ASSOCIATION BETWEEN GAMES

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A THEORETICAL AND EMPIRICAL INVESTIGATION OF A NEW EXPLANATORY MODEL IN GAME THEORY

ASSOCIATIE TUSSEN SPELEN

EEN THEORETISCH EN EMPIRISCH ONDERZOEK NAAR EEN NIEUW VERKLARINGSMODEL BINNEN SPELTHEORIE

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Dedicated to Jaap van Dijk
(1955–1999)

I was trying to tell you that the search for explicative laws in natural facts proceeds in a tortuous fashion. In the face of some inexplicable facts you must try to imagine many general laws, whose connection with your facts escapes you. Then, suddenly in the unexpected connection of a result, a specific situation, and one of those laws, you perceive a line of reasoning that seems more convincing than others. You try applying it to all similar cases, to use it for making predictions, and you discover that your intuition was right. But until you reach the end you will never know which predicates to introduce into your reasoning and which to omit. And this is what I am trying to do now.

Umberto Eco,
"The name of the Rose"

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PREFACE

Being an economist I have always been fascinated by game theory. However, also being a philosopher I was raising questions about the foundations of economics, and especially game theory. This combination of economics and philosophy made me think about issues so–far overlooked or unresolved by game theory. In this dissertation I try to deal with one of those issues.

When joining the Erasmus Institute for Philosophy and Economics I had the idea of incorporating all kinds of different theories and ideas. I have learned that writing a thesis is narrowing down your ideas to comprehensible size. Obviously, this wisdom would not have been reached without my supervisors, Maarten Janssen and Jack Vromen. Their guidance and support have proven to be indispensable to me in completing this thesis. They were able to keep me on the right track when I was wandering off, and kept me alert by always asking the right questions.

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Furthermore, I want to thank Daniel Doornink who designed the cover of my thesis. You managed to come up with the most incredible and magnificent design reflecting all the abstract ideas of this thesis.

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During the years I spent at the Erasmus University I had the honour to follow some courses of Jaap van Dijk. He taught me a lot in those courses, but most of all he motivated me (and all students) to be innovative. Even though most of the economics courses are quite formal, as was his, he taught us to be critical and creative. Existing theories were not enough for him; new ways of looking at problems were needed. One of the main reasons this thesis is written is his enthusiasm, which motivated me so much I wanted to continue scientific research after graduation. For me Jaap was a great inspiration as a teacher, colleague and friend. I regret he is not around to see the result of my studies and lament the loss of a friend. This dissertation is dedicated to him.

I am indebted to my friends and family. They all helped me in motivating me to continue studying and giving me the opportunity to write this dissertation. Even though writing the thesis meant that I was not able to spend as much time with them as I maybe should have.

Finally Esther. Her contribution to this thesis is exceptional. Besides all the work she has put into the correction of English, helping with the layout, and giving me important critique, she endured my constant working and lack of time invested in her. Even though all words will fail to express my gratitude, thank you for supporting me throughout the whole process.

Peter Marks
Rotterdam, 2002

CHAPTER 1

INTRODUCTION

1.1 Subject of study

Whenever people interact with each other a game is being played. People drive their car consistently on the left in the United Kingdom, while the rest of Europe drive on the right. All drivers on a particular street in London are playing games with the other drivers. European people driving a car in a street of London will (automatically) drive on the left hand side, even though they are used to driving on the right in their own country. The interaction of a European driver with the other drivers in that particular street in London can be modelled as a game. There are many different interactions that take place in real life. These different interactions can be modelled as different games (see Appendix A for a subset of all possible 2×2 symmetric games,).

The basic ideas, assumptions and definitions of game theory are given by Von Neumann and Morgenstern in 1944, in their classic book *The Theory of Games and Economic Behaviour*.

> They define a game as any interaction between agents that is governed by a set of rules specifying the possible moves for each participant and a set of outcomes for each possible combination of moves. One is hard to put to find an example of social phenomena that cannot so be described. (Hargreaves Heap and Varoufakis, 1995; p.1)

In other words, game theory can be defined as the abstract modelling of any strategic interaction between individuals. When taking this definition in mind game theory can be seen as a tool or instrument that helps social scientists clarify issues relating to human behaviour (and social institutions). For this reason, game theory is quite popular among social scientists, but especially among economists. Economics is about the allocation of scarce resources. These resources are scarce because more people want them than there are people that can have them. That is, "people have (limitless) desires, and no matter how wealthy an individual becomes, resources will never be plentiful enough to ensure that all their desires can be fulfilled" (Browning and Zupan, 2002; p. 6). In other words, people are interacting to become the possessor of scarce resources, which, again, can be modelled as a game.

Over the past few years game theory experiments have gained popularity. These experiments indicate that a lot of behaviour expected by traditional game theory is absent, and participants in the experiments behave differently than expected by traditional game theory[1]. The ultimatum bargaining game is a game where one player offers an amount to another player, who can either reject or accept the offer. In the case of acceptance the amount is divided as offered, when rejected both get nothing. Experimental results of this particular game show that the participants offer close to half the money that is to be divided to the other player even if the opponent cannot penalise (in the so−called dictator games) the other player for not giving anything.

This result is also shown in an experiment by Hoffman and Spitzer (1982), where one player can either take $12 and leave the other player nothing, or they can split $14 in any mutually agreed upon manner. Cooperative game theory predicts that the players will agree upon splitting $14. The $14 should be split $13 vs. $1 (the Nash bargaining solution[2]). The winner, chosen by the flip of a coin, should under no circumstance settle for less than $12. The result of the Hoffman Spitzer experiment shows that participants choose for the joint profit maximising outcome, that is, to split the $14. However, most participants divide this reward $7 vs. $7. In other words, the winner of the coin flip agrees on taking $5 less than he could have obtained if he does not consider the other player.

The non−selfish behaviour in the experiment cannot be explained by traditional non−cooperative game theory. Hoffman and Spitzer (1985) design another experiment to test whether possible fairness considerations play a role in the way people divide money. In this experiment they design four different set−ups to test how people act with different fairness perceptions. One set−up of this experiment is the starting point for the approach developed in this dissertation. In this particular set−up the participants play two (different) games in

[1] See for instance, Hoffman and Spitzer (1982, 1985), Hoffman, et al. (1994, 1996, 1998), Huck and Oechssler (1999), Prasnikar and Roth (1992), Ruffle (1998), Schotter, et al. (1996), Zizzo and Oswald (2001).

[2] For explanation of the Nash bargaining solution see (Kreps (1990), Binmore (1992), Bierman and Fernandez (1993), Hargreaves Heap and Varoufakis (1995)), but what it boils down to is: "The Nash solution selects the outcome which maximises the product of the utility gains from the final agreement of the two bargainers relative to the conflict point." (Hargreaves Heap and Varoufakis, 1995; p.123).

a row. The first game is a so–called hash–mark game, which always ends up with a loser and a winner. The second game is a face–to–face bargaining game with the winner of the hash–mark game designated controller of the bargaining game.[3] In the other set–ups of this experiment the controller of the bargaining game is designated by either a coin flip, or by the experimenter telling the participants who the controller is. The result of the combination of hash–mark game and bargaining game compared to the other set–ups is that both controllers and receivers accept a higher share of the bargain for the winner of the hash–mark game and a lower share for the loser, while the split in the other set–ups is almost equal. In other words, the bargaining games are played differently by the participants because of the result of the hash–mark game.

Game theorists have not investigated the idea of a former game influencing a different second game. Game theory should be able to describe the behaviour of individuals, and in that sense be able to explain what happens in interaction situations. When looking at people interacting in everyday life one can see that people constantly have encounters with one another in different situations, i.e., they are playing different games. The games they play one after another are sometimes the same, called a repeated game, but most of the time the games are different. In this thesis an approach is developed to see how we can model and analyse people playing different games against each other instead of the same game: this approach I call the *associative approach*.

In the next section the motivational issues relating to this study are elaborated upon. This leads to the formulation of the main research goals and the relevant research questions and endeavours that need to be undertaken in section 1.3. The remaining section (1.4) outlines the thesis.

1.2 Motivation of study

The last ten years the credo 'history matters' has been employed a lot in several disciplines of social science. Within game theory the only way history matters is when the same game is repeated several times, be it a finite or infinite number of times. However, people also play different games through time. When two players play games against each other they build up a history together. Players know of how the other player played in the previous game. What if that previous game is a different game instead of the same game? History still matters. The players can incorporate the actions, behaviour or play of previous games into their perception of the game at hand. What sort of game theoretic framework

[3] The combination of the two games in this experiment will be clarified and analysed in section 2.2.

needs to be developed in order to be able to model that behaviour and explain that behaviour?

Traditional game theory analyses one–shot games, repeated games, and sequential move games. One–shot games are, as can be imagined, games that are played once, and once only. In one–shot games it is assumed that the players have complete information about the possible actions they can make, and on the payoffs belonging to the different combinations of actions of both players. Previous play is not incorporated; in other words, there is no information about the history of the players. When repeating games, complete information, as in one–shot games, is assumed available to the players, but also that the players are able to adjust their behaviour based on the history they create by playing the same game over time.[4] When the game is infinitely repeated and all players are informed about each other's past actions the repeated game can be called a supergame. In these supergames players can build a reputation, e.g., the players can be 'nice', 'tough', or 'crazy'. The other player has to think about his possible actions given the reputation of the opponent. Sequential move games are games in which the players act one after the other until the game is over, such as the game of chess. It can happen that the second player does not even get to act, because player one already ended the game. In sequential move games complete and perfect information is assumed, which means that the players know all the possible actions of themselves and their opponent and all the possible results of the actions in the whole game. Backward induction can then be used for solving these kinds of games. The centipede game, where two players alternately get a chance to take the larger portion of a continually escalating pile of money, is one of the most known and analysed sequential move games. Backward induction predicts that the first mover should take the large pile on the first round. This result is not supported in experiments, because the participants have altruistic motivations, and the participants have some uncertainty over the payoff functions of the players, which makes the game a game of incomplete information. In other words the traditional game theoretic solution methods[5] cannot be applied in these cases (see Kreps, 1990; p.78, and McKelvey and Palfrey, 1992)

When people interact they play many different games, a lot of which are played against the same opponent (think about husband and wife for instance).

