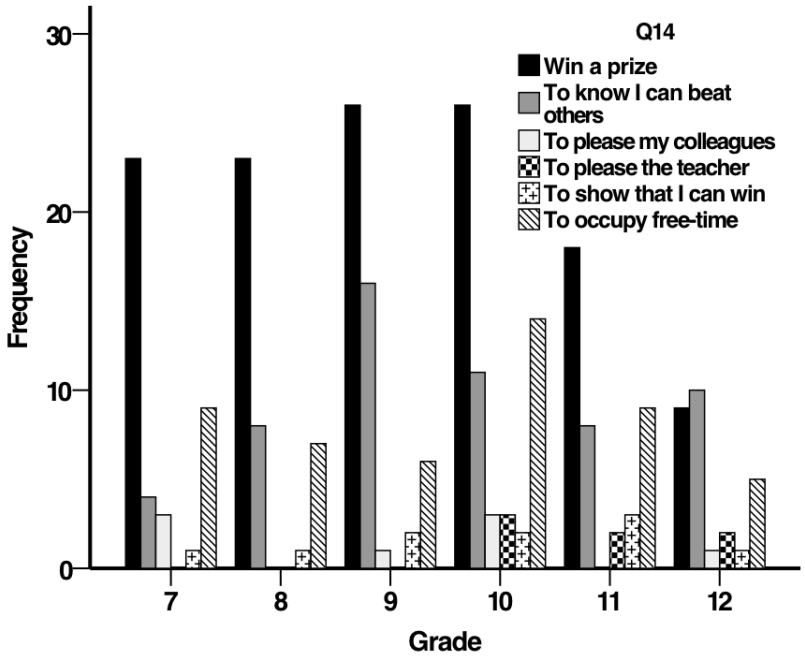

Figure 5.28: Answers to question: What was your motivation for participating in the experiment? per Grade

One of the questions asked to students was whether they were only considering their own points (rational view) or whether they were considering their and their opponent's points (other-regarding view). Even though the question *per se* did not provide much information, comparing the students' answers with others would confer if there was a behavioural pattern or not.

The first comparison to be made was Question 6 (When playing did you only think about your points or both yours and your opponent's points) with Question 8 (When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round?). This comparison was meant to understand whether students were consistent in their behaviour. If more students answered they were only thinking about their points in question 6, then they should answer never to question 8 more often than any other answer. Students who only thought about their points on the other hand replied they retaliated sometimes more often than any of the other answers. Only a few

students replied they never retaliated to spiteful strategies for both groups.

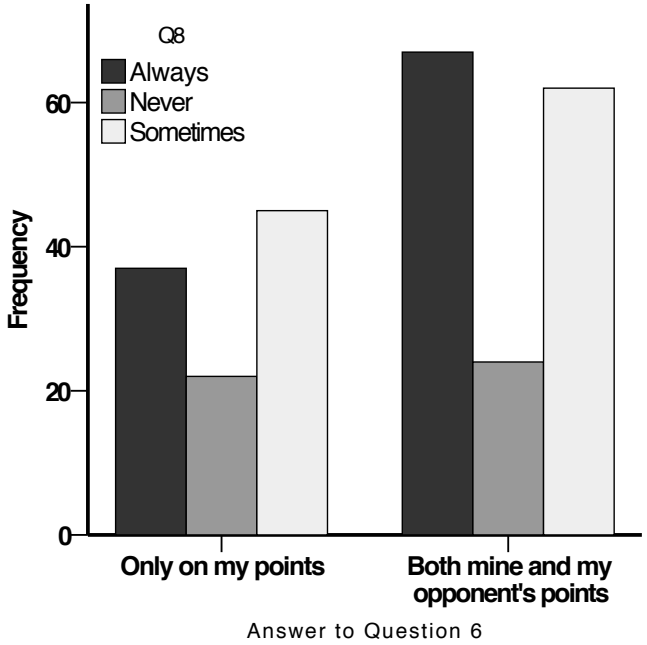

Figure 5.29: Answers to question: When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round? per answers to question: When playing, did you prefer winning many points, or beat your opponent, regardless of the number of points you won? $\chi^2_{(2)}$=2.179, $P = n.s.$

The only other positive result was obtained when comparing answers to question 12 between answers to question 6 (Figure 5.30. Here, students who compared their points with their opponent's were clear in answering more often that they understood what to do to win a prize. Students who only considered their points however, divided their answers between yes and no, with a slight upper-hand in the no answers ($\chi^2_{(2)}$=7.986, P<0.05; Spearman's Correlation =-0.176, P=0.05)

Another significant result occurred when comparing students divided by answers to question 7 (When playing, did you prefer winning many points, or beat your opponent, regardless of the number of points you won?) with the answers they provided for Question 8 (When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round?). Here, students who claimed they had higher competitive tendencies (i.e. preferred to beat the opponent regardless of the points), were clearly less inclined to never retaliate against spiteful strategies, when opposed to students who preferred winning many points ($\chi^2_{(2)}$=10.728, P=0.05; Spearman's Correlation =-0.055, $P = n.s.$)

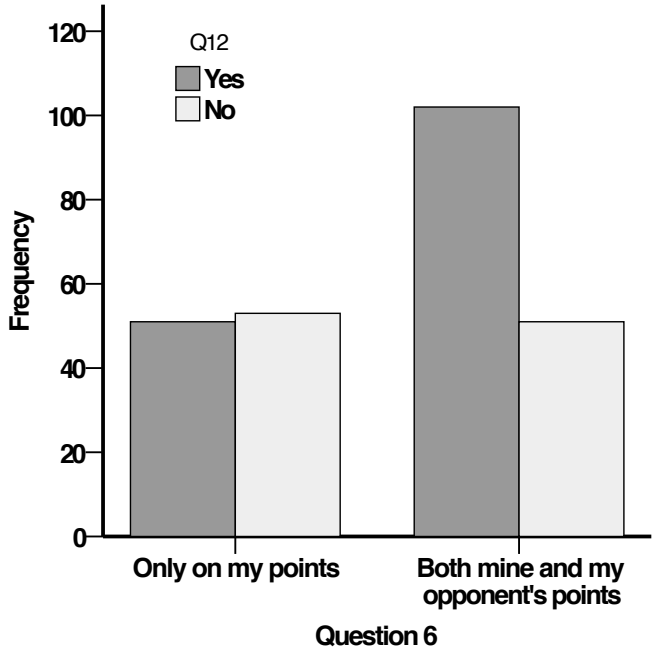

Figure 5.30: Answers to question: Did you understand which strategy you needed to play in order to win a prize? per answers to question: When playing did you only think about your points or both yours and your opponent's points?

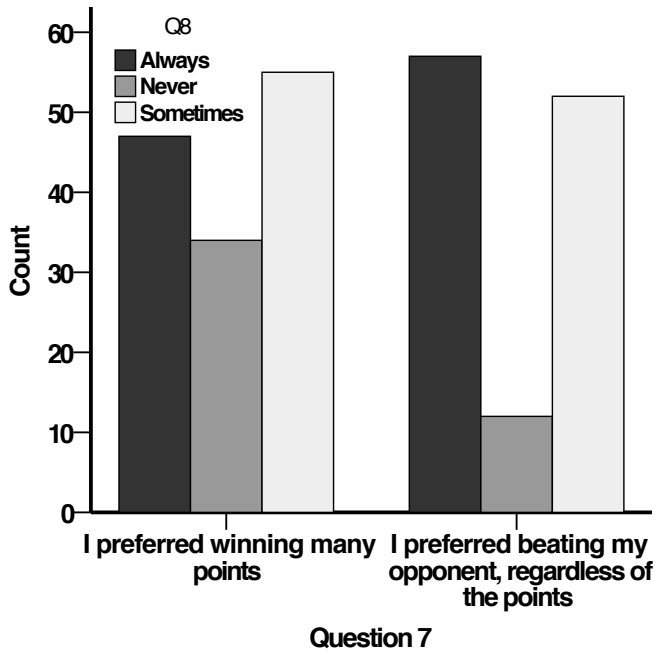

Figure 5.31: Answers to question: When your opponent played a strategy that reduced your points, did you want to fight back and reduce his points in the next round? per answers to question: When playing, did you prefer winning many points, or beat your opponent, regardless of the number of points you won?

5.11 Results: Post-game interview analysis: Responses per Gender

Students views on how they felt when playing the game were not influenced by gender, although performance in the game was, as seen above with Table 5.11. This could be explained by the fact that when asked if they understood what to do in order to win a prize, female students equally responded yes and no, while male students mainly responded yes. The result was not only significant for χ^2 but also there was a negative correlation between being in either gender and answers in Question 12 (Spearman Correlation= -0.190 P<0.05).

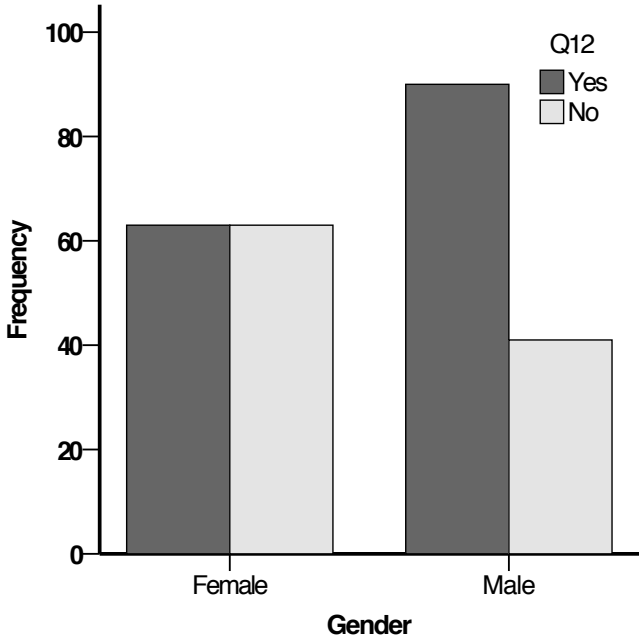

Figure 5.32: Answers to question: Did you understand which strategy you needed to play in order to win a prize? per Gender $\chi^2_{(2)}$=9.352, P<0.05

5.12 Conclusion

The results for the anonymous experiments were clearly different from those presented in Chapter 4. Overall, students were better maximisers than they were relativisers, with the exception of 14 year old 9th graders. It was also shown that overall male students performed better than female students in Treatment A and both performed equally poorly in Treatment B, which means that there is no

clear difference in spiteful preferences in genders, but there is a clear difference in maximising preferences in boys than in girls. Interestingly, repeating students were the most spiteful ones in Treatment B, which could point to age effects being in play. Finally, it seemed that 9th graders visions on the game as reported by their answers in the post-game questionnaire justified their behaviour. There were differences between genders in the ability to understand the experiment and the strategic differences of each Treatment, and students who answered that they compared their points with their opponent's felt more negative feelings when loosing points and more positive feelings when gaining points. Also, Students in Treatment A were more positive when a mutualistic outcome occurred (i.e. a $max; max$ equilibria) than students in Treatment B.

Next, the control group of students who played both treatments face-to-face[4] will be analysed, albeit with less detail than with this chapter.