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[4] One can think of punishing the opponent who showed 'bad' behaviour in a prisoner's dilemma, but also rewarding 'good' behaviour.

[5] Bayesian reasoning, which can be put into the traditional game theoretic category, is maybe the only method that can solve the incomplete information and uncertainty about the payoff functions in these cases, but is still unable to say anything conclusive about the altruistic behaviour.

The time span between the repetition of one and the same game can be quite long, while in the intervals several other games are played. Is it possible that a game that is played in the interval of a repeated game[6] has more influence on the play of the repeated game than the first repeated game? For instance, a coordination game that is played between two battle–of–the–sexes games, can have more influence than the prior battle–of–the–sexes game, because of the connection players can make between the (result of the) coordination game and the battle–of–the–sexes game. People can incorporate the more readily available information of the previous different game instead of the information of the more latent previous repeated game. In other words, people may prefer an easy way out of a problem over a complex method. That is, when the information of the coordination game is more readily available for solving the battle–of–the–sexes game than the repetition of the battle–of–the–sexes game, players can use this. Is it possible to create a framework that is able to explain the behaviour of individuals just as good, or better, with less information than the amount of information needed for analysing repeated games? That is, is it possible to create an approach where players solve the problem at hand by incorporating the information of the previous different game? The information that the players need in this approach then is less than the information needed in the repeated game analysis, because the players only take the previous different coordination game into consideration and not all (which can be many) of the previous battle–of–the–sexes games.

A combination of two different games played after each other can be seen as a sequential move game. There are, however, two problems with this idea of seeing two distinctively different games as a sequential move game. First, in sequential move games players can react on each others moves, while the games in the combination are simultaneous move games. One could argue that the possible actions and reactions of the players are simultaneous in the two games, but action and reaction can take place when moving from the first to the second game in the combination. Second, even if we assume that two games in combination can be seen as a sequential move game, the game theoretic solution methods applied to sequential move games are not applicable to the combination of two (different) games. There is no perfect information on the two games; the players might not even know there is a second game, or the second game does not create dominant actions for the first game. The game theoretic tools for analysing sequential move games can be applied to the sort of games in combination that are the focus of this thesis, but are inconclusive about the

[6] It may even be that a different game played before a sequence of the same game has more influence that the repetition of this same game.

behaviour of players in the games. In other words, there is no value added in applying these game theoretic tools. The approach that is going to be developed in this thesis will investigate combinations of games (like the Hoffman and Spitzer example above) where the first game of a combination *can* influence the play of the second, but the second game is not able to influence the first.

1.3 Research: goals, questions, and strategy

The social sciences try to explain social phenomena, like actions and behaviour of individuals, groups, etc. A subset of social phenomena is social interactions between individuals. The individual and what sort of (social) interactions he or she is in will be the point of departure for this dissertation. Of course, many theories have already dealt with this issue, including game theory. Game theory has contributed a lot to understanding human behaviour in strategic interaction situations. However, thus far game theory has not looked into human behaviour when people play different games. Hopefully this thesis can contribute to an even better understanding of human actions by dealing with the issue of players playing different games in combinations.

The first question one has to ask is whether the idea of people playing different games is completely new or whether some scientists have already dealt with the issue. What line of reasoning is needed when looking at different games in combinations? What have other theories contributed to this idea even in a distant manner? Are there theories that deal with analogical or similar ideas? The first question this thesis will deal with is:

1. In existing literature, where should the idea of players playing different games in combination be positioned?

If other literature on the subject of playing different games exists, what can the associative approach borrow from these theories to build up the framework? Or if there does not exist any closely related work, what theories can help the associative approach in building up its framework? That is:

2. What kind of approach needs to be built in order to explain behaviour of individuals playing different games in combination, and what theories can assist in this?

As the approach is developed throughout the thesis the main question that remains unanswered is whether or not it has any empirical support. Is the associative approach able to explain human behaviour any better than other theories, or is it even able to explain human behaviour at all? To be able to test whether or not a new theory has any explanatory value, or any predictive value, the theory has to be empirically tested.

3. Is there any empirical support for the associative approach?

To be able to address the last question the associative approach needs to be translated into testable hypotheses. When there are testable hypotheses one can see how people behave in strategic interactions and check whether the theory has any validity. Alternatively, one can test the hypotheses in a laboratory by letting participants play certain games in a controlled environment.

Summarising: The associative approach tries to explain how individuals act in combinations of different games. As there is no existing theory on this particular subject, one has to be created. In order to do so, conjectures are made on what kind of approach (theory) is able to explain the behaviour of individuals in these combinations. By relating the unexplained social interactions of individuals to existing related theory, the associative approach is developed using both the conjectures about the unexplained interactions and the related theory as input. A common method for testing a new theory is an experiment, because the theory can then be tested in a controllable environment. For the associative approach experiment some testable hypotheses are formulated by narrowing down the interactions that need to be explained to only one combination of two games. These hypotheses are then tested in the experiment. If the theory is unable to explain the behaviour of the participants in the experiment the theory needs to go back to the drawing board and be reformulated. If the theory turns out to have explanatory power it needs to be tested in more situations to see how robust the theory is, and what needs to be adjusted.

1.4 Thesis outline

In the preceding sections of the introduction the different ideas, research goals and questions are formulated, as well as the design of the research project. The remainder of this thesis develops these ideas, tries to reach the formulated goals, and answers the questions raised.

In chapter two different theories that contribute to the construction of the associative idea are discussed. The associative idea is developed in order to see whether a framework and/or theory is able to explain certain social interactions so−far unsatisfactorily explained by traditional game theory. However, there are many more theories that deal with different possible explanations of these unsatisfactorily explained interactions. In this chapter a survey of the ideas proposed by others is given to see what the idea of associative approach can add and what the associative approach can borrow from other theories (research question 1). Because the associative idea itself is new and is developed by looking at many different theories, a whole chapter is spent on building up the associative idea.

When the idea for explaining behaviour of players by making associations has been shaped and the associative approach is positioned in the existing literature, it is time to develop the real (formal) model in the third chapter. Here the 'rough' idea of the associative approach is refined by taking specific characteristics of other 'formal' theories and incorporating these into the framework of the associative approach. The formal model of Janssen (2001) is discussed to show the parts of his theory that serve as the foundation for the associative framework (research question 2). An example at the end of the chapter will clarify how the formal model can be applied.

The first two chapters discussed are theoretical; the following two chapters have an empirical nature. Is there any empirical support for the associative idea? In order to test the validity of the associative approach an experiment is designed to test the formal associative approach. All the problems and details of the associative approach experiment are discussed in chapter four. The results of and the implications of the experiment are discussed in chapter five (research question 3).

The conclusions of the present study are presented in chapter six. The problems of the associative approach that need further attention, both theoretical and practical (experimental), are mentioned. Recommendations for future work are also mentioned here.

CHAPTER 2

RELATED LITERATURE

2.1 Introduction

When trying to explain behaviour of players in games different (analytical) perspectives arise. The theories based on these perspectives all have their different emphases and instruments for explaining behaviour. The idea of players incorporating (external) information for solving the problem at hand is a quite common method for analysing and explaining behaviour of players. In this chapter several approaches and theories will be discussed. When discussing the theories it becomes obvious that all these theories have certain explanatory value: they are all able to explain certain (different) aspects of human behaviour in strategic interactions. However, as will be shown in this chapter, the results of the game theoretic experiment of Hoffman and Spitzer (1985), mentioned in the former chapter, cannot be properly explained by existing literature. Different theories will be used to analyse the two games in the experiment to show what their explanatory value is, but also to show where they fail to give an explanation.

The associative approach provides a new framework, which is able to explain behaviour in two distinctively different games. The approach can learn a lot from existing literature. The strong (related) points of the existing literature will be the foundation for the associative approach. That is, parts of theories that have explanatory value for the (so−far unexplained) behaviour will be used for constructing the idea of the associative approach. When the idea of players making associations has become clear, it will also be discussed in relation to the Hoffman and Spitzer (1985) experiment.

The chapter is organised as follows: First in section 2.2, the experiment of Hoffman and Spitzer (1985) will be discussed and reformulated in such a way that the distribution game is symmetric, because most theories that will be discussed later on (section 2.3) are only able to explain behaviour in symmetric games. Here the different merits and shortcomings of the different theories are discussed by showing what the theories are, and what they can explain, and more importantly what they cannot explain. In section 2.4.1 the idea of the associative approach and the location of its 'roots' are discussed. By analysing an example in section 2.4.2 the idea of the associative approach is made clearer. Finally the associative approach is confronted with the two games in combination to show what the possible explanation is for the observed behaviour in these games. A conclusion will end the chapter.

2.2 The Hoffman and Spitzer experiment

In the former chapter the article by Hoffman and Spitzer (1985) is mentioned. In this article they design an experiment to test non–selfish behaviour of players. There are four different set–ups in this particular experiment. The subjects are divided in four groups that all have different instructions. There are four instructions, one for each group that state that: i) the winner of the first game *earns the right* to be designated "controller" of the bargaining game; ii) The *earning of the right* to be controller is done by a flip of a coin instead of by winning the first game; iii) Same as i) except that the (experiment) instruction does not say *earns the right*; and iv) Same as ii) except again no statement about *earning rights*. The different set–ups are designed to test whether players have a certain notion of fairness. The group of participants that are in the first set–up, playing a so–called hash–mark game first followed by a bargaining game (see below), are the relevant group for testing whether players behave according to the Lockean principle of distributive justice.

> Natural law/desert theories assert that, as a matter of natural law, someone or other *deserves* resources. [...] The Lockean theory posits that an individual deserves, as a matter of natural law, a property entitlement in resources that have been accumulated or developed through the individual's expenditure of effort. The individual deserves the entitlement because he has "mixed his labour" with the resource. A subject who holds a Lockean theory of distributive justice will behave in a self–regarding manner whenever he perceives that he has "mixed his labour" with a resource. (Hoffman and Spitzer, 1985; pp.264–265)

The assumption of Hoffman and Spitzer is that a Lockean will regard himself as deserving the property entitlement, i.e., the right to be controller in the distribution game, when he wins the hash–mark game, because he has put effort into getting it. Even if both players have put in the same effort, the Lockeans will still put the winner as the one who deserves the property entitlement, because his effort was more effective than the effort of the loser.

> In our experiment, subjects were likely to interpret winning the game as evidence that the winner did a better job of playing the game and is therefore justified in treating the entitlement of the controller's position as a right. (Hoffman and Spitzer, 1985; p.273)

The result of the experiment suggests that players perceive the latter of the two games differently because of the result of the first. Traditional game theory cannot explain this phenomenon. The result of the experiment shows that the behaviour of the players in the second game is influenced by the first game, i.e., the perceptions of the players towards the second game is different depending on whether they are loser or winner of the first game. Hoffman and Spitzer refer to existing conventions (Lockean principle of distributive justice) as a possible explanation for this particular behaviour, but they do not give a framework that explains how the first game is connected to the second.

In the remainder of this chapter different game theoretic approaches and theories are discussed to see whether they are able to give a proper explanation of the behaviour of the players in the experiment. Even if some approaches or theories are not able to explain the behaviour, they may give some extra insights in what might be a possible explanation. The idea of the associative approach is based on particular ideas of the theories that are going to be discussed. Where other approaches and theories fail to give a (complete) explanation for the behaviour, the associative approach will combine and extend the different ideas in order to explain the behaviour of players in a combination of two games. In the next section a slightly amended set−up of the two games that are played after each other in the Hoffman and Spitzer (1985) experiment is given. The second game is adjusted, because the bargaining game that players play in the experiment is not symmetric, while most approaches and theories that are going to be discussed in this chapter are designed to explain behaviour in symmetric games.[7]

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[7] The associative approach as it will be developed in this thesis, is so far also only able to explain the behaviour of the players in the second game if this game is symmetric. However, one should keep in mind that most theories in this chapter and the associative approach say that the incorporation of external information makes a symmetric game asymmetric in the perspective of the players.

2.2.1 The combination of two games

Consider two players playing two consecutive games. The players do not have any prior history together. The first game they play is the so–called hash–mark game, followed by a battle–of–the–sexes game[8] (BOS–game).

Game 1: Hash–mark game

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Above is a picture of 17 vertical hash–marks. Each player must, on each turn, cross out 1, 2, 3, or 4 hash–marks. After a player has crossed out as many hash–marks as he or she wishes, it is the other player's turn to cross out 1, 2, 3, or 4 hash–marks. The game continues until all hash–marks have been crossed out. The person who crosses out the last hash–mark loses the game. A will go first; B will go second, and so on (the players will randomly be assigned A or B). Note that neither player receives any monetary reward in this game.

Example:

A goes first and crosses out 4 marks

~~/ / / /~~ / / / / / / / / / / / / /

Then B crosses out 4 marks

~~/ / / / / / / /~~ / / / / / / / / /

Then A crosses out 4 marks

~~/ / / / / / / / / / / /~~ / / / / /

Then B crosses out 4 marks

~~/ / / / / / / / / / / / / / / /~~ /

A must cross out the last mark on his turn, so A loses the game.

[8] This BOS–game replaces the bargaining game of Hoffman and Spitzer (1985). In their experiment the winner of the hash–mark game became the controller (player A) of the following bargaining game. Player A may choose number 2 without consulting player B. However, B may attempt to persuade A to make a joint decision to choose another number and/or division of payoffs. If a joint agreement is reached both have to agree on the chosen number and how money is transferred from one player to the other, and the money will then be divided accordingly. The following table is the payoff distribution example of Hoffman and Spitzer (1985).

Number	A's payoff	B's payoff
1	$4	$1
2	5	2
3	3	5

Game 2: Battle−of−the−sexes game[9]

The players in this game have the possibility of sharing five euro. In order to get the money both players have to be in agreement on how to share the money. Both players cannot communicate with each other, however. If both choose matching alternatives, that is, the same distribution, one will get the amount prescribed by his part of the distribution and the other player will get her part of the distribution. If the choices lead to disagreement about how to share the money, both will receive nothing.

Both players have to circle one alternative as displayed below.

Alternatives:

- ❑ You get € 2.− and your co−player gets € 3.−.
- ❑ You get € 3.− and your co−player gets € 2.−.

If the observed behaviour of the participants in the Hoffman and Spitzer experiment is extrapolated to this particular set−up it means that players following the Lockean principle of distributive justice perceive the winner of the hash−mark game as being entitled to the larger share in the BOS−game, and the loser should settle with the smaller share.[10] That is, the winner gets three euro and the loser receives two euro.

By applying backward induction the participants may figure out that winning the hash−mark game is not a matter of putting effort into playing it, but just a matter of going first. This undermines the idea of the Lockean principle of distributive justice, because participants do not have to mix their labour with the resource. The reply by Hoffman and Spitzer (1985) is that “if the subject figures out the winning strategy, he is likely to regard his knowledge as the product of superior effort expended to solving the game. It is true that the subject’s ability to figure out the game will be a product of natural ability and training, both of which are partly a matter of chance. However a Lockean would not regard this type of chance arbitrary, because to do so is to destroy the internal logic of his

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[9] By making the bargaining game symmetric it can be formulated as a battle−of−the−sexes game. The formulation of this BOS−game is taken from an experiment by Holm (2000).

[10] In the hash−mark game there are seventeen lines to cross, and the player who crosses the last line loses, one has to cross the one−before−last line to win. Once can cross the one−before−last line by crossing one to four lines. This means, no matter how many lines your opponent crosses, one has to make sure that the opponent will have to cross the sixth line from the right. So one has to cross the seventh line. The former procedure continues backwards to the first line. Backward induction states that if one starts, and one wants to win, one has to make sure that the opponent will always have to cross, from left to right, lines 2, 7, 12, and 17.

theory. Without some fortuitous chance there is no possibility of proper desert" (pp.273–274).

2.3 Different approaches

Many different theories and approaches have been developed through the years in order to explain behaviour of players in games. All these different theories and approaches have their own emphases and frameworks, and thus explain different aspects of behaviour of players. In this section the different approaches are used to analyse the two games in combination of the former section.

The first subsection will show how traditional game theory analyses the battle–of–the–sexes game of the combination, and how the behaviour of players can(not) be explained by it. In the section following the traditional game theory section, several theories will be discussed that analyse the incorporation of external information. Within games a distinction can be made between the mathematical structure and it's labelling. Within traditional game theory the only thing taken into consideration for solving games is the formal structure of the game. "The normal form game is comprised of three things: (1) a list of participants, or *players*, (2) for each player, a list of *strategies*, and (3) for each array of strategies, one for each player, a list of *payoffs* that the players receive." (Kreps, 1990; p.10) This normal form is in most cases just the mathematical structure of a game. "Any presentational features which are not entailed by the mathematical structure of a game, such as the names given to players and strategies, constitute the labelling of that game" (Mehta, *et al.*, 1994b; p.163). These extra presentational features, not considered by traditional game theory, can give clues to players how to solve the problem at hand. That is, in games with multiple Nash equilibria one equilibrium often stands out from the others, because of extra information present outside the mathematical structure of the game. This particular equilibrium is, according to Schelling (1980), *salient*; it is a focal point. Players, then, choose the strategy corresponding to the focal point, based on the expectation that others will follow this focal point as well.

Players use information that is readily available to all of them in order to help them solve the problem at hand. The properties that make a particular equilibrium salient are often properties of labelling. In many interactions players share a common experience or common culture. The properties of labels derive their significance from relations between labels and this common experience and/or culture.[11] These properties are not taken into consideration in traditional game theory since they are invisible in the mathematical structure of a game. For

[11] See for example, Holm (1997, 1998, 2000); Mehta, et al. (1994a, 1994b); Sugden (1995a).

this reason traditional game theory often cannot help resolve games, or explain why one equilibrium is played more often than another if played by a large population. The incorporation of external information is analysed by many different theories. In the subsections following the traditional game theory section different approaches and/or theories dealing with the issue of salience are discussed and analysed. The different approaches and/or theories will be dealt with in each subsection grouped by their shared emphasis.

2.3.1 Traditional game theory

In the combination of games, traditional game theory does not take the result of the hash−mark game into consideration when analysing the battle−of−the−sexes game, because the two games are distinctively different. This means that no matter what the result of the hash−mark game, the players will always play the BOS−game as though they have not played the hash−mark game. The BOS−game can be modelled in a matrix (see appendix A.5, where $x = 3$, and $y = 2$), depicted in table 2−1.

Table 2−1 Battle−of−the−sexes game

		Player B_i	
		alt. 1	alt. 2
Player A_I	alt. 1	(0 ; 0)	(2 ; 3)
	alt. 2	(3 ; 2)	(0 ; 0)

According to traditional game theory players do not have extra information they can use to solve the battle−of−the−sexes game. Because players do not have any dominating strategies they have no good reason to choose one alternative over the other. Both players prefer the highest outcome of the alternatives over the lower one. Both players know that they both prefer more money over less. However, if both players would choose the alternative with the largest share for themselves they will not receive anything, because the alternatives do not match. The same is true when both would claim the smallest share. The BOS− game has two Nash equilibria in pure strategies, that is either (2, 3), or (3, 2). The game has also one Nash equilibrium in mixed strategies[12], namely that the players will choose alternative 1 with probability $2/5$ and alternative 2 with probability $3/5$, resulting in an average expected payoff of $6/5$. When the population of players is large (enough) the traditional game theoretic prediction will be the mixed strategy equilibrium: some players will play alternative 1, while others will play

[12] For the remainder of this dissertation, the term Nash equilibrium will refer to an equilibrium in pure strategies; when the same solution concept involves mixed strategies it shall be referred to as a Nash equilibrium in mixed strategies.

alternative 2, and some players will mix between the two alternatives. In other words, traditional game theory has nothing to say about what one particular player will do, only the average result of many players in a large population playing the battle–of–the–sexes game can be predicted by traditional game theory.