[4]To remind the reader, the difference between the face-to-face interaction and the anonymous interaction was that students were told who their opponent was before starting to play the game (Refer to Section 3 for details on how this was controlled for)

6

Face to Face experiments

6.1 Introduction

The anonymous experiments of the previous chapter provided a surprising result when compared with the Azores experiment. However, given that the protocol was slightly different, it was necessary to test the anonymous protocol within a face-to-face context. Because, as stated in the methodology chapter (3) the sample size for this experiment was small, the analysis was not as extensive as in the previous chapter (5).

6.2 Descriptive statistics: Face-to-face experiment

The descriptive statistics for Treatment A in the face-to-face experiment are presented below in Table 6.1.

The total sample equates to only 24 subjects, which is approximately 3% of the total school population. The same poisson distribution seen in the anonymous experiments is reproduced here with a similar median (15).

When looking at the Age histogram (Figure 6.1), it is possible to see a high skewness towards 14 and 15 year olds, which in the anonymous experiments were the age groups more responsible for spiteful behaviour. Male and Female

students were in a 1:1 ratio, although female students were underrepresented in Treatment B (37.5%). Another important aspect that should be highlighted is that the sample in Treatment B is half the size of Treatment A and only contains two grades (9th and 11th).

Table 6.1: Descriptive statistics for the face-to-face experiment sample

Treatment	Frequency	Percent
A	16	66.7
B	8	33.3
Grade		
9	10	41.7
10	4	16.7
11	6	25
12	4	16.7
Age		
14	6	25
15	7	29.2
16	2	8.3
17	2	8.3
18	1	4.2
19	3	12.5
20	3	12.5
Gender		
Female	12	50
Male	12	50
Total	24	100

6.3 Results: Treatments A & B

Because sample size is small and not all grades were represented in the face-to-face experiment, overall data will be pooled for each Treatment. Starting with Treatment A, the first analysis performed was a binomial test on the entire sample. The 16 students that participated in the experiment played a total of 320 strategies. The observed proportion of max plays was significantly different to the observed proportion of min plays (max prop.=0.60, min prop.=0.40, P<0.001) when compared with the randomness threshold 50%.

After demonstrating that there was no clear difference in overall students behaviour in the face-to-face experiment when compared with the anonymous experiment in Treatment A, their choices during the 20 rounds were analysed to

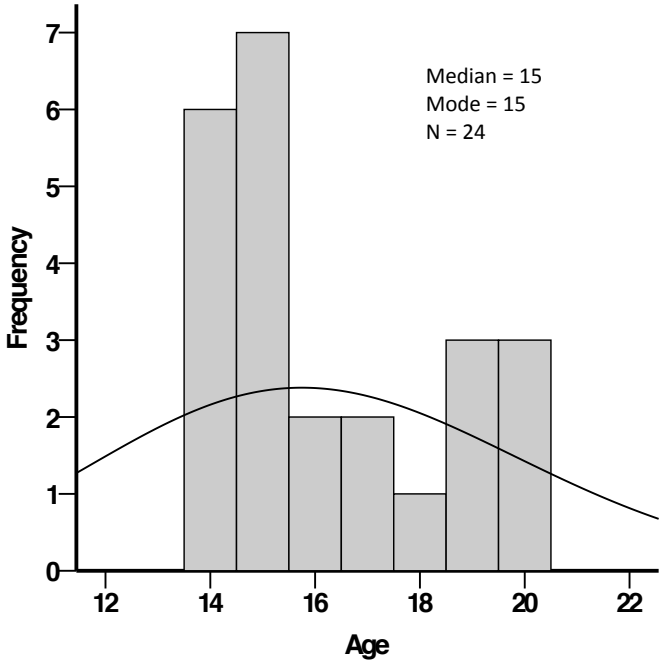

Figure 6.1: Age distribution histogram for the face-to-face study sample. The sample presents a poisson distribution curve with Median = 15, Mode = 15, Skewness = 0.652 and St. Error of Skewness = 0.472.

see whether the same pattern emerges (Figure 6.2. Overall, students behaved in a very similar way in Treatment A of this experiment to that of the anonymous experiment. However, the tit-for-tat (Axelrod & Hamilton, 1981) like behaviour was more pronounced in the face-to-face context as students started out by playing max 88% of the time, then plunged to 40%, then back again to 75%, and so on and so forth. This means that there was more retaliatory behaviour when students knew who their opponent was and comparing payoffs was normal when in a face-to-face context.

Next, the choices made be each of the genders in Treatment A were analysed. Looking at Figure 6.3, it is possible to see that in a face-to-face context, female students played both max and min strategies more often than male students. Although in the case of max strategies this is purely an artefact of there being more females in the sample, the same thing cannot be said of min plays which are significantly greater than chance in a binomial test (P<0.05).

Because there were only 8 students in Treatment B of the face-to-face experiment, there would be no statistical test that would allow a proper analysis of the results except for overall behaviour. Overall, students did not perform well in this treatment and max was chosen 58% of the time and min was chosen 48% of the time (N=160). When looking at the overall frequency of max and min plays

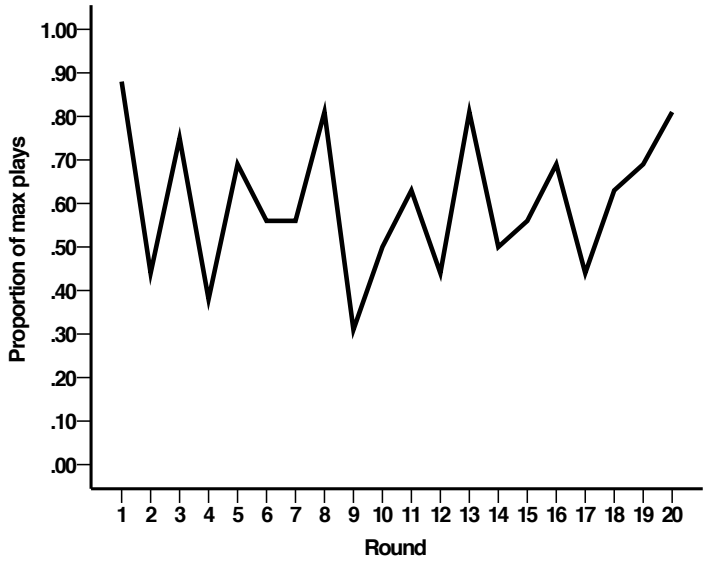

Figure 6.2: Total max plays during the 20 rounds of Treatment A face-to-face experiment. Binomials tests for each round yielded the following significant results: Round 1: max prop=0.89, P<0.05; Round 8: max prop.=0.81, P<0.05; Round 13: max prop.=0.81, P<0.05; Round 20: max prop.=0.81, P<0.05

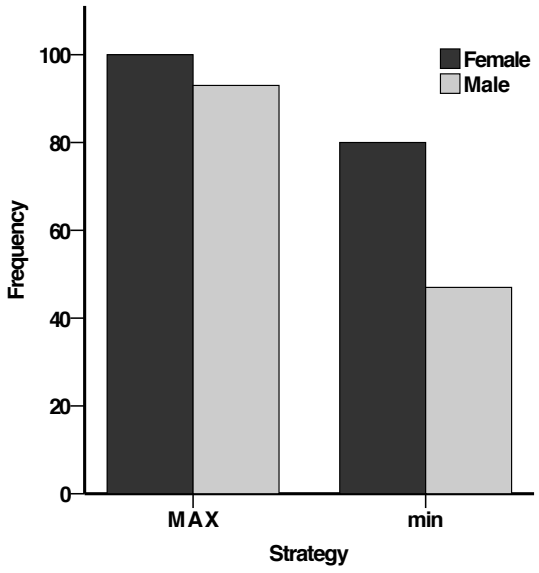

Figure 6.3: Total max and min plays for males and females in Treatment A.

for both grades represented (9th and 11th, Figure 6.4), it is possible to see that 9th graders did not perform the same way in the face-to-face experiment as they did in the anonymous experiment, while 11th graders randomised their strategy choices.

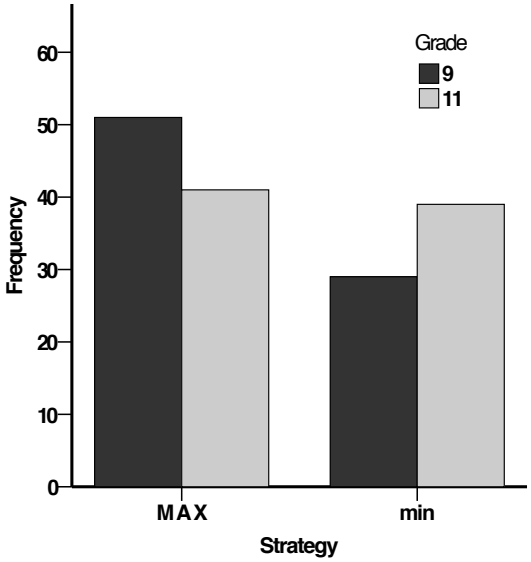

Figure 6.4: Total max and min plays for 9^{th} and 11^{th} in Treatment B.

Overall behaviour during the 20 rounds was characterised by the same oscillation seen in Treatment A (Figure A.11 in appendix). However results

6.4 Results: Post-game interview

In terms of the post-game interview, only one answer elicited a significant response from the students in Treatment A. When asked whether they preferred winning many points or beating their opponent, regardless of the number of points, 9th and 10th graders answered the former more often than the latter ($\chi^2_{(3)} = 7.543$,P< 0.05), meaning they clearly understood the prize system for this Treatment. No significant answers were found for the students in Treatment B.

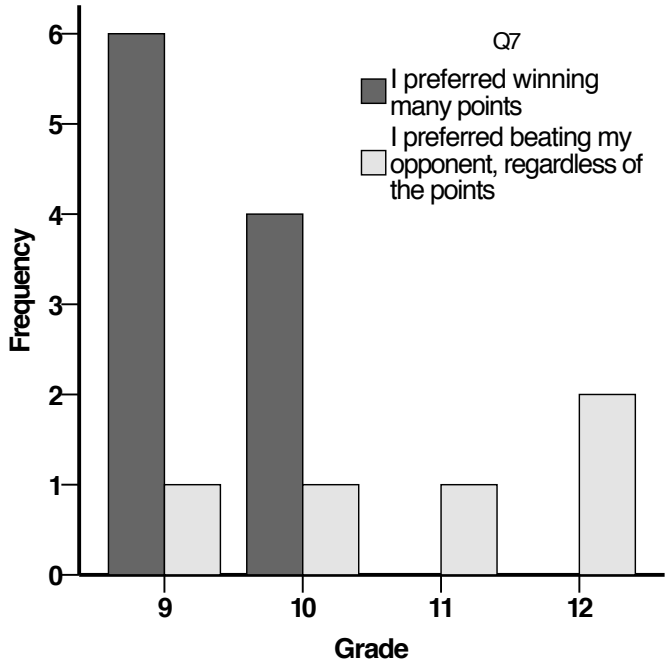

Figure 6.5: Answers to question 7, when playing did you prefer winning many points, or beating your opponent, regardless of the points you won? Per Grade.

6.5 Conclusion

In this experiment, it was possible to see that students continued the trend seen in the previous chapter (5) for Treatment A. However, students were behaving more as tit-for-tatters and their plays oscillated from high max to low max quite often. Nonetheless, this could be an effect of the sample size. Contrary to the previous chapter's results, 9th graders understood what to do in order to win a prize, according to their responses from the post-game interview.