When extrapolating the result of the experiment by Hoffman and Spitzer (1985) to the combination of hash–mark game and battle–of–the–sexes game, over half the players act according to the Lockean principle of distributive justice. That is, 68% give the winner of the hash–mark game the larger share and give the smaller share to the loser. This 68% corresponds to the percentage of players matching their alternatives resulting in a payoff of three euro to the winner and two to the loser. Compared to the expected outcome of traditional game theory (24% matching[13]) this ex–post coordination percentage is much higher. In other words, it looks like traditional game theory is not able to explain the behaviour of players in this particular BOS–game. The main reason for lacking the ability to explain this behaviour is that traditional game theory is not able to incorporate two distinctively different games into one framework, and thus explain or predict the behaviour of the players in the BOS–game without looking at the history these players have built up by playing the hash–mark game before the BOS–game.

2.3.2 External information

The relations players can make between external information and a game are varied. It usually is not just one sort of external information players (can) use to approach the game they are playing. However, there is one part of the external information that players (based on the shared background and/or culture) see as the most important to incorporate into the problem at hand. The next sections will analyse the different methods grouped by their common emphasis on, or analysing method of, the incorporation of external information. In the sections, first the ideas or methods are explained and then they are applied to the two games of section 2.2.1. When applying the different methods to the two games it will become obvious where certain approaches have some explanatory value, or where the different theories fail in explaining the experimentally observed behaviour.

[13] The coordination, based on the Lockean principle, in the relevant cell of the battle–of–the–sexes game is $\frac{2}{5} \times \frac{3}{5} = \frac{6}{25} = 0{,}24$

Conventions

Most ways of incorporating external information in games are based on conventions.[14] In this section the used definition of a convention is by Lewis (1969; p.58):

> A regularity *R* in the behaviour of members of a population *P* when they are agents in a recurrent situation *S* is a *convention* if and only if it is true that, and it is common knowledge in *P*, that, in any instance of *S* among members of *P*,
>
> (1) everyone conforms to *R*;
> (2) everyone expects everyone else to conform to *R*;
> (3) everyone prefers to conform to *R* on condition that the others do, since *S* is a coordination problem and uniform conformity to *R* is a coordination equilibrium in *S*.

Conventions create the possibility for finding a key, because the key is built on the process of mutual expectations in a shared background which is common knowledge, that is in terms of Lewis, *what the other expects one to expect to be expected to do…*

> Finding the key, or rather finding *a* key –any key that is mutually recognised as the key becomes *the* key— may depend on imagination more than on logic… It is not being asserted that they will always find an obvious answer to the question; but the chances of their doing so are ever so much greater than the bare logic of abstract random probabilities would ever suggest. (Schelling, 1980; p.57, emphasis in original)

It is not necessarily the convention that makes one equilibrium more salient than another, however, when conventions are established they are the underlying basis for people to see certain equilibria as a focal point or as the more salient equilibrium. The convention need not be consciously thought of, the convention can also be 'innate', which means that without consciously thinking about the convention players automatically incorporate the latent convention into their perception of the problem at hand.

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[14] Conventions are also present in the following subsections. Most explanations that have their emphases on other aspects than conventions still need (underlying) conventions in their approaches in order to be able to explain behaviour of players in certain games.

Simple examples of conventions influencing games are, for instance, described by Schelling (1980), and Lewis (1969).[15] One of the games discussed by many theorists analysing conventions in game theory is the road game. The story in the following example is based on Young (1993)[16]. The game is situated in the Dutch countryside, at the end of the eighteenth century. Two horse−drawn carriages are rapidly approaching one another from opposite directions. (Both are riding in the middle of the road given the fact that in those days only the middle of the road was not too bad for driving.) The drivers of both carriages have to decide in a split second to pass either on the left or on the right hand side. Assume, for the moment, that there is no established convention or law to help them decide on what to do. The difficulty with making the decision is that you do not know what your opponent is choosing. If you choose left and he chooses right (and vice versa) you will collide. If both of you choose the same option you will be able to pass without any harm. This game can be modelled as follows:

Table 2−2 Road game

	Left	Right
Left	1, 1	0, 0
Right	0, 0	1, 1

This game has three equilibria (see also appendix A.3): both go left, both go right, or both randomise with 50−50 probability between going left and right. Again traditional game theory does not give any coherent account of how people would play a game like this. There is no external information players can incorporate to decide what they ought to do.

> The relevant focal points cannot be defined a priori; they depend on the coordination problem at hand and on the culture in which the players are embedded. (Young, 1993; p.108)

The relevant factor in his story is that once conventions are established people use them to solve coordination problems at hand. “The main feature of a convention is that, out of a host of conceivable choices, only one is actually used. This fact also explains why conventions are needed: they resolve problems of

[15] For other examples of relating information and conventions to possible play of games, see, for instance, for theoretical studies Bhaskar (1997, 2000), Binmore (1994), Gauthier (1975); Gilbert (1989), Goyal and Janssen (1996, 1997), Janssen and Menard (1995), Lewis (1969), Sugden (1984, 1989, 1993, 1995b), Young (1993, 1996), and for experimental surveys see, for instance, Huck and Oechssler (1999), Prasnikar and Roth (1992).

[16] Another subsection is devoted to the approach of Young (1993, 1996, 1998).

indeterminacy in interactions that have multiple equilibria" (Young, 1993; p.107).

In the largest part of the world we nowadays drive on the right–hand side of the road (except some countries like United Kingdom and Australia). Assume that this convention was already established at the end of the eighteenth century in the Netherlands. The convention of driving on a particular side of the road creates a solution to the game at hand. Both carriage drivers will pass on the right–hand side, because they do not want to collide, and they expect that the other will pass on the right.[17] The convention can also be seen as a rule of thumb, because when driving in Holland nobody thinks about driving on a particular side of the road. People automatically drive on the right hand side without thinking what others will do: the convention has become innate to the principle of driving.

The principle of conventions as an (un)conscious helping device for players when facing the problem at hand can now be applied to the two games in combination. The different approaches in this section do not consider the hash–mark game when analysing the second game. That means that just as the traditional game–theoretic analysis, the different approaches do not make a distinction between players being losers or winners in the hash–mark game. However, the information created by the play of the hash–mark game is considered relevant by the different approaches. The first game creates information that players (un)consciously recognise as creating a possible regularity that, if all players conform to it, and everyone expects everyone to conform to it, everybody will prefer to conform to, because it helps players find a coordination equilibrium in the battle–of–the–sexes game. In other words, the first game creates information that triggers the players in (un)consciously adopting a certain convention (Lockean principle of distributive justice) when entering the second game. This convention helps resolve the indeterminacy of the multiple BOS–game equilibria. One of the two Nash equilibria in the BOS–game is more salient, because the underlying Lockean principle of distributive justice creates the key for players in the combination of games to solve it. That is, the *Lockean principle* equilibrium in the battle–of–the–sexes game is recognised by

[17] Lewis (1969; pp.44–45) shows, in an example quite similar to the road game, that even if there are complications, for instance if we do not drive on the right side of the road the police will catch and punish us, the convention will still hold. We have an independent incentive to drive on the right, because of the police. However, if I expect others to drive on the left, I would drive on the left as well, police or no police. In other words, the preference for driving on the same side as the others outweighs any incentive the police may give me to drive on the right. And so it is for almost everyone else. The same argument goes for other considerations favouring one coordination equilibrium over the other.

the players as the odd–one–out equilibrium, because it is built on the process of mutual expectations in a shared background, which is common knowledge.[18]

The focal point theories can then explain the behaviour of players in the BOS–game by taking the result of the hash–mark game as external information creating a focal point in the second game. The explanation is based on conventions already rooted in society. Only why a certain equilibrium is selected and not another can be explained by the theories. As mentioned in footnote 18 other equilibria can be selected based on other conventions. Given the result observed, the theories can explain that a certain convention is the underlying mechanism for selecting that particular equilibrium as the odd–one–out. In other words, the end result can be explained but not the process of getting there. If two games are played in a combination where the possible underlying convention is harder to define the explanation becomes more difficult as well. The theories can only explain afterwards what the underlying convention has been. And most importantly, the focal point explanation does not have a (formal) framework that is able to link the external information to the saliency of a certain equilibrium. The theories are also only able to explain why a certain equilibrium is selected if the (underlying) convention can be defined. If there is no obvious convention the theories cannot say much about the possible saliency of the strategies or equilibria. The same holds if there are more, different (conflicting), conventions. The theories have no framework to show that one convention is stronger than another. In other words, the theories cannot explain why one convention is more 'salient' than another.

In the discussed theories the players have expectations about what other players will do, triggered by existing conventions. In the next section the theories that will be discussed not only use external information to trigger mutual expectations, but also the development of conventions in search of a mutual selection mechanism.

(Conventions as) determinants of salience

In the former section the different conventions that may help players in resolving the indeterminacy of multiple equilibria in games are just assumed and unspecified. Several approaches try to specify the mechanisms or selection criteria that make certain equilibria salient or more prominent. In this section the

[18] Other existing conventions may be recognised by the players and hence make another equilibrium the odd–one–out. In the discussion of the theories, however, only the experimentally observed behaviour in the games is trying to be explained, using the theories in a way to give the best possible explanation. In this case, the Lockean principle offers the best explanation of the behaviour in the game within the theory of using conventions as external information in a game.

emphasis is on the approaches and theories of Sugden (1986), and Mehta, et al. (1994a, 1994b)[19].

One of the more fundamental books that combines economics, philosophy (with emphasis on social contract theory) and game theory is *The Economics of Rights, Cooperation and Welfare*, by Robert Sugden (1986). This book can be a great inspiration for every student or scholar who is trying to work in one of these fields. In this book Sugden's goal is "to explain how social conventions can emerge out of anarchic interactions between individuals" Sugden (1986; p.16). To be able to model these interactions (or the representation of a way of thinking about interactions between individuals) he uses (evolutionary) game theory. To show how certain conventions can grow spontaneously he analyses the road game (see also previous section). For Sugden to be able to show how conventions can evolve in this game he first needs to explain certain aspects of Schelling's focal point theory. There is a basis for possible conventions to arise because in some cases people are able to coordinate their behaviour better (in coordination games) than traditional game theory predicts. That people are better at coordinating is because some behaviour is more prominent, conspicuous, or salient than others. This prominence depends on shared backgrounds, common culture, time, etc. Because people share common notions of prominence they are able to solve coordination problems. Sugden goes on to explain different reasons for prominence:

> Prominence is sometimes a matter of unconscious ideas of *precedence*. […] Prominence is often linked with uniqueness. […] Prominence may also be determined by analogy. […] The explanation is an association of ideas. […] Analogies are particularly important because they provide a means by which conventions can reproduce themselves in new situations. In a sense, of course, all conventions rest on analogies, since no two coordination problems are ever exactly the same. It is the analogies that strike most people most quickly that will provide the basis of the conventions that establish themselves. (Sugden, 1986; pp.49–50)

Sugden then continues to argue that some conventions are better equipped to reproduce themselves by analogy than others, and that the possible application of conventions is relevant to the possible predomination in the pool of established conventions. Sugden argues that for a convention to develop it must be recognised by people. "People are most likely to find those patterns that – consciously or unconsciously— they are looking for" (Sugden, 1986; p.92). In

[19] Other articles by Sugden are also more or less related to the subject (See Sugden (1984, 1989, 1993, 1995a, 1995b, 1998a, 1998b)).

other words, conventions are more likely to develop if people have some prior expectations that they will develop. This concept is in line with Schelling's concept of prominence: that is, that there can be no doubt that some solutions are more prominent than others.

> Prominence is often dependent on analogy. When people face new problems of the kind that are resolved by convention, they tend to look for prominent solutions by drawing analogies with other situations in which conventions are well established. Thus conventions can spread from one context to another. (Sugden, 1986; p.94)

When faced with a new problem people are eager to find a solution to it. That is, they use every possible form of external information to solve the problem at hand if the (mathematical form of the) game itself does not provide a solution. This extra information that players find creates labelling of strategies or players. In traditional game theory it is assumed that the solution of a game is independent of how strategies are labelled for the players. In other words, "the assignment of labels is treated as *strategically irrelevant* and is not analysed explicitly" (Mehta*, et al.*, 1994a; p.659). However, in the context of Schelling's focal points it is necessary to be explicit about the labelling of the strategies. The following quote of Mehta, *et al.* summarises their ideas put forth so far.

> Some labels are more prominent or conspicuous or *salient* than others; they "stick out" or "suggest themselves," typically by virtue of analogies or associations of ideas which connect those labels to some aspect of the common experience, culture, or psychology of the players. Players tend to choose those strategies whose labels are salient. An equilibrium which results from such choices is a *focal point*. (emphasis in original, Mehta*, et al.*, 1994a; p.659)

Mehta, et al. (1994b)[20] report "an experimental investigation of the hypothesis that in coordination games players draw on shared concepts of salience to identify 'focal points' on which they can coordinate." (p. 163) As an illustration they use a pure coordination game (Heads or Tails game) in which players try to achieve coordination by choosing either heads or tails. Players who treat labels as irrelevant have a probability of 0.5 to achieve coordination. Ordinary human players, however, seem to be capable of achieving coordination in higher degrees. They are able to do this because "the players use a clue provided by the labelling of the strategies to connect the game with something in their common

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[20] Bacharach and Bernasconi (1997) also conduct experimental research to test subject behaviour of identifying focal points in coordination games. Their approach is slightly different, however, and will be dealt with in a separate section.

experience: the conventional priority of heads over tails." (Mehta*, et al.*, 1994b; p.165)

In other words, in real–world interactions that game theory models, strategies have labels. These labels potentially influence the choices of individuals, and therefore if game theory is trying to explain (or predict) human behaviour it is important to know how labels influence players' choices and behaviour. To test a number of specific hypotheses about the determinants of salience Mehta, *et al.* design experimental games in such a way that the equilibria of the games can only be distinguished from one another in terms of the way the strategies are labelled. They make a distinction between three different possible ways (rules of selection) that they think are likely to be recognised by players for solving assignment games (which is a particular sort of coordination game).

> Our immediate objective is more modest: to isolate a small number of rules of selection that can be used to generate hypotheses which can then be tested in controlled experiments. i) *The rule of closeness*, ii) *The rule of accession*, and iii) *The rule of equality*. [...] Given that salience often depends on analogy and metaphor, the salience of these rules in our pure coordination games might conceivably arise out of analogies with common ideas of fairness. (Mehta*, et al.*, 1994b; p.169/p.183)

The behaviour of the participants in their experiment all draw on each of the three rules to identify focal points. In case of conflicting rules some people are attracted to one rule while other people are attracted to another. The important result of their experiment is that "behaviour in coordination games is sensitive to elements of common knowledge which relate to the labelling of strategies, and which are usually treated as external to any solution concept" (Mehta, et al., 1994b; p.182). They also extrapolate the result of the experiment to bargaining games: the rules of closeness, accession and equality can all be interpreted as rules of fairness, which means that in bargaining games the players should have some preference for fairness.

Back to the two games in the combination. The hash–mark game itself is again not of any interest for the analysis. The idea or approach discussed in this section would without the hash–mark game predict that in the second game the distribution between the two players is the same as predicted by traditional game theory. The fact that the first game generates losers and winners creates a different expected result, however. The hash–mark game is now nothing more than the triggering device for players to label the battle–of–the–sexes game differently than without the information from the hash–mark game. Given the information of the first game players label themselves as loser or winner, and thus perceive the BOS–game differently. Based on the information and their labels, the mentioned fairness notions can now be applied to the BOS–game. One possible notion of fairness is the distributive justice principle of Locke; the players perceive it as fair that the winner should get the larger share of the distribution. This shared concept of fairness creates labelling of strategies and/or players that make one alternative in the BOS–game more prominent than the other, depending on whether you are the loser or the winner in the first game.[21]

A problem remains that the discussed theories are not able to incorporate the two games into one framework. As said the information needed by players to label their strategies to elements of common knowledge is usually treated as external to any solution concept (Mehta, et al., 1994b; p.182). The play of the first game can now create the trigger for the players to find this common element and label their strategies. That is, the players can now be labelled as either winner or loser (instead of player A or player B). The theories are not able to link the two games, however. If it were possible to incorporate the play of the first game, the theories would only be able to do so in the sense that the information created by play of the first game is 'given' when entering the second. In other words, the hash–mark game in itself is not relevant, only the result is, because this can be used for labelling.

Information relating to strategies

Another way in which players look for a focal point is by incorporating external information into their strategies. There are many different ways in which external information makes a certain strategy more salient than another. In this paragraph the incorporation of information relating to strategies will be analysed. The following example, based on Gilbert (1989)[22] will make things more clear.

Suppose two complete strangers are put into two separate cells by their kidnapper. They have no means of communication with each other. In front of them is an electronic board with four differently coloured buttons (red, blue, orange, and green) that are completely identical besides the order of the coloured buttons. The boards are connected with a central unit in another room that records which button the two strangers press. The strangers cannot see the other or the other's coloured board. The kidnapper tells both strangers: "If you both press the same coloured button, I will let you go, if, however, you press different

[21] Other ways of relating external information to the game are also consistent with Sugden's approach, but again only one principle, able to provide a plausible explanation of the experimentally observed behaviour, is used for clarifying the theory.

[22] Only the example is used (Gilbert, 1989; pp.64–68), not her theoretical line of reasoning in the rest of the article.

buttons, or do not press at all, you will both be shot. It makes no difference which colour you choose. The only thing that matters is that you both select the same colour. You have to press the button of your choice exactly at 12.15. I will turn on the radio five minutes before you have to press the button, and when the radio stops you have one minute to press the button, but it has to be pressed within that one minute and not later." This (coordination) game is depicted in normal form in table 2–3[23].

Table 2–3 To live or to die

		Stranger 2			
		Red	Blue	Orange	Green
Stranger 1	Red	(live, live)	(death, death)	(death, death)	(death, death)
	Blue	(death, death)	(live, live)	(death, death)	(death, death)
	Orange	(death, death)	(death, death)	(live, live)	(death, death)
	Green	(death, death)	(death, death)	(death, death)	(live, live)

In this game both players have no clue whatsoever about what the other player will do. They both, however, want to survive this cruel game. They don't know what the board of the other looks like. In other words, the position of the coloured buttons on the board does not provide any extra information. This game has four equilibria in pure strategies, that is, both choose the same colour. There is no equilibrium, however, that is more salient than the other.

The story continues with the radio being turned on. There is some music first and then the radio announcer says: "Today it is Queen's feast in the Netherlands. The traditional colour of the royal family in the Netherlands is orange. The party that is organised to celebrate her birthday is held in the Royal Dutch Mansion of the family of Orange. Most people attending the party will have orange accents in their clothing. Most dishes and drinks that are served will also be orange. The entry is orange soup, the main dish is duck breast in orange sauce, and for dessert there will be orange pudding." At this time the radio clicks off.

Both players will still search for external information to incorporate into their approach of the game. There is only one factor in the radio story that they both can use for the different coloured buttons: the colour orange. In terms of Gilbert (1989; p.63): "a particular combination of actions (equilibrium) is *salient* if and only if it is entirely out in the open among the agents concerned that this combination is 'the odd man out' or 'stands out from the rest' for all." The

[23] The specific location of the colours in this matrix form is of no significance. The colours can change place within the matrix, and it will still remain a coordination game based on the preceding story.