In Treatment B, students again did not play spitefully at any age, and even 9th graders who were the most spiteful players in the anonymous experiment did not perform well here. Again, sample size is a problem and the results at hand could be an artefact of that shortcoming.

This chapter concludes the results from the computer experiments with the Spite Game. In the next chapter (7), the preliminary results of the dictator game will be analysed.

7

The Dictator Experiment

7.1 Introduction

The spite game presented in the previous chapters was devised to be played by children and teenagers. However, in order to test the ontogenic argument, it is necessary to understand how younger children behave when presented with a maximising and a spiteful strategy. Because of the somewhat complex nature of the spite game, another experiment was devised to study children's behaviour in the first four years of school. The dictator game is a game where a subject is presented with two or more options for a prize allocation between herself and an unknown partner. After making the choice, the prize allocation is definite and the subject receives her payoff with the other individual receiving the payoff while remaining anonymous before the decider. This anonymity allows for the subject to act freely without fearing later "consequences" from her partner, making the subject's choices more "natural", so to speak (Henrich, 2005; Fehr & Fischbacher, 2003).

This particular game was inspired by that of Hager and colleagues (2012) for studying envy in two different cultures (german and indonesian children) and was modified in order to better fit the payoff differences of our spite game (see section 3.2.3 for details on the methodology and payoffs). Here children could choose between a 3/5 (option A) candy allocation and a 2/1 (option B) candy

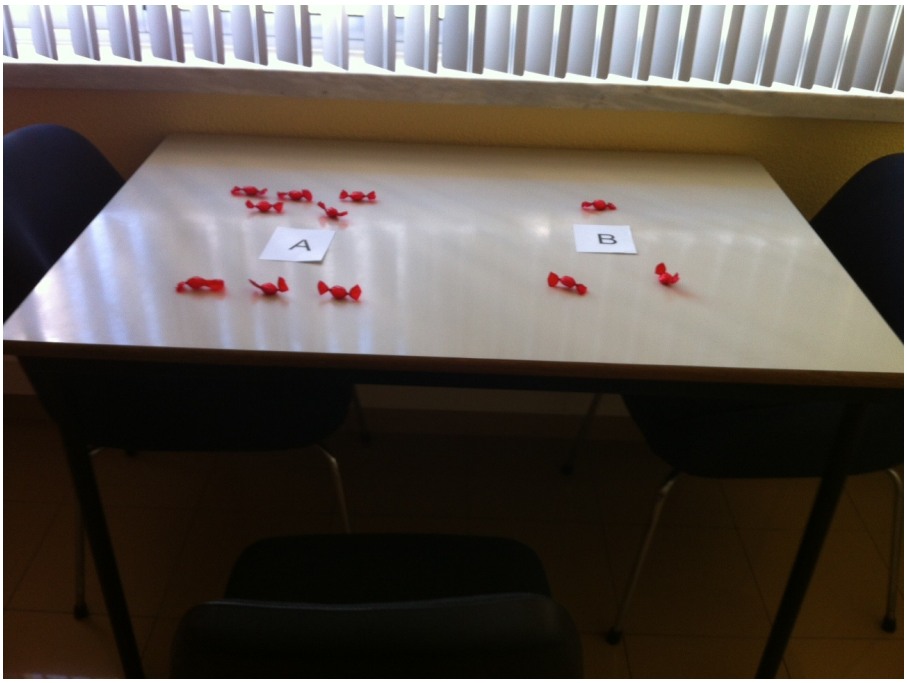

Figure 7.1: Experimental room with the table setup for the dictator's choices

allocation. If choosing option A, children are being altruist if they considered their colleague, but at the same time being maximisers if they only consider their payoff, as rational choice theory suggests (Tversky & Kahneman, 1986; Bicchieri, 2003). On option B on the other hand, children are being spiteful because they rather loose 1 candy to take 4 away from their colleague. Because this experiment did not muster enough participation authorisations from parents in order for its results to be considered as solid, this chapter must be taken in mind as a preliminary study aimed at finding patterns that would be better studied in the future[1].

7.2 Results: Choice analysis

Before the study started, children who received authorisation from their parents were given a brief introduction on the study and participated in a pre-test in order to verify if they understood how the game was played. The teachers were in the classroom when the explanation was being made and the pre-test performed and verified that all students that received authorisation passed the pre-test.

[1]Only 54 authorisations were received from parents out of a total sample of 180 children. Also, not all teachers showed interest in the experiment and did not send out authorisations to the parents

After passing the pre-test, teachers randomly assigned the participating students in pairs without the children's knowledge. Then, each "dictator" student was given a Decider code and a matching Receiver Code went to the appropriate receiver. The students playing the dictator role were then called to a separate room where they were presented with the table as shown in Figure 7.1 below. As the children walked in, they were asked to sit down and make their choice, bearing in mind that the candy below the letter were for them and the candy above the letter were for their colleagues. After making their choice, the receivers were then called in to receive their allocation of candy and asked whether or not they would reject the offer and make both students loose their candy. This question was asked in order to provide a comparison with the ultimatum game.

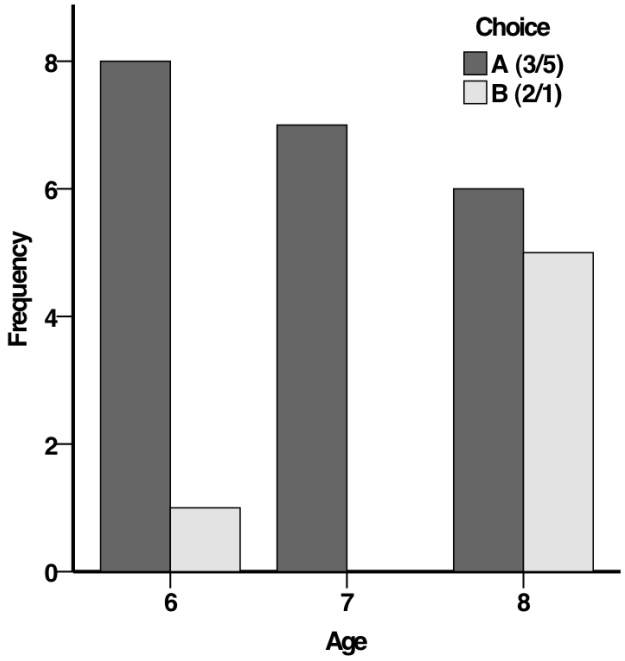

Figure 7.2: Frequency of dictator choices per age.

Overall 27 children of the 1st(N=9), 2nd(N=10) and 3rd grade (N=8) participated in the study as deciders comprising the ages of 6 (N=9), 7 (N=7) and 8 (N=11). Mean age was 7.07 $\pm$ 0.874. In terms of gender, there were 59.3% females and 40.7% males. Overall, children preferred the first option with 78% of Children choosing option A and only 22% of children choosing options B (Binomial test: P<0.05). When separating children by their respective grades, 8 out of the 9 1st grade dictators chose option A and only 1 chose option B (3/5 prop.=0.89, 2/1 prop.=0.11, P<0.05). Second graders followed the same pattern with 9 out of 10 children choosing A and only one choosing B (3/5 prop.=0.90, 2/1 prop.=0.10, P<0.05). With 3rd graders however, there is an emergence of spiteful subjects

with half of the children choosing A and the other choosing B (3/5 prop.=0.50, 2/1 prop.=0.50, $P = n.s.$). When looking at children's behaviour in terms of age, it is possible to see that there is an increase in spiteful subjects as students get older (see Figure 7.2). When looking at gender behaviour, there was no difference between boys and girls' behaviour in choosing either option A or B (see appendix Figure A.12).

7.3 Results: Post-game questions analysis

After knowing how children behaved as deciders in the dictator experiment, it was necessary to understand their intentions and beliefs regarding why they were choosing each option. For that, a series of questions were asked to each one after they had made their choice (see section 3.2.3 for detailed questionnaire).

7.3.1 1st grade

When asked why did they choose their option, all children that chose A identified selfish reasons for their choice, as their answer was mainly "because I wanted more candy for myself" or variations thereof. Following this question, children were asked whether they felt they were being nice to their colleague, wanted more candy for themselves or both. Here, four children maintained the rational paradigm and answered they wanted to get more candy for themselves, three children answered both, and only one answered he was being fair to his colleague. When asked if they thought the candy allocation was fair, 7 out of 8 children answered no, meaning that they were aware they were being rational but did not agree with the inequitable distribution of candy and felt they were loosing to their partner. Only one child answered yes for fairness. Curiously, the child that answered he was being fair to his colleague did not agree the choice was fair for him.

The child who chose option B on the other hand, answered with what seemed to be a clear spiteful intention: "This way my colleague gets less candy". This means the child was more concerned in taking candy away from his colleague. His answer to both the following questions was yes, meaning he chose B so that he could have more candy than his opponent and that he was happier because they both have less candy. In fact, this child specifically displayed inequity aversion, a behaviour already explained as one of the possible precursors of spite and

altruism (Hauser et al., 2009; McAuliffe et al., 2013; Forber & Smead, 2014).

7.3.2 2nd grade

For 2nd graders who chose A, when asked why they chose that option, 4 out of 8 said they wanted their colleague to have more candy, 2 of them said it was because they had more candy to themselves, one simply said he preferred the letter A and finally one said it was random. When asked the follow-up questions, 6 of them agreed they were specifically fair to their colleague, and two of them answered they were being fair to their colleague and wanted more candy at the same time. Also, only three children did not agree the distribution was fair, and one of them said he didn't mind it being unfair because he already ate too many things he shouldn't! However amusing this last answer is, there is a clear shift in the children's answers from the 1st to the 2nd grade. While in the former, children were acting under a rationality principle and displayed behaviours of inequity aversion, the latter were acting under a fairness and altruistic principle and found the distribution to be fair.

The one child who chose option B, this time acted under a preference principle and said he just wanted less candy for himself, not agreeing that he wanted more than the colleague and not being happy that they both had less candy.

7.3.3 3rd grade

In 3rd grade responses, we can see a clear cognitive leap in the explanations provided for their choices and also an increase in spiteful preferences. Of the 4 children that chose A, 3 said they wanted more candies (one of them even answering she was a bit of a sweet-tooth) and one said everybody would win that way. All of these said they were being both fair to their colleague and wanted more candies at the same time. Interestingly, only one of them considered the allocation fair, and the child that mentioned that everybody would win actually did not share this opinion.

Regarding the children who chose B, there is an interesting effect that might be explained by gender differences in friendship behaviour discussed in chapter 2 (see section 2.3.8.1). Two of the B choices were of girls who said they wanted to share the other candy with someone else, meaning they specifically had a person in mind to share with (one of them mentioned her sister, the other did not specify)

and completely disregarded their receiver. To the follow-up questions, one of them had selfish interests because she did not want to eat much candy and the other answered she wanted to share. None of them were happier the other party had less candy.

The two boys on the other hand, described they did not want to give 5 candies to their colleague. While one of them said he wanted to have more than his receiver, the other said he wanted a more equal distribution, meaning he responded yet again in terms of inequity aversion.