(*orange*, *orange*)–equilibrium is the odd man out or stands out from the rest, i.e., it is the salient equilibrium.

This form of incorporating external information to find an equilibrium as the odd man out, is one of the most analysed form of salience, both in theoretical and in experimental work. The example used here is just one way out of many possible ways (relating objects, colour, etc.[24], but also communication between players) of incorporating external information relating to possible strategies.[25] In possibly every case where players relate external information to strategies they use a convention to do this. Why does the 'orange–orange' equilibrium become the salient one based on the story? Players expect of each other, given the shared background, that they will conform to the 'orange'–strategy, because if everyone conforms to the orange–strategy it will become a coordination equilibrium in the game (see the resemblance with Lewis). It is totally clear and out in the open to the players that the orange action is the odd man out.

When going back to the two aforementioned games the far–fetched story can be replaced by the hash–mark game. The hash–mark game is not explicitly connected to the battle–of–the–sexes game in this approach. However the hash–mark game does provide some possible information that the players can use to solve the BOS–game. The explicit information created by the play of the hash–mark game is linked to a shared intuition or convention so that the Lockean equilibrium is recognised as the odd man out by the players. That is, the information makes the alternative (strategy) of claiming three more salient if you are the winner, and vice versa it makes the alternative of claiming two salient if you are the loser of the hash–mark game. This Lockean equilibrium is (maybe) not consciously thought of by the players but is implicitly guiding them in recognising the odd man out strategy or odd man out equilibrium. Just as the other so–far discussed approaches, the approach is not able to make a formal connection between the two games.

The incorporation of external information into strategies alters the perceptions of players towards the games they are playing. The idea of different perceptions of games is elaborated by Bacharach (1993) who introduces a new

[24] These ways can also be inherent within the mathematical structure of the game, and thus create focal points. These focal points are then created by incorporating internal information. This, however, is not the focus of this chapter.

[25] For other examples of incorporating external information into actions, see, for instance, for theoretical studies , Bacharach (1993), Crawford and Haller (1990), Gauthier (1975), Gilbert (1989), Janssen (2001), Lewis (1969). For experimental studies see, for instance, Bacharach and Bernasconi (1997), Cooper, et al. (1989), Crawford (1998), Hoffman and Spitzer (1985), Knez (1998), Mehta, et al. (1994a, 1994b), Sopher and Zapater (1993), Sugden (1995a).

representation of multiperson decision problems, which he calls 'variable universe game'[26]. In traditional game theory the way players conceive their situation is not treated as a variable (or is not incorporated at all). All players think about are the 'rules of the game' and their consequences. It is assumed that all these rules are clear and unambiguously given to the players. The idea of unambiguously given rules of the game is restrictive. The possibility for players to derive rules[27] is neglected. Bacharach *does specify* the way players conceive their situation and their variations, and *does give* the possibility for players to derive rules themselves.

> (In Variable Frame Theory) strategies are chosen in a way which is rational in a perfectly familiar game–theoretical sense. However, the *game* that gets played is determined by non–rational (though not *ir*rational) features of the players. These are the players' "frames." A player's frame is, most simply, the set of variables she uses to conceptualise the game. Frames may vary both across players and from occasion to occasion. (Bacharach and Bernasconi, 1997; p.4)

"When one thought involving given concepts occurs to someone, related thoughts involving the same concept are likely to, also" (Bacharach, 1993; p.259). For instance, if somebody observes several objects and recognises that one of the objects is round, related concepts come to mind, namely that other objects might be triangular or square. "Concepts also give structure to the set of belief–spaces in another way: they *hang together*"(Bacharach, 1993; p.259). Because all players differ from one another, they may have different frames. However, some conceptual competences are shared in communities. This not only creates the possibility of people having similar thoughts about certain phenomena, but also that these phenomena is common knowledge. That is "not only does everyone have certain conceptual competences by virtue of belonging to the community, but every member knows that every member has them" (Bacharach, 1993; p.259).

Bacharach is one of the first who makes (game) theorists aware of the fact that players may perceive games differently from what traditional game theory assumes. Players, given their shared beliefs in the community, are able to label a game even without conscious construction of external information. The aspect that players have the ability to use concepts in helping them solve the game at

[26] In Bacharach and Bernasconi (1997) he calls the theory 'Variable Frame Theory'.

[27] That is "…formulate their problem to themselves as a certain game — from some initial apprehension of their situation" Bacharach (1993; p.257).

hand reaches far beyond what traditional game theoretic concepts have been able to show so far.

In terms of the variable frame theory, in the combination of two games players perceive the two alternatives in the battle–of–the–sexes game differently depending on whether they are the loser or the winner of the hash–mark game. They label the players and possible strategies according to concepts they think both players in the combination will have given their shared common culture or background. That is, if one player thinks the other player might see the shared cultural concept of the Lockean principle she will label the relevant strategies accordingly. The underlying Lockean convention changes the perceptions of the players in the direction of thinking about the higher claim as winner and the lower claim as loser. Because of the labelling process one of the two possible alternatives is more salient than the other, and so is the belonging equilibrium.

The problem remains that labelling can be done in many different ways for many different reasons, because of many different underlying shared conceptual competences. The two games can in no way be formally linked together by the theory.

Information relating to players

In this section the incorporation of external information relating to players will be analysed. One very nice example of how external information influences play of a game is offered by Holm (1997, 1998, 2000).[28] He investigates what kind of influence the knowledge of the gender of the opponent has on the way players play the game. He tests this through an experiment, where subjects play a bargaining game and a coordination game (see section 2.2.1 for the bargaining or BOS–game of Holm). In his experiment the money to be divided is 500 crowns. Holm models the bargaining (distribution) game as a battle–of–the–sexes game, see appendix A.5, with $x = 300$ crowns, and $y = 200$ crowns, depicted in table 2–4.

[28] For other examples of incorporating external information onto the labelling of the players, see, for instance, for theoretical studies Stahl and Wilson (1995), and for experimental surveys see, for instance, Mason, et al. (1991), Keser, et al. (1998).

Table 2–4 Splitting 500 crowns

		Column player	
		C_1	C_2
Row player	R_1	(0, 0)	(200, 300)
	R_2	(300, 200)	(0, 0)

There are two Nash equilibria, (R_1, C_2) and (R_2, C_1), in this game. There is also a mixed strategy equilibrium with $p_1 = 2/5$ and $p_2 = 3/5$, where p_i denotes the probability of playing the *i*th strategy. If there is no external information, the prediction of expected play in a large population will be the mixed strategy equilibrium. The expected payoff in this equilibrium is 120. Players can both do better by coordinating on either of the Nash equilibria than by mixing. There is, however, no extra information available in order for one equilibrium to be more salient than another.

In the experimental set–up he created extra information by giving the co–player's gender. This had to be done such that it would not be clear to the subjects that this was the extra information they needed for solving their games. The signalling was accomplished by giving a label to the category of the co–player on each subject's questionnaire as if it was an unimportant detail that helped the experimenter to organise the subject–pairs in a practical way. Only two labels were used for the co–players: 'male student' and 'female student'. The subjects were asked during the session as if it was a standard procedure to check that there was a co–player category marked on their questionnaire making sure that they got the information. The subjects were never told that there only were two category labels (both referring to the student category). To further minimise the focus on gender the subjects were never asked their own sex.

The main result from the experiment is that "the subjects behaved significantly more 'hawkish' in an experimental battle–of–the–sexes game when the co–player was a woman compared to when it was a man" (Holm, 2000; p.292) The hawkish behaviour must be seen as demanding the higher payoff of the two alternatives for oneself. This behaviour can be seen as a convention in a broad sense; we might refer the observed behaviour as a convention. As such it is a pattern of behaviour that everybody conforms to and expects everybody else to conform to" (Holm, 1997; p.3–4).[29]

Back to the two games in combination. The idea of hawkish and dovish players can be extended to the adjusted BOS–game of the experimental set–up of Hoffman and Spitzer (1985); losers are more dovish and winners more hawkish. The players label the opponents as either being doves or hawks based on the result of the hash–mark game. In this sense the hash–mark game, again, triggers the players in searching for a focal point or salient point (as in the previous cases), without making a formal connection between the two games. The first game in combination is only the triggering device which sets a certain (underlying) convention (in this case the Lockean principle of distributive justice) in motion for players so that they perceive the situation differently: losers behave like doves (claim the small share) and winners behave like hawks (claim the larger share).

Information relating to payoffs

When analysing external information in relation to payoffs most theories are based on repeated games. In repeating a game, the first game in many cases is the external information that players will use for play of the next game(s). This means players can make meta–strategies over the range of the repetition. The following theory of Harsanyi and Selten (1988) looks at one–shot games, and is maybe more in line with traditional game theory than any of the other discussed theories in this section. It is discussed in this section, because it does implicitly assume different behavioural attitudes than traditional game theory assumes: that is, risk (averse) behaviour.

One of the possibilities of one equilibrium standing out compared to other equilibria, is by risk dominance. Harsanyi and Selten distinguish between Pareto dominance and risk dominance. "A Nash equilibrium is Pareto dominant when it makes at least one player better off than any other Nash equilibrium without making anyone else worse off" (Hargreaves Heap and Varoufakis, 1995; p.264, note 2). In this sense one Nash equilibrium can be a Pareto improvement over all

[29] This gender effect can be described as discrimination. The discrimination in this game, however, differs from the usual conception of discrimination. In the usual conception of discrimination one person (or a group) is actively discriminating the other party, which does not want to be discriminated. In the case of the BOS–game even the discriminated party is better off following the 'discriminating' convention, since this leads to a coordinated outcome, which creates a higher payoff to both parties. The discriminating party cannot help taking more, because when he does not follow the convention everyone will be worse off. This does not mean that the discriminated party would not like to change the convention the other way around. "The fact that one party gets a smaller payoff than the other is a regrettable necessity in some situations" (Holm, 1997; p.50).

other Nash equilibria in a game.[30] The notion of risk dominance embodies "the idea that some equilibria are riskier than others" (Binmore, 1992; p. 299). Consider the following game *G'*, where $0 < x < 9$[31].

Table 2–5 Game *G'*

	1	2
1	9, 9	0, x
2	x, 0	6, 6

This game has two Nash equilibria, that is (1, 1) and (2, 2). There is also a Nash equilibrium in mixed strategies, that is $p_1 = 9/(15 + x)$, and $p_2 = (6 + x)(15 + x)$, where p_i denotes the probability of playing the *i*th strategy.

The (1, 1) Nash equilibrium is a Pareto dominant equilibrium, because in this equilibrium both players are better off than in the other Nash equilibrium. Of course since both players are better off it is impossible for a player to be worse off, in other words, equilibrium (1, 1) is a Pareto improvement over equilibrium (2, 2).

According to Harsanyi and Selten equilibrium (1, 1) risk dominates (2, 2) if "$(a_{11} - a_{21})(b_{11} - b_{21}) \geq (a_{22} - a_{12})(b_{22} - b_{12})$[32]. Similarly, equilibrium (2, 2) is risk dominant if the reverse inequality holds. In other words, in a 2×2 game an equilibrium is risk dominant if and only if it maximises the product of the gains from unilateral deviation" (Young, 1998; p. 66/68). When this inequality holds strictly, the corresponding equilibrium is *strictly* risk dominant. According to Harsanyi and Selten (1988; p.83) "risk dominance and payoff dominance may point in different directions." When $x > 3$ equilibrium (2, 2) risk dominates equilibrium (1, 1) and thus points in another direction than payoff dominance. In this case a player aiming for equilibrium (2, 2) is sure to get *x*, while a player aiming for (1, 1) will get nothing if there is a coordination failure. When $x < 3$ risk dominance points in the same direction as payoff dominance, because then equilibrium (1, 1) risk dominates equilibrium (2, 2). Even though the players will receive nothing in the case of coordination failure, equilibrium (1, 1) both risk and payoff dominates equilibrium (2, 2).

Whether risk dominance outweighs Pareto dominance is an open question. For answers to this question see Harsanyi and Selten (1988). However, if $x = 4$

[30] "It is often argued that this is enough to guarantee focal point status for the Pareto dominant equilibrium, and even that the selection of any other equilibrium is somehow irrational" (Binmore, 1992; p.298).

[31] If x exceeds nine there is of course no longer a coordination game, because both players have dominant strategies in that case.

[32] For explanation of the variables in this coordination game see appendix A.3.

for instance, there are still two Nash equilibria in pure strategies, and also one mixed strategy equilibrium with $p_1 = 9/19$, and $p_2 = 10/19$. Given the risk domination of equilibrium (2, 2) player can be more eager to play that equilibrium than the other, because then they are sure of a payoff of at least four. In this case players incorporate risk behaviour (which again is quite similar for people in a common background, shared culture) in their perceptions of the game they are playing, and behave accordingly.[33]

When looking at the two games in combination the first game cannot be analysed by the tools given by Harsanyi and Selten. Furthermore, the battle–of–the–sexes game has neither a Pareto dominant nor a risk dominant equilibrium. In other words, the ideas of Pareto and risk domination cannot be applied when analysing the two games in the combination. From a speculative point of view, a possible explanation for observed behaviour in the games may be the idea of players incorporating a certain attitude towards risk. The loser of the hash–mark game may 'feel' it is more risky to ask for the larger share than for the smaller share. And vice versa, the winner may think it is less risky to ask for the larger share than for the smaller share. In other words, the risk attitude of the players has its roots in the Lockean principle of distributive justice. There may be many other reasons for a certain risk attitude by players than the one just mentioned. This shows the problems of applying the ideas of payoff and risk dominance, namely that they cannot be formally linked to the two games and there may thus be many other factors influencing the BOS–game than the hash–mark game.

Conventions on two games

In the former sections a convention is a rule of thumb on how to play games. In this section, in a repeated game, "players may use a convention, i.e., a rule which maps asymmetric histories to continuation paths along which the players use different actions in each period, to ensure asymmetric coordination in the base game" (Bhaskar, 1997; p.2). In other words, the possible strategies for the repeated games are conventions. There are many such conventions, and the coordination problem recurs unless players are able to make a unique selection. The following example, based on Bhaskar (1997; pp.1–8)[34], shows that a *slight*

[33] For other examples of incorporating external information relating to the payoffs, see, for instance, for theoretical studies Stahl and Wilson (1995), Bhaskar (2000), Crawford and Haller (1990), Sugden (1993), and for experimental surveys see, for instance, Harsanyi and Selten (1988).

[34] The argument in this section is mostly based on the 1997 draft paper by Bhaskar instead of the published version, because the arguments in this (more extensive) paper are more elaborated by Bhaskar. However, the published version of the paper (Bhaskar, 2000) extends his argument to more games (besides the battle–of–the–sexes game, he also analyses the hawk–dove game).

conflict of interest in the base game is often sufficient to allow the players to select one convention in preference to all others.

Bhaskar's paper analyses the role of repeated interaction in facilitating asymmetric coordination when the base game is symmetric, in his case the BOS−game, with a slight conflict of interest. Players must play symmetric strategies in the repeated game, and these will involve randomisation in the initial game. The realised actions of the players differ with positive probability, and because of this the history from the point of view of both players differs. Players, then, can use this asymmetry to ensure asymmetric coordination for the remaining periods of the repeated game.

The base game is the battle−of−the−sexes game with a pair of asymmetric equilibria (α, β) and (β, α). For this game to be a BOS−game the following restrictions have to hold: $x > 0$, and $x \neq 1$ (see table 2−6, and appendix A.5). The players have a conflict of interest, where one player prefers one equilibrium (e.g., (α, β) depending on the value of x) while the other player prefers the other (in this case (β, α)).

Table 2−6 Battle−of−the−sexes game

		Player two	
		α	β
Player one	α	0 , 0	x, 1
	β	1, x	0, 0

This base game is played twice.[35] Any convention in the repeated game is associated with an equilibrium strategy profile, which specifies randomisation probabilities in the initial period. These randomisation probabilities are sensitive to the choice of convention. Assume two different conventions, one is the *bourgeois* convention, the other the *egalitarian* convention.

As the name already implies the *bourgeois* convention is a convention where if coordination on (α, β) is achieved in the initial period, players will play the same equilibrium in the next period. Over the two stage games players have a larger incentive to play α (if $x > 1$) or β (if $x < 1$), because they have a large stake in achieving coordination on their higher outcome. As a consequence the probability of realised coordination will be relatively low. The *egalitarian* convention is a convention where players alternate between the two equilibria if they coordinate in the initial period, i.e., the players play (β, α) in period two if

[35] Later on in the paper Bhaskar goes on to analyse this base game when it is repeated many times, and the basic idea for the twice repeated game generalises when the game is repeated finitely or infinitely.

coordination in period one has taken place on (α, β). In this case it does not matter too much for the players whether they get the preferred equilibrium in the first or second period. Coordination in two periods always creates higher outcomes for both players than any other combination of outcomes. In other words, for both players the incentive to try and ensure coordination on the equilibrium they prefer most is reduced, because following the egalitarian convention is rewarding for both players. "The convention induces a player to play each action with probability close to one–half, so that the probability of realised coordination is higher.[36] Hence the symmetric equilibrium associated with the egalitarian convention payoff dominates[37] the symmetric equilibrium associated with the bourgeois convention." (Bhaskar, 2000; p.248).

If $x = 1$, the game is no longer a battle–of–the–sexes game, but a pure coordination game. Crawford and Haller (1990) focus on games of pure coordination without any conflict of interest. Their essential point relates to the optimal use of past realisations. They argue that players can ensure coordination in the second stage game, even after randomisation in the first stage game. In the first period, the players will play the mixed strategy equilibrium of the stage game. The probability that the players' realised action will differ is positive, for instance, player one plays α and player two plays β. In this case, Crawford and Haller argue that the players will be able to coordinate with probability one in the next period. To show the flaws in their argument, Bhaskar repeats the argument of Goyal and Janssen (1996; pp.36–41) that there is a multiplicity of possible conventions that will maintain coordination in the game. When the players would use either the *bourgeois* or *egalitarian* convention the players would just face a new coordination game at the supergame level (twice repeated coordination game). In this new game they would mix their strategies between the two conventions with equal probability. In other words, this "mixed strategy is behaviourally equivalent to the strategy which ignores history and plays α and β with equal probability after each history!" (Bhaskar, 1997; p.5).

He then continues his argument by introducing a small conflict of interest, that is $x \neq 1$. The players are now no longer indifferent between the two conventions. The slightest form of conflict of interest destroys the payoff

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[36] The probability of ex post coordination is higher in this case compared to both the bourgeois convention and the mixed equilibrium in the one–shot game.

[37] One essential assumption of Bhaskar is that if one equilibrium payoff dominates the others, players will be able to coordinate on playing this equilibrium (see Bhaskar, 1997; p.4). This assumption creates a sufficient condition for singling out an equilibrium in a symmetric game. In the remainder of his argument this assumption is necessary in order for players to be able to coordinate on pure equilibria in the repeated game.

equivalence between the two strategies, and thus allows the players to select one. Bhaskar's approach to symmetric games "relies on the use of history to 'break' the symmetry and studies the optimal use of history in this context" (Bhaskar, 2000; p.258). Players must play the mixed strategy equilibrium in the second period if in the first period the result was either (α, α) or (β, β). However, if in period one the outcome was (α, β) the history from the point of view of player one (which is (α, β)) is different from the history from the point of view of player two (which is (β, α)). A convention is a rule, which achieves asymmetric coordination by conditioning upon history. In this case we have two different conventions, the *bourgeois* convention and the *egalitarian* convention. Bhaskar's key point is that different conventions generate different incentives for first period actions. He compares the equilibrium payoffs belonging to both conventions. It turns out that for every value of x ($x > 0$, $x \neq 1$) the (discounted) expected payoff for the egalitarian convention is always higher than the expected payoff for the bourgeois convention. He then shows that the probability of ex post coordination in period one is greatest under the egalitarian convention. In other words, the egalitarian convention ensures higher payoffs than the bourgeois convention.