7.3.4 Responder analysis

In terms of responder analysis, all the receivers who were given 5 candy (A) answered they were happy with their allocation and that they would not reject the offer and take the candy away form the decider (the only exception was a girl who was declared as autistic by her teacher, and who answered that she was happy with the candies she got, but she also would reject and take the candy away from the colleague if possible; another girl was a foreign student and did not understand either of the questions). Of the receivers who were given only one candy (B), the receiver in the 1st grade said he was happy and would not reject, behaving in rationally in the classic economic sense (Tversky & Kahneman, 1986), the receiver in the 2nd grade was not happy with the allocation but would not reject the offer either, meaning that the child did not display spiteful tendencies. Finally, the 3rd grade students who received 1 candy, both boys, were neither happy with their allocation and would reject to take away their candy and their colleagues, if possible.

7.4 Conclusion

The dictator experiment allowed some patterns of behaviour to emerge that reflect those already reported by previous studies (Fehr et al., 2013). Younger children seem to act rationally in the classical economic sense, while inequity aversion and fairness starts developing as they get older. This brief report shows that it is possible to evoke the ontogenic argument when applying a much simpler protocol to children of a younger age. Further study, expanding sample size and geographical reach would allow this experiment to pinpoint when spiteful preferences start emerging during childhood and would help understand when

these preferences could be tackled by professionals in order to improve not only children's school performance in school, but also how they relate to others.

8

Discussion

The previous chapters that dealt with results (4, 5 and 7) presented the findings on the game theoretical experiment that was the starting point of this thesis. Because the analysis was lengthy, this chapter will be divided into sections and subsections with the interpretation of the results obtained.

8.1 Spiteful strategies in the Azores experiments

The Azores experiment (Chapter 4) introduced the spite game in a face-to-face context and showed that younger subjects preferentially played the absolute maximisation strategy max in both Treatments. On the other hand older students, especially 10th graders, tended to play optimal strategies in both Treatments (i.e. max more often in Treatment A and min more often in Treatment B). Overall, students clearly understood the purpose of the experiment as in Treatment A max was played more often in Round 1 then declined over the other 4 rounds, while only a few students played min in Round 1 of Treatment B then slowly increased this strategy (d'Almeida et al., 2014). When looking at factors that influenced students' behaviour, probit analysis revealed that min strategies were more common when they were not advantageous. A possible explanation for this phenomenon is that students perceived treatment A across all grades as a coordination game and min responses triggered reciprocal and vindictive behaviour as reported by

Fehl et al. (2012) in previous game-theoretical experiments with adults. This could have occurred either as punishment against a non-coordinating individual or simply out of pure spite to inflict loss of payoff to the opponent.

The best description for the students' behaviour is the win-stay lose-shift strategy (Nowak & Sigmund, 1993). This type of strategy entails dividing plays into successes and failures, according to a specified expectation. For example, on the one hand, if a play in the previous round meets the expectation of success, then an individual stays in the same strategy in the following round. On the other hand, if the play is a failure, the individual switches strategies. Despite max being the rational maximising strategy, the probability of playing min in any Round was highly influenced by not only min plays, but also payoffs and relative payoffs of previous Rounds. This means that students were comparing their gains with each other and envy and consequent anger towards the other player's could have drove them to reduce the effective max plays after most of them started playing correctly. Previous findings claim that socialisation practices that affect altruistic and competitive behaviour impact at similar ages and the circumstances that drive each of these behaviours are acquired with age (Benenson et al., 2007). Other studies have reported that spiteful strategies are more common in pre-school children with greater cognitive capacity, as they are inherently more complex (Bügelmayer & Spieß, 2011). In Treatment B, grade was influential in the decision of playing min in the first round, meaning that older, more cognitively developed students were slightly better at a competitive game than younger students.

Nonetheless, students behaved more often as expected in Treatment A than in Treatment B and max strategies were preferred more often then chance. One possible explanation was that reputation effects were at play. Because students were in the same class and already knew each other, acting spitefully in this experiment could have had negative consequences for the students' friendships in the future. Also, the fact that the teacher was present and ran the experiment could have made students to act in order to please the teacher. Moreover, it is not possible to rule out the influence of gender in students' behaviour because it was not collected as a parameter in data analysis. Nonetheless, the results could mean that students were simply expressing altruistic (Fehr et al., 2013) and other-regarding preferences (Hardy & Van Vugt, 2006) which start developing at the end of pre-school years (Thompson et al., 1997).

Spiteful strategies were clearly not dominant in either Treatments, but were

nonetheless played more frequently than expected in Treatment A. The existing evidence for spiteful strategies being used in experimental studies has shown that they do occur in dictator and ultimatum games (Fehr et al., 2011; Levine, 1998) and to a lesser extent in two player symmetric games (Fehr et al., 2008b).

8.1.1 Shortcomings of the Azores experiments

One of the possible problems of the study was the fact that prizes in the form of candy and chocolate may not have provided enough motivation for older students (Fan, 2000). Also, there was no collection of gender data nor of students' underlying motivations for participating in the experiment, which made it difficult to understand whether or not students were taking the experiment seriously. Another potential problem was that, due to logistic considerations, the study was conducted without the author's presence. Overall, it cannot be ruled out that effects out of the researcher's control could have influenced how children decided how to choose.

Another important shortcoming is the fact that some of the students had to be removed from the sample. 6th graders, 9th graders and 11th graders were removed, which does not allow a more careful analysis of the plays across all years.

8.2 Spiteful strategies in anonymous experiments

In summary, the anonymous experiments showed that in Treatment A most subjects preferred selfish but mutualistic strategies that allowed a sharing of points that would make both players succeed. Students also acted this way when it was not in their best interest to do so (Treatment B). In a sense, most children were "rational" in the Treatment that involved coordinating to achieve a better result (A), but were not rational when their prize depended on outcompeting their opponent by maximising the payoff difference between them(B). The exception to this rule were students from the 9th grade students, particularly between 13 and 14 years old.

In detail, the first result that stood out was that 7th graders responded quite well in Treatment A and were the overall best performers in this Treatment, contrary to what happened in the Azores experiment (d'Almeida et al., 2014). In Treatment B, 7th graders did not play min significantly more often than max.

Once again, it is possible that the cognitive apparatus necessary to perform well in the more complex Treatment B was not yet fully developed (Bügelmayer & Spieß, 2011). The only grade that clearly understood Treatment B was the 9th grade (13/14 year olds). Older students aged 15 to 22 (10th to 12th grades) also tended to behave randomly or played max more often than min. This could be a reflection of the tendency to accept disadvantageous inequality more often in ultimatum games at later stages of adolescence (Almås et al., 2010; Fehr et al., 2011). Also, Treatment A promoted what are known as Egalitarian types (Fehr et al., 2011). These prefer equal allocations of payoff for both parties independent of who wins. Altruistic types however, will value the other's payoff positively with the opposite occurring for Spiteful types. Fehr et al. (2011) discovered in a dictator experiment with children and teenagers aged 8 to 17 that not only egalitarianism, but also spitefulness decrease with age in opposition to altruism. On the contrary, parochialism (preferring in-group to out-group) was found by Fehr et al. (2011) to increase with age. The difference between dictator experiments and 2x2 games such as the one used here in chapters 4, 5 and 6 is that the result depends on both players decisions and that it is played across twenty rounds and not a single decision. This means that players can choose which type they are throughout the experiment according to their beliefs and motivations for the game. However, if a player is more intended on matching her opponents' plays, in Treatment A playing max will make her egalitarian (as both players can win 15 points) while on Treatment B would make her altruistic (as she incurs in the chance of loosing 10 points) The differences in types for both Treatments are in the final prize attribution. Because the player always wins something in Treatment A, regardless of the number of points, the risk in choosing max is lesser than in Treatment B as she is pursuing self interest. On the opposite side, playing min in Treatment A is a truly spiteful behaviour, because the individual is readily declining both her game payoff and the final prize in order to maximise the difference between her and the opponent, while in game B it is a delayed benefit spiteful behaviour because in order to outcompete the opponent, an individual must win less points herself in order to win the prize.

Results in Treatment A could be explained by the same phenomenon as found by Charness & Rabin (2002). In their studies, subjects were more concerned in increasing overall player payoffs than reducing payoff differences. Charness & Rabin (2002) also found that reciprocity was one of the subjects' main motivations: Whenever anyone refrained from acting similarly (i.e. changed strategies or consistently chose a strategy that would lead to payoff differences) , there was

a concern in punishing these types of players. In the present study, probit analysis demonstrated that spiteful responses to max were highly influenced by payoff differences and plays in previous round. The non-conformity of students to the expected outcome could have provoked punishing behaviour from students who were concerned in maximising both players' payoffs. When looking at the player's responses to previous rounds, both their opponent's and their own, it was possible to see that most players sought to copy max strategies, and less often but also significantly, to continue playing max strategies in the following rounds (See Figures 5.7 and 5.9 in Chapter 5). This can have two possible explanations: i) in Treatment A, the majority of subjects understood that max was a mutualistic and hence egalitarian strategy as defined by Charness & Rabin (2002) and Fehr et al. (2011); ii) students chose their strategies solely based on previous events and immediate payoffs without considering the final prize, as was identified in extensive experiments of rock-paper-scissors games by Wang et al. (2014).

Results in Treatment B showed that 9th graders clearly preferred spiteful strategies more often in Treatment B than 9th graders preferred mutualistic strategies in Treatment A. This means that there could be an increased eagerness to compete in students entering their teen years (14 year olds). Also, individuals can be experiencing a drive to assert "toughness" as a gender role by being more competitive according to their colleagues' perceptions (Eliasson et al., 2007). This result was also confirmed in the post-game questionnaire, as students in this grade answered they most often retaliated when their opponent played a min strategy in the previous round. Moreover, when asked their motivation for participating in the experiment, 9th graders answered more often than students in other grades that they wanted to participate to know that they could beat others. Another indication of why 9th graders were better at Treatment B than A, was given by their answers to the question of how they felt when their opponent won more points than them. Here the sentiment most used by 9th graders was defeat rather than envy, or disdain[1].

When pooling results, younger students in the 7th grade played min more often than max in this Treatment, despite differences not being statistically significant and only 8th graders played max more often than min. When looking at how the different age groups played Treatment B, spiteful preferences remained

[1]Please note that most students replied they felt nothing. Nonetheless, the number of 9th graders who responded they felt defeat (19 students) was rather close to those who reported feeling nothing (24 students), while the latter answer was preferred by the wide majority of students in the other grades.

fairly stable with peaks in 14, 18 and 20 year olds (decline in 22 year olds was due to there being only one student of this age) contrary to Fehr et al. (2011). When looking at Probit models, it was shown that the max responses to min were highly influenced by payoff, relative payoff and previous plays more often than any other factor or co-variate. This was corroborated by the previous round analysis where students rarely continued playing min. Instead, they rather either copied their opponents' max plays (grades 8 and 10) or copied their min plays more often (grade 9). This corroborates what was argued earlier in that students engaged in tit-for-tat strategies rather than paying attention to the prize, a characteristic that is common in prisoner's dilemma games (Axelrod & Hamilton, 1981).

Interestingly, teachers concerns about how their repeating students would perform in the experiments were quickly dispelled when students engaged in Treatment B, the competitive paradigm. When only analysing repeating students separately by grade, they were playing more min than max strategies with non-significant differences. However, repeating 14 year olds in the 7th grade played min significantly more often than max. This means there is a clear age effect of 14 year olds. Fighting for status is a strong possibility for explaining these results. In essence, repeating students are placed in an out-group with a new hierarchical establishment that an older student would feel confident in overthrowing. It could also mean that the emergence of cognitive skills coincides with an increase in competitiveness in these first years of adolescence, which is compensated later with the emergence of the capacity for cooperation, derived from the development of self-control and a more complex rationality This will be discussed in the following section.

8.2.1 How does status seeking influence spiteful behaviour?

Status seeking is a clear influence in competitive behaviour (Fiske, 2012; Gaspart & Seki, 2003; Loch et al., 2006a) and individuals will often compare their status position when interacting with others (Elster, 1986; Fiske, 2012). However, when hierarchies are established, status seeking is often played down by the individuals within a given group and give way to cooperative or mutualistic interactions (Geary, 1999). Here, it was seen that in the Treatment where students had to beat their opponent in order to win a prize (B), repeating students played the optimum strategy more often. This could have two explanations. First, older students with more developed cognitive skills (Fiske, 2012; Bügelmayer & Spieß, 2011) could have been paired with younger students. However, this should have

made older students in their correct grades be preferentially more spiteful than younger students in their correct grades, which was not observed. Second, the fact that repeating students are moved from their original group and placed in a new group with possibly already formed friendships and bonds might have caused older students to want to assert their dominance and status before others.

Informal observation was made before and after the experiment was conducted to understand some of the students' behaviour. After experiments were over, some students (always male) were very keen on wanting to know their colleagues' scores by asking out loud "who won?". They were clearly not asking who won out of the competing pair, but out of the whole class. This means that some students felt the need to compare who was the best in that particular sample of students who participated in the experiment. Comparative behaviour is hardwired into the human brain (Fiske, 2012) and is highly important to establish how individuals value themselves. Another possible explanation is that punishing other students who failed to conform to behaving as mutualists in Treatment A might have made individuals feel like they would be gaining reputation that would later aid them in status seeking behaviour (Nowak & Sigmund, 2005).

8.2.2 How does gender affect spiteful behaviour?

The theoretical background discussed that gender differences in behaviour are a mix between cultural background and biological pre-disposition. For example, women were frequently classified as a more egalitarian type than men, and less often as altruistic type (Fehr et al., 2011) and that males tended to be more risk-prone than females (Wilson & Daly, 1985; Zinkhan & Karande, 1991; Byrnes et al., 1999; Schubert et al., 1999), with parental background often influential in risk taking behaviour. In the present study, male students had more competitive and less altruistic interests for participating in the experiment, meaning that they wanted to "see if they could beat their opponent" rather than to please their classmates or teachers. Also, male students answered they retaliated to min strategies with min strategies more often than female students and were more confident in asserting they knew what strategy to play in order to win a prize. Interestingly, the main differences found between males and females in this study were that the former were either more selfish or more mutualistic (in the sense that they played max more often across rounds than females in the entire sample). In the 9th grade in Treatment B, where the most spiteful individuals were found, almost all participants were males (72.2%). Whether this gender bias was one of the main causes

for spiteful behaviour to be widespread in this grade is debatable, as males and females were equally spiteful when pooling all grades together.

8.3 Comparing Face-to-Face against Anonymous results

The face-to-face game displayed very similar results to the anonymous interaction in Treatment A, with the exception that tit-for-tat behaviour appeared to be more prominent. Almost 90% of students started out by playing max and then oscillated throughout the rounds. In this Treatment, female students played min strategies more often than males. One of the explanations for this phenomenon could be simply an effect of the low sample sizes, however, considering female relationships as discussed in section 2.3.8.1, it is possible that female students felt that their colleagues were "betraying" them by playing a strategy that would make them win less points. This would have led to the tit-for-tat (Rapoport & Chammah, 1966) and win-stay-loose-shift (Nowak & Sigmund, 1993) like behaviour seen in this experiment.

8.4 Spiteful behaviour in dictator games

The dictator experiments performed for this research identified that younger children gave selfish motivations for choosing the 3/5 option, whereas older students gave altruistic motivations for choosing the same option. Spiteful choices however started to emerge in 8 year olds in the 3rd grade. These results support previous findings that showed spiteful preferences emerging spontaneously in 3 to 6 years old Fehr et al. (2008a) and more often than chance at ages 5 to 8 in face to face experiments (House et al., 2012). The results also agree with studies that reported that younger children have more selfish tendencies and that altruistic choices increase as children become older (Fehr et al., 2008a; Harbaugh et al., 2003; Hook & Cook, 1979). Because the study did not measure kinship as a parameter, it was not possible to confirm if children tend to be selfish towards unrelated individuals (Damon, 1977; Eisenberg & Fabes, 1998). Nonetheless, it was possible to ascertain that younger individuals are more concerned with maximising their own payoff than taking into account their colleague's payoffs, as predicted by Camerer (2003). In line with Hager (2010) and Hager et al. (2012), 8 year olds

in this study were also developing spiteful choices at higher rates than younger students[2]. Also, male students were more spiteful than female students. Female students who did choose the spiteful option were more concerned with sharing their prize rather than with their self-interest. These findings also corroborate what has been reported by Gneezy & Rustichini (2004) that boys are more competitive than girls and also data that state that males are more interested in their relative standings than girls (Charness & Grosskopf, 2001).

8.5 Final remarks

8.5.1 Envy and spite

Envy was described as the feeling that triggers the psychological mechanism that could later elicit spiteful behaviour. Only a very limited number of students reported feeling envy for loosing points to their opponent or when opponents won the same amount of points as they did. If taken at face value, then it should be recognised that the argument that related spiteful behaviour to envy and beliefs in the evil eye are incorrect or at least lack further investigation. However, it was discussed that envy is a feeling that is commonly repressed in many cultures. Moreover, belief in the evil eye is meant as a protection for envious and spiteful individuals and individuals who share this belief tend to downplay any sort of achievement that might cause envy from others (Baldacchino, 2010; Elworthy, 2008; Galt, 1982). There could also be the tendency to counterbalance the negativity of this emotion with the belief that by being envious one is balancing the scale of equality between the envier and the envied. It is also very plausible that students refrained from reporting envy because of the experimenters presence, even though their anonymity was assured at all times. It should also be taken into account is that maybe, expressing such feelings does not equate agree with the gender roles expected of some of these students (Eliasson et al., 2007). Envy implies paying a cost in order to improve relative standing (Hager, 2010; Hager et al., 2012), which is also within the definition of spite in this thesis. As spiteful choices were non-negligible in any of the experiments performed, it could be said that students actively compared their standings relative to their opponents and

[2]Unfortunately, I was unable unable to collect for children above 8 years old (4th grade) because the school where the experiments were held did not offer this grade due to the agglomeration of schools into mega-groupings by the Regional School Board. This means that it was not possible to understand whether the same phenomenon as reported by Hager et al. (2012), where children 9 and above behaved with more altruistic rather than spiteful concerns.

were often willing to pay costs in order to improve them.

8.5.2 Competition and spite

As stated in the methodology, the spite game compared two different types of competition: one absolute (and at the same time mutualistic): meaning that both players could win the maximum prize; and one relative: meaning that the individual with the most payoff would win the maximum prize. Students did perceive the experiment to be competitive as most of them replied their motivation was winning a prize. In informal observations prior to, and following the actual experiment, I witnessed that most male students engaged in competitive discourse, such as "I'm going to beat you". Some students also commented that certain others would be easy to beat because they were "dumb" and had bad grades in mathematics. This behaviour is natural in young males as competition is part of their daily lives (such as sports for example) (Gneezy et al., 2003; Gneezy et al., 2006; Geary, 1999). The present experiment showed that male students were better at competitive interactions that resulted in mutualistic outcomes, except for individuals in their early teen years (14 year olds). This phenomenon could be explained by hormonal factors that come into play at that age for males, reflected in the clear link between testosterone levels and competition (Booth et al., 1989). However, female students were proportionally as spiteful as male students in Treatment B (see section 5.7). Nonetheless, the grade that had less female students in the experiment (under 30%) was that one where students were more spiteful. This can either reflect one of two things: i) it is not possible to ascertain if female students would be as spiteful as male students in this grade; or ii) that gender-bias itself was the cause of spiteful behaviour. Previous findings state that individuals are willing to pay to reduce other's income (Zizzo & Oswald, 2001) and have shown that relative positions make people happier than absolute positions, i.e., people are better off comparing themselves better than someone else, rather than considering themselves to be well (Charness & Grosskopf, 2001; Solnick & Hemenway, 1998). Other-regarding preferences are also the basis of altruism. In essence, altruism and spite could be considered as two-sides of the same coin (Vickery et al., 2003; Johnstone & Bshary, 2004) and one could not exist without the other. Comparing our own position with that of others is hard-wired into the human brain (Fiske, 2012), which means that spite and altruism must have evolved together in the anatomically modern human lineage (Possajennikov, 2000). In this study, altruistic other-regarding preferences

were found in dictator experiments in children ages 7 and upwards, and spiteful other-regarding preferences emerged in 8 year olds. In the spite game, only negative other-regarding preferences were studied and it was shown that male students in early teenage years were the most spiteful.

9

Conclusion

9.1 What has been said

This thesis set out to understand how spiteful strategies are used by children and teenagers and if these are ontogenically acquired. It set out to do so by firstly proposing that spite is a stable strategy in nature, and given that populations are small, or that the competition arena is small even within a large population, spite will emerge as a successful strategy. I also provided examples on how spiteful behaviour can rise if one considers the scale of competition rather than full population size. Given that competition in a population may not occur between all individuals, but rather within a small subset of that population, then the question of spite needing small numbers to evolve disappears because that subset of the population might be small enough to make it advantageous. Spite was also found to be scarce in nature and not present in chimpanzees, which are our closest animal relatives. This could mean that spite is a behaviour that is only present in the anatomically modern human lineage and does not have deep evolutionary roots in the hominin evolutionary tree. Despite there being few examples of spite in nature besides social insects and certain bacteria, Wilsonian spite is more common in humans because of emotional effects, and notions of inequality aversion and envy, and possibly because it entails a disposition in humans to take interactions in the present as part of potential chains of interactions in the future.

When reviewing classic social anthropological literature, I argued that reciprocity systems of trade such as the potlatch and the kula were spiteful in nature. This is because the actual gift itself implies not only gifting of valuable resources, but also their destruction with the underlying intent of gaining status. Status however, was not immediately gained and there was an ever present suspicion involved in any potlatch or kula endeavour. I also argued that one of the evidence that points to the spiteful nature of reciprocity exchange systems is the use of magical punishment for those who do not payback their gifts as this type of punishment was reported to cause great harm to those who practiced it (paying a cost to inflict greater harm on another).

I also looked at how certain beliefs such as the evil eye could be considered as a protection against spiteful individuals. This is because the evil eye is related to envy, which is the emotion that leads to spiteful action. It was seen that classical mediterranean studies provided examples of structures that promoted intense cooperation in the familial context (similar to the kin selection theory) and intense competition and envy towards other families, under a shroud of reciprocal performance. What Sahlins (1972) coined as negative reciprocity outside the realm of the household was argued as akin to both Wilsonian and Hamiltonian negative relatedness, which was one of the prerequisites for spiteful behaviour.