When applying the theory of Bhaskar to the two games in combination a problem arises in fulfilling the symmetry assumption: the hash–mark game is not symmetric. The battle–of–the–sexes game is symmetric and there can be other historical events that can break the symmetry in the second game.

> In any real context, there may be other cues such as gender, race, or the age of the players, although there may be several such cues and their significance may also not be unambiguous. Consider now a repeated interaction where players also have access to such cues. Our analysis suggests that these cues will be more readily accepted if they are combined with an egalitarian convention, but are less likely to be taken if combined with a bourgeois convention. (Bhaskar, 2000; p.258)

In the BOS–game the symmetry between the two equilibria is broken because there is an historical cue: the result of the hash–mark game. The formal framework of Bhaskar is able to link the two games if they are symmetrical, but in the case of the combination his idea can still be extended to the notion that the result of the first game is able to break the symmetry, and that players will behave more towards a certain convention, in this case the Lockean convention. The cue (winning or losing the hash–mark game) pointing to a certain convention and not another creates a higher coordination chance.

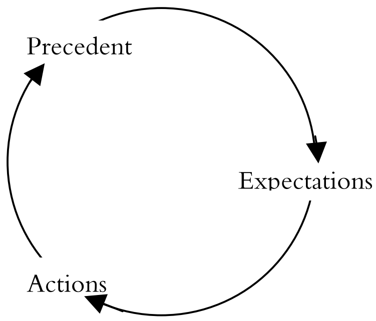
Evolution of conventions and limited cognitive capacities

Young (1993, 1996, 1998) examines the process by which conventions emerge through the accumulation of precedent. Young (1996) uses the road–game to explain the evolution of conventions, which he defines as "a pattern of behaviour that is customary, expected, and self–enforcing. Everyone conforms, everyone expects others to conform, and everyone wants to conform given that everyone else conforms" (Young, 1996; p.105). Economic and social institutions coordinate people's behaviour in various spheres of interaction. Over long periods of time the cumulative impact of many individuals interacting shape the different institutions. In the long run one form of behaviour becomes standard and customary for a given type of interaction. This institution does not have to be optimal, but because everyone expects others to behave accordingly it serves the purpose. Deviating from this institution that coordinates the behaviour is costly.[38]

The players have limited cognitive capacity, and hence have a limited memory, m. The memory is the maximum number of time periods an agent is able to look back into the past. For simplicity Young assumes that in each period there is exactly one encounter. People acquire information about prior encounters by word of mouth. Given his limited cognitive capacity the agent is unable to access all the acquired information. He will therefore draw a random sample from the last m encounters. The informational network for an agent, which is an inherent property of the agent and not the result of an optimal search, is reflected in the sample size s. The agent calculates the observed frequency distribution of left and right in the road–game, based on the sample size. The agent will use this calculation to predict the probability that the next 'opponent' he meets will go either left or right, and choose a best reply.

> Information from previous plays of the game shapes the expectations of those who are going to play the game in the future. (Young, 1998; p.27) On the basis of these expectations the agent takes an action, which in turn becomes a precedent that influences the behaviour of future agents. This creates a feedback loop: (Young, 1998; p.6)

[38] Young (1998; pp.8–9) in this case refers to the notion of path–dependency (see for instance Arthur, et al. (1997), David (1985)).



Young makes a distinction between repeated games and recurrent games.

> In standard game theory, each player is identified with a fixed individual, and if the game *G* is repeated for several periods, the same individuals always play it. This is known as the *repeated game*. […] We shall be interested in games that are played repeatedly, but not necessarily by a fixed group, i.e., a *recurrent game*. (Young, 1998; p.30)

When applying the framework of Young to the two games in combination the history that agents build up is only one game. When entering the battle–of–the–sexes game they only know what happened in the hash–mark game. This means letting go of a long time horizon, many repetitions and thus the recurrent game used by Young. However, in order to be able to apply Young's theory to the two games, it has to be interpreted open–mindedly. In Young's theory the agents would not sample the hash–mark game from memory, because it is not a repeated or recurrent game. However, when one abandons the assumption of sampling only repeated or recurrent games, the agents can sample the different game when facing the problem at hand, that is sample the hash–mark game as possible information for the BOS–game. Let's assume both agents will sample the first game. Now the information both agents have is that one of the two players is the loser and the other the winner of the hash–mark game. There is no observed frequency distribution with which the agents can confront their sample. Assume now that the agents have a common shared culture, and that the players know that of each other. The sample can now be confronted with existing conventions (frequency distributions of responses) and the agents will choose a best reply on the predicted calculations of what the opponent will do; that is, choose smaller share when loser of hash–mark game and the larger share when winner.

2.3.3 Conclusion

In this section several approaches and theories have been discussed with respect to their ability to analyse the combination of two games of section 2.2.1 (based on the experiment results of Hoffman and Spitzer (1985)). Starting from the 'barest' theory, traditional game theory, the outlook went to more sophisticated theories that look outside the game theoretic framework to external information. Traditional game theory is not able to properly explain the behaviour of individuals in the combination, because traditional game theory is not able to link information from the first game to the second. The other theories, sometimes somewhat freely interpreted, are able to explain the intuition of the battle–of–the–sexes game result, but are still not able to properly link the two games. These theories can explain why external information makes one strategy or equilibrium more salient than another, and thus explain the higher coordination rate in the BOS–game of section 2.2.1. Whatever form of external information the theories incorporate from the hash–mark game, they are never able to connect the two games together. The information of the hash–mark game both triggers thoughts, or underlying conventions, so that players perceive one strategy or equilibrium as more prominent and act accordingly. All in all the theories create new insights in behaviour of players, but cannot fully link two distinctively different games and hence explain how the behaviour in the second game relates to the first.

2.4 The associative approach

2.4.1 Borrowing and building

In the first section of the chapter different approaches and theories on how external information may relate to the game people are playing have been discussed. The associative approach borrows different concepts of the discussed theories. All the ideas are more or less related to each other. They all tackle problems that traditional game theory is unable to explain.

Another idea in the associative approach is that players can make associations, because, in ‘real life’, repetition of play of an abstract game (for instance, prisoner’s dilemma, battle–of–the–sexes game) can have very long time periods in–between. Many other games can be played within the different intervals that exist between the repeated game. Given the limited cognitive abilities of people they may long have forgotten the last pure coordination game when playing the pure coordination game at hand. They might, however, remember a battle–of–the–sexes game which they incorporate in their approach for the pure coordination game at hand.

Combined together and extended, the different theories form the basis of the associative approach. None of the theories discussed deals with the idea that players who try to solve a problem at hand can look for external information in an analogous (different) game. Given the limited cognitive capacities of players a preceding different game can be more prominent than a repeated game (with large time intervals of play). The associations that players make between two different games can be many. However, because players draw from a shared background, common culture, established conventions, they may make the same associations and hence are able to solve the problem at hand better than traditional game theory predicts.

The associative approach assumes that people will look for prominent solutions by analogies with other situations not only in the cases that conventions are well established, but also in cases where no conventions are established. The relevant point of Sugden (1986) for the associative approach is that "all conventions rest on analogies, since no two coordination games are ever exactly the same." This means that players never play a repeated game, but instead play similar games. In other words, players see a resemblance between the former game(s) and the game at hand. What will happen if the former game(s) is a different game, instead of being similar (in abstract modelling terms)? In other words, what will happen if the precedence that creates prominence is a preceding (different) game? The associative approach tries to answer this question. That is, if two games that are not the same (or similar), are played in a sequence, the former game can have an influence on the latter game; the former game creates a focal point in the latter.

As said before, people will look for prominent solutions with other situations both in cases where conventions are well established, but also in cases where they are not. If a convention exists that players can use to solve their game it makes it easier, but if no convention exists people can still try to find extra information from the preceding game that can help them solve the game at hand. And if there is this extra information from the former game they will find and use it. This extra information that the players will find creates labelling of strategies. By incorporating information from the first game into the second players make an association between the two games. There are many different ways players can make associations between two (or more) games. There are different associations available to players, of which some are more prominent than others (compare with Mehta, *et al.*). That is, the players perceive the game they are playing differently compared to what traditional game theory predicts (compare with Bacharach).

Given the limited cognitive capacity of people, the last game they played, which might be completely different, can be of more significance for helping them solve the game at hand than the same game they played a long time ago. The idea of limited cognitive capacities is implicit, in that the associative approach assumes that players trying to solve the problem at hand look for external information in the preceding (different) game, while this information is easier to gather than games played earlier in history[39] (compare with Young). The associative approach will borrow the idea that readily available information of a previous game (although not the same) can break the symmetry of a second game and thus raise the chance of coordination (matching) (compare with Bhaskar). An example in the next section will illustrate the way the associative idea roughly works, then it will be applied in section 2.4.3 to see how it can explain the behaviour of players in the combination of two games of section 2.2.1.

2.4.2 Example of possible associations

In this section the intuitive idea of the associative approach will be illustrated by analysing an example. The example and analysis are kept simple, that is there will be no formal analysis of the example. The only goal of the example in this section is to make the associative idea more clear. In the next chapter the associative idea will be formalised, which will then be applied to the combination of hash–mark and battle–of–the–sexes game (again).

In this example there are two players who play two games against each other. The two games are completely different from one another. To see the different possible ways the players can associate the games, several different combinations of the two games will be analysed. For simplicity, assume that every time two players play a combination there is no former history, i.e., they play against each other for the first time in every combination of two games.

In each combination of two games the first game the two players will play against each other is a game with a strongly stable equilibrium (in terms of Rapaport and Guyer (1966), see also A.2.2) As the name already implies both players have an optimal