Gender differences in competitive and cooperative behaviour were also discussed, and it was found that males are more competitive and more risk prone than females, however, when a hierarchy is already established, males tend to band together more easily than females because of the patrilocality effect. Females on the other hand, tend to form one-on-one bonds more often with other females and are more competitive when trust is broken among them. Parochialism, or the preference of in-group individuals and de-humanisation of out-group individuals, is also more strongly associated with males than females; however, this can be an effect of males preferentially acting on this motivation through aggression and violence than females.

Finally, I looked at cross-cultural economic decision making and found that most individuals respond to experimental economic games much in the same way as they do in their social life. Individuals in highly cooperative groups tend to offer as much as 50% of a total sum to be divided by two people with high acceptance rates, while individuals in groups that participate in reciprocal exchange systems offering sometimes above 70% with high rejection rates. This means that economic games are a valid way of assessing and quantifying specific behaviours

that can provide ethnographic data a means to be statistically compared.

The next step was to identify the underlying psychological mechanisms of spiteful behaviour. Emotional reactions were discussed as being adaptive in the sense that these are a 'quick and dirty' way for the brain to assess a given scenario. It was also argued that emotions were not universally felt and that some cultures put much emphasis on repressing certain emotions. In order to understand emotions as universal I looked at the theory of emotional algorithms. These are certain emotional processes that are engaged according to competitive, and cooperative motivations, reflecting the needs of acquiring resources and status on the former and reciprocation and group identity on the latter. Each of the emotional algorithms is called upon when individuals are in one of these situations and can act as a trigger mechanism to elicit or suppress a given action. These were linked to neurological processes as areas of the brain light up when people react to other individuals. The neurological basis for parochialism was also discussed and found to be highly linked with a lesser activation of the brain areas responsible for perceiving human qualities in others. This is important as spiteful behaviour towards out-group individuals could be a consequence of strong emotions hard-wired in our brains to ensure the protection of those that are close.

Finally, I reviewed the sociological literature. This final section was intended as a justification of using experimental game theory as a social science method. First I discussed how game theory has been used in sociology and how it has been a valid method in assessing strategic behaviour. Next, I provided a primer in game theory explaining how it works how it is possible to understand human behaviour using this tool. The question of status and how it is always present in human interaction was addressed. Finally, I presented the case of status seeking and costly punishment as a precursor of humans altruistic capabilities. It was apparent that the choice of individuals to punish non-cooperators, at a cost to themselves and with no immediate benefit, allows cooperation to survive. This costly punishment, which I argue is spiteful in wilsonian terms, is indeed one of the foundations for human cooperation.

After the extensive literature review, the methodology chapter introduced the model that was the basis of this thesis. I argued that spite can be manifested in three ways: malevolence (implying incurring a loss to provoke greater loss in another), status competition (incurring a loss to provoke a greater loss in another leading to a possible future gain) and punishment (incurring a loss to provoke a greater loss on another, leading to an eventual future group gain). These three

forms encompass both Hamiltonian and Wilsonian spite as they focus on both the positive and negative aspects of other-regarding preferences in humans. Next, I introduced the populations being studied, the protocols used during experimental procedures and the questionnaire applied to students after the game. The students took part of an experimental study that involved two Treatments. Treatment A awarded a prize for both players proportional to their accumulated payoff and Treatment B awarded a prize for the player with most points. This means that Treatment A analysed spiteful behaviour in terms of malevolence and Treatment B analysed spiteful behaviour in terms of status competition.

The first results chapter presented the findings of the preliminary experiments pursued in the Azores islands. Here, a face-to-face version of the Spite Game was presented to students from 6 different schools and findings suggested that students are more adept at choosing selfish but mutualistic strategies and that older students were more cognitively equipped to understand the strategic differences between both Treatments. Nonetheless, spiteful strategies were being played throughout the experiment in both treatments, albeit the reasons underlying such choices were not clear due to shortcomings identified for this experiment.

These shortcomings were addressed in the following experiment performed in mainland Portugal within a single school (Chapter 5). Here, Rounds were increased in order to maximise sample size, gender was taken into consideration as a parameter and a post-game questionnaire was applied to students in order to assess their psychological state. Here, the reader found that students in the 7th grade were those that understood Treatment A better, and 9th graders were spiteful more often in Treatment B than they were rational in Treatment A. Also, Students min responses in Treatment A were the result of payoff comparisons with their opponents and they preferentially copied opponent's max plays in the previous round, consciously matching payoffs to attain a better result and punishing those who did not conform to this behaviour. It was also found that repeating students were of no influence in the results obtained.

In Treatment B, it was possible to see that 14 year olds were the students most responsible for spiteful behaviour. This occurred not only in the 9th grade (the natural grade for 14 year olds), but also when 14 year olds repeated their year. Even more substantial was the fact that they always played min more often than max in Treatment B, across all grades that had repeating students. Probit analysis verified that decision to respond to min plays was highly influenced by payoff,

relative payoff and decisions in the previous round. However, players did not choose to copy min plays in a previous round more often than they chose to change strategies, meaning Treatment B elicited tit-for-tat strategies rather than win-stay-loose shift strategies as in Treatment A.

Regarding gender differences in behaviour, it seemed that considering the overall sample, male students were more adept at matching payoffs in Treatment A than female students, while both genders were not prone to spiteful strategies in treatment B. In the face-to-face computer experiments although, female students were shown to be more spiteful than their male counterparts. Face-to-face control experiments also demonstrated that students were more prone to acting as tit-for-tatters than in the anonymous experiments, mostly because they preferred punishing the other player more often with spiteful strategies.

Finally, dictator experiments were consistent with earlier findings showing an increase in spiteful and altruistic preferences in children aged 8, and that younger children acted as rational maximisers. However, results were not conclusive due to low sample sizes.

9.2 Answers to the questions posed in the introduction

After summarising the main arguments and conclusions of this thesis, the answers posed in the introduction should be answered. In order to do so, a list will be provided with the questions, their answers and the justification based on the results and arguments of the thesis.

1. If indeed gender differences and cognitive capacity are related to an individual's spiteful affinities (in the sense of taking into account other's payoffs or results), should this mean a shift from absolute to relative grading in evaluations?

   No and Yes. No, because students overall seemed to respond better to egalitarian and altruistic principles, meaning that an absolute grading system such as the one in place now in Portuguese schools is the better option. If students are better at matching payoffs, it would mean that a system that would allow students to coordinate their studying efforts in order for everyone to achieve a better grade would be best suited. In this study, boys were better at matching

payoffs with their opponent than girls, but both genders were equally poor at maximising payoff differences. Because the portuguese school system uses an absolute method of grading without gender separation, then in light of the results in this thesis, the current system is more than adequate. However, it is also possible that students behaviour was influenced by the education system itself.

Yes, because it seems that repeating students have completely different behaviours in regards to competition. Because repeating students are taken away from their main network of interaction, and put in another network of interaction that has individuals that have already formed bounds and friendships, the need to compete for status and to assert themselves will be higher. This means that mixing together several repeating students might lead to dysfunctional class-rooms because status competition would be more common than banding among boys. In the case of girls, it seems that they are more prone to spiteful behaviour in face-to-face interactions which could cause disruptions in terms of group work, competition for grades etc. However, this does lead to a chicken or egg type of question. Does being a repeating student cause these children and teenagers to act spitefully, or is being spiteful and responding better to relative and not absolute grading systems the cause of failing and having to repeat the year? Of course this is not a simple question and many factors could have influenced why a specific student fails at a specific subject. However, one solution to understand why some students struggle could be to give them the opportunity to use their competitive drive in school by allocating them tasks in which the grade is given in a relative rather than an absolute system.

2. Do spiteful individuals also preferentially act altruistically, taking into account that both mechanisms require other regarding preferences, ultimately resulting in inequity aversion?

   No. Although results in the Spite Game cannot answer this question specifically, results in the dictator game can. Students who acted spitefully rejected earning more in order to reduce opponent's payoffs and specifically answered they considered the distributions to be unfair. Students who were not spiteful, on the other hand, were able to choose the outcome that made them distribute more candy to their colleague and get more candy for themselves.

3. How does accounting for spiteful strategies improve on how institutions are devised and thought about?

According to this study, spiteful strategies were preferentially used as a punishing mechanism in Treatment A. In Treatment B, spiteful strategies were needed to win a prize and only students in early adolescence played accordingly. Also, repeating students played spiteful strategies more often than mutualistic strategies in this Treatment. This means that individuals placed in novel environments will tend to be more competitive and could use spiteful strategies in order to get ahead at the expense of their colleagues. If repeating students are better at using spiteful strategies than mutualistic or cooperative ones, this should be taken into account when attributing educational tasks and how these students are evaluated in order to understand whether underperformance at school relates to lack of competitive stimuli.

4. Is it correct to state that smaller groups are better at cooperation when there is evidence that reduction in the scale of competition makes the evolution of spite viable even when whole populations are considered (Gardner & West, 2004a; Hamilton, 1970; West et al., 2006a)?

   According to this study, yes. Lowering the scale of competition of the classrooms to only two individuals did not increase the drive to compete, and be spiteful. However, it did elicit tit-for-tat behaviour and punishment of individuals who did not want to conform to maximisation, which students considered as the norm for Treatment A, thus making students re-assess their strategies. This means that spiteful punishment was seen in this study as a means to attain coordination between students.

9.3 Shortcomings of the study

The shortcomings for this study are mostly concerned with three issues: i) the Azores experiment not taking into account gender, students' feelings and considerations on the game they were playing, and the fact that teachers had to run the experiment due to logistical concerns; ii) the fact that the experiments had to be run class by class because of school scheduling issues and therefore it was impossible to compare if students in the same grade but in different classes would behave differently; and iii) that the sample sizes for the face-to-face computer experiments and the dictator experiments were too small.

These concerns are important because they could have contributed for a better and more in depth study, however, logistical and time-constraints derived from school scheduling limited this possibility. Moreover, the Ministerial authorisation

process was highly time consuming and not all parents provided their children with authorisation to participate in the study. This limited the capacity to start experiments early and also the number of subjects available.

9.4 What has the study contributed

The present study has presented as a main contribution to the field a new game paradigm, the Spite Game. This game allows comparing spiteful and mutualistic motivations in a round game rather than the normal one-shot encounters that are highly unrealistic. It was also suggested that, overall, children and teenagers in the observed Portuguese schools are more concerned in being mutualistic than they are in being spiteful. However, spiteful strategies were shown to be used as a punishing mechanism, tying the study well with previous predictions of costly punishment as a strategy for the emergence of cooperation. It was suggested that children responded better to absolute payoff systems, where everyone can win together, rather than competitive payoff systems where prizes are won at the expense of one of their colleagues. Hopefully, the study has also contributed to social sciences with a quantifiable means of analysing certain strategic interactions previously difficult to analyse. Finally, this thesis has suggested that a school system based on absolute rather than relative grading is more adequate to (at least) the observed Portuguese students and that new evaluation and assessment tools could be applied to repeating students in order to improve their results. However, further investigation is still needed in order to fully understand spiteful strategies in children and teenagers.

9.5 Where do we go from here?

Because this study provides a new game paradigm that can be easily studied and applied to many places and locations, the possibilities for future studies are limitless. Besides increasing sample size and diversity, in order to achieve deeper and more significant insights, further targets should be set. Understanding how subjects behave without prior knowledge of the prize attribution rules should require further investigation, as well as how social network structure affects spiteful behaviour. Another important future study would be to pitch individuals and children who are kin against non-kin in order to understand if behaviour in the spite game reflects concepts discussed in this thesis such as kin selection

and amoral familism. Finally, cross-cultural comparison of behaviour in the spite game would shed light on how cultural background influences the use of spiteful strategies.

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Appendix 1

A.1 Computer experiment instruction sheet

Treatment A

- Olá, Bem vindo a esta experiência!
- Vais fazer parte de um jogo económico que te vai permitir ganhar um prémio. O teu prémio nesta variante vai ser dado de acordo com a regra seguinte:

  Vais ganhar 0.05 EUR por cada 30 pontos que acumules neste jogo num vale para o bar.
- O teu prémio vai depender das tuas escolhas. Tens apenas duas opções, a estratégia **M** e a estratégia **R**. A cada rodada vais acumular pontos que vão depender não só da estratégia que escolheste, mas também da estratégia que o teu adversário escolheu.
- Quando iniciares a experiência vais ver esta janela:
- Isto é a matriz do jogo. O computador vai indicar-te (em inglês) qual dos jogadores tu és. Se disser que tu és o row player, significa que és o jogador 1 e os teus pontos são os da esquerda, se disser que és o column player, então és o jogador 2 e os teus pontos são os da direita.

Figure A.1: Janela de Jogo para a Experiência

- Quando a experiência iniciar, vais poder clicar ou na estratégia **M** ou na estratégia **R**. Tens o tempo que quiseres para decidir, mas atenção, a escolha é final e não podes voltar atrás! Depois de tu e o teu colega escolherem, o computador avisa e podes clicar ontinueara prosseguires para a ronda seguinte.
- Poderás sempre ver quantos pontos tens e o que foi jogado pelos dois nas rondas anteriores clicando na janela istory mas nunca vais saber qual é a escolha do teu colega na ronda atual.
- Como funcionam os pontos?

  Por exemplo, se os dois jogam **M**, então ganham os dois 15 pontos (15.0, 15.0) se tu jogares **R** e ele **M**, então ganhas 11 pontos e ele 5 (11.0,5.0) Quando terminares o jogo, clica na janela da internet para responderes a um questionário rápido, depois disso podes ir levantar o teu prémio!
- Atenção, não discutas os resultados da experiência nem digas o teu username aos teus colegas para não influenciar as suas decisões! Isto é muito importante para os resultados desta experiência.
- Obrigado!

For Treatment B, the same text in portuguese was presented with the students with one exception:

Treatment B

- Olá, Bem vindo a esta experiência!
- Vais fazer parte de um jogo económico que te vai permitir ganhar um prémio. O teu prémio nesta variante vai ser dado de acordo com a regra seguinte:

  O jogador com mais pontos ganha 0.50 EUR num vale para o bar.
- (...)

A.2 Student post-game questionnaire: Anonymous computer experiments

Original portuguese version of the Post-Game questionnaire as presented in the GoogleDocs platform:

Agora que acabaste de jogar, responde por favor a estas perguntas. Escolhe todas as tuas opções e depois clica em "Submit" no fim. Depois disso podes levantar o teu prémio. Obrigado!

- Q1: Que idade tens?
- Q2: Qual o teu ano de escolaridade?
- Q3: És?

  1. Rapaz
  2. Rapariga

- Q4: Qual das variantes de jogo jogaste?

  1. A
  2. B

- Q5: Qual a letra do teu computador?
- Q6: Quando jogaste, pensaste só nos pontos que estavas a ganhar ou também nos do teu adversário?

1. Só nos meus pontos
2. Nos meus pontos e nos dele

- Q7: Quando jogaste, preferiste ganhar muitos pontos, ou ganhar ao teu adversário, independentemente do número de pontos ganho?

1. Preferi ganhar muitos pontos
2. Preferi ganhar ao meu adversŕio, independentemente do nÚmero de pontos que ganhei

- Q8: Quando o teu adversário jogava uma tática que te tirava pontos, na ronda a seguir também lhe querias tirar pontos?

1. Sempre
2. Nunca
3. Às vezes

- Q9: Quando ganhavas pontos ao teu adversário, o que sentias?

1. Orgulho
2. Felicidade
3. Justiça
4. Vitória
5. Arrependimento
6. Vergonha
7. Nada

- Q10: Quando o teu adversário ganhava pontos a ti, o que sentias?

1. Inveja
2. Tristeza
3. Vergonha

4. Desdém
5. Derrota
6. Justiça
7. Resignação
8. Nada

- Q11:Quando tu e o teu adversário ganhavam muitos pontos juntos, o que sentias?

1. Inveja
2. Tristeza
3. Orgulho
4. Felicidade
5. Injustiça
6. Justiça
7. Nada

- Q12: Percebeste que tática tinhas de utilizar para ganhar um prémio?

1. SIm
2. Não

- Q13: Se soubesses com quem estavas a jogar, jogavas da mesma forma? (Ignora se estás se estás a jogar a variante em que sabes com quem jogas) if playing face-to-face game)

1. Sim
2. Não

- Q14: Qual foi a tua motivação para fazer a experiência?

1. Ganhar um prémio

2. Quis participar para saber se ganhava aos outros
3. Quis participar para agradar os meus colegas
4. Quis participar para agradar ao professor
5. Quis participar para mostrar que sei ganhar
6. Quis participar para ocupar os tempos livres

A.3 Student post-game questionnaire: Dictator experiments

Original portuguese version of the questions asked after the dictators made their choices:

1. Porque é que escolheste esta opção?
2. (Se escolheu A) Sentiste que estavas a ser bom para o teu colega, ou querias mais rebuçados para ti?
   - Justo para o meu colega
   - Queria mais rebuados para mim
   - As duas coisas
3. (Se escolheu A) Achas que é justo que, só por ficares com mais um rebuçado, o teu colega fique assim com tantos?
   - Sim
   - Não
   - Outra
4. (Se escolheu B) Escolheste só dois rebuados em vez de três porque querias ficar com mais rebuçados que o teu colega?
   - Sim
   - Não

- Outra

5. (Se escolheu B) Ficaste mais contente por terem os dois poucos rebuçados em vez de ele ficar com muitos e tu só com três?

- Sim
- Não
- Outra

Chapter 5: Response to previous round treatment A

Here, Students preferred in the 7th grade also preferred to continue playing max while students from other years shifted strategy choices more often.

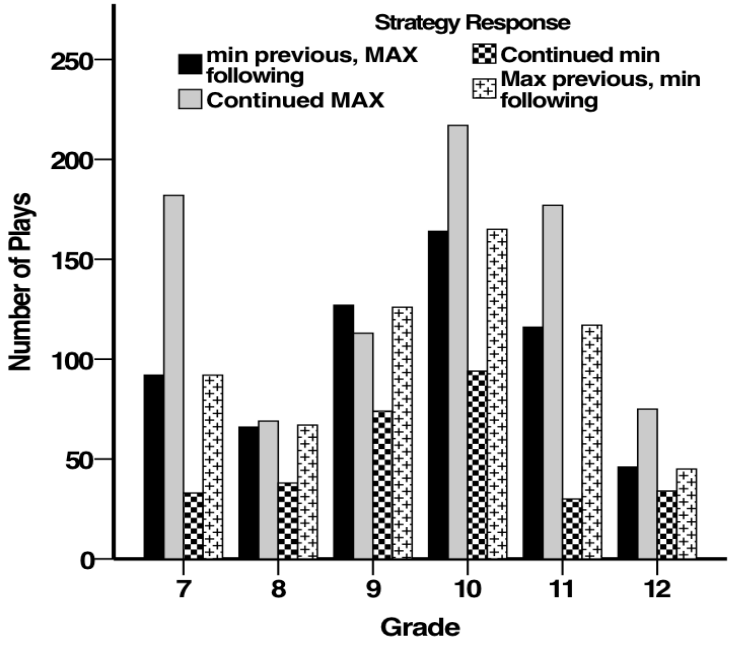

Figure A.2: Frequency of player's response to their own decision in the previous rounds per grade.

Chapter 5: Repeating students analysis

As can be seen in Figure A.3 below, removing repeating students from the analysis did not change overall trend in max plays. In Treatment B, removing repeating students slightly lowered the frequency of min plays as can be seen in Figure A.4. However results were non-significant.

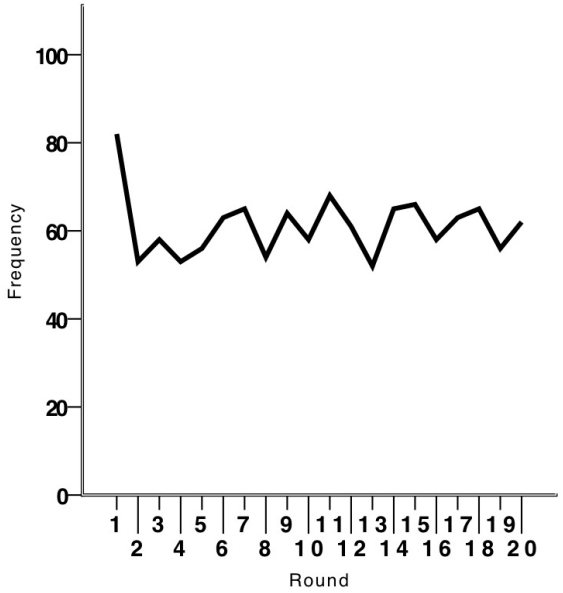

Figure A.3: Frequency of max plays in the 20 rounds of Treatment A, repeating students removed.

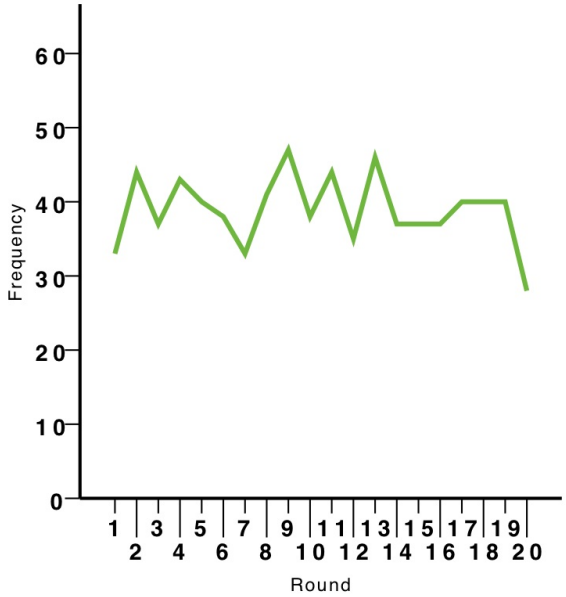

Figure A.4: Frequency of min plays in the 20 rounds of Treatment B, repeating students removed.

Chapter 5: Post-game questionnaire answers

In this section of the appendix, it is shown that defeat and sadness were the most common expressions of emotion among the students, when disregarding the answer nothing (Figure A.5).

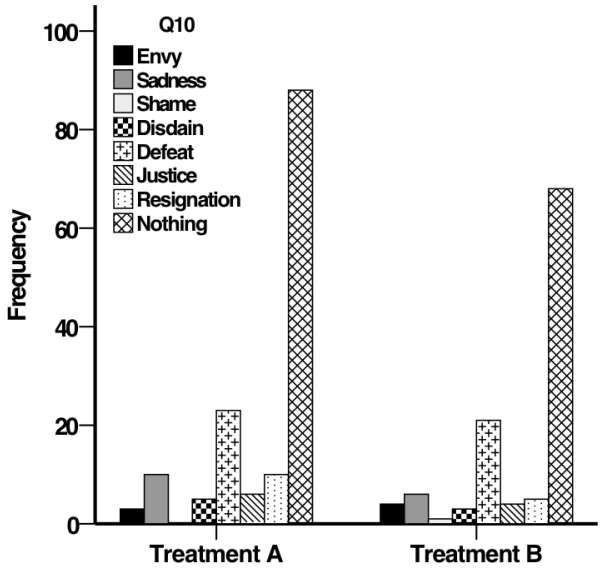

Figure A.5: Answers to question: When your opponent won more points than you, what did you feel? per Treatment

As the reader can see in Figure A.6 below, children participating in each of the Treatments provided similar rates of answers for the question "Did you understand which strategy to play in order to win a prize".

In terms of motivations (Figure A.7, children in either Treatments described they wanted to win a prize as the principal reason for participating in the experiment, followed by "to know I can beat others". This shows children had competitive motivations for participating in the experiment.

Students in the 9th grade explained they felt emotions such as Happiness, Victory and Pride, more often than nothing. Moreover, none of the children felt either regret or shame (Figure 5.24.

When winning points together (Figure 5.25, more students in the 9th grade answered they felt envy than any other students in the other grades. However, differences were non significant.

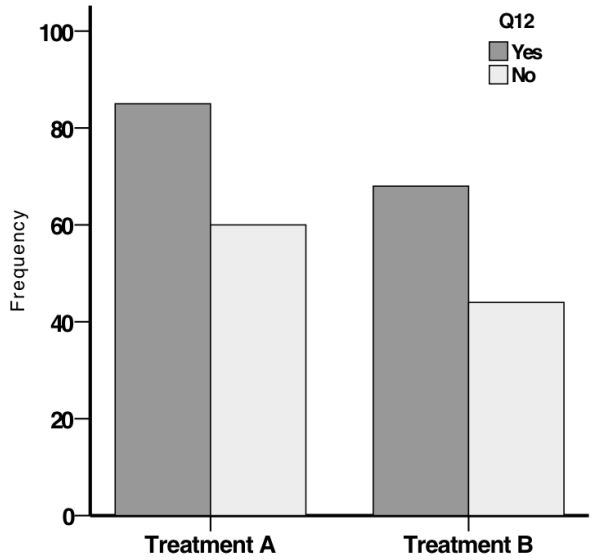

Figure A.6: Answers to question: Did you understand which strategy to play in order to win a prize? per Treatment

Finally, when considering if players understood which strategy they needed to play in order to win a prize, younger students claimed they knew what to do more often than older students (Figure A.7).

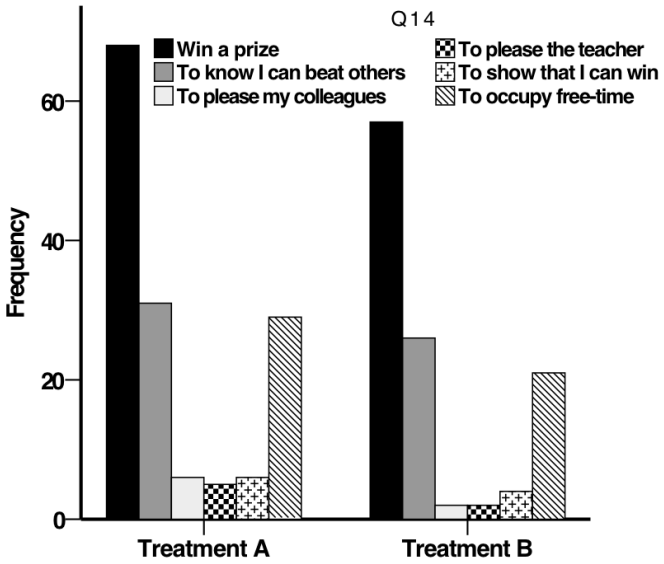

Figure A.7: Answers to question: What was your motivation for participating in the experiment? per Treatment

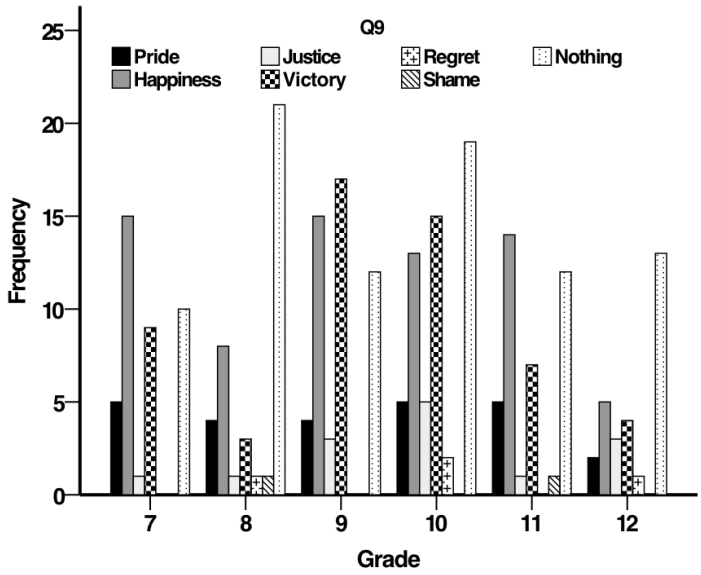

Figure A.8: Answers to question: When you won more points than your opponent what did you feel? per Grade

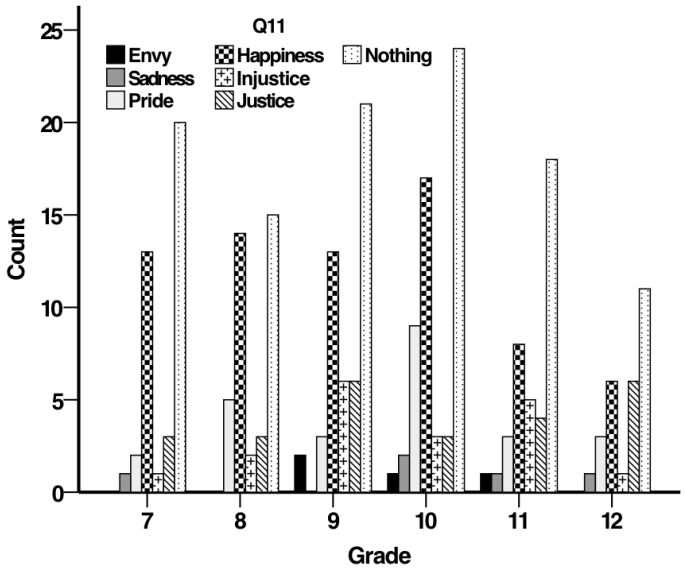

Figure A.9: When both you and your opponent won many points together, what did you feel? per Grade

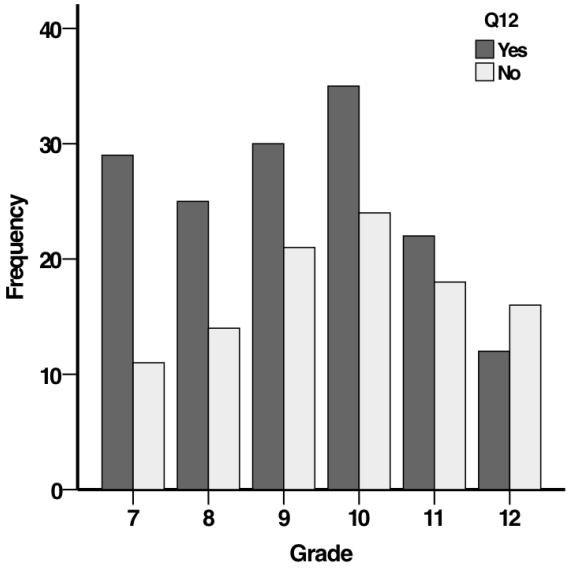

Figure A.10: Answers to question: Did you understand which strategy to play in order to win a prize? per Grade

Chapter 6: Face to Face experiments

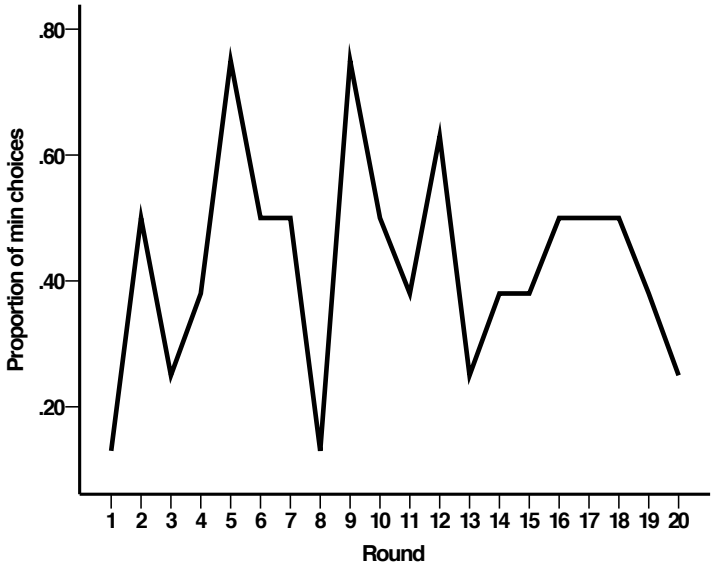

Figure A.11: Total min plays during the 20 rounds of Treatment B face-to-face experiment. Binomial tests could not be calculated for this Treatment due to low sample sizes.

Chapter 7: Dictator Game response analysis

As can be seen in Figure A.12, female students chose option B as often as males (although their motivations for doing so were not spiteful. For option A, difference in choice can be explained in terms of a bias in frequency of female children.

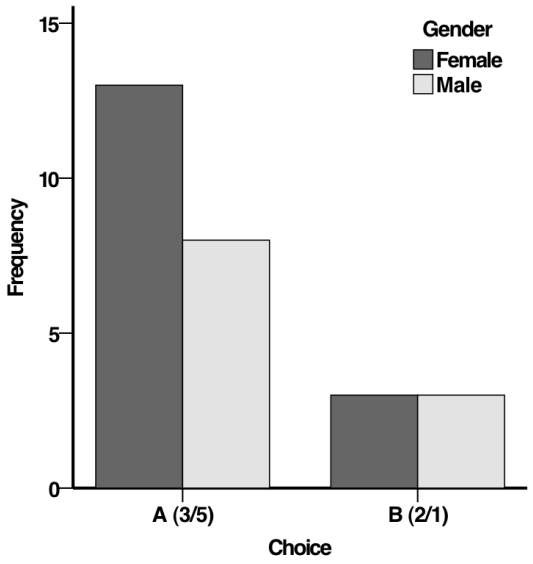

Figure A.12: Frequency of dictator choices per gender. Differences in female and male choices can be explained by differences in the gender ratio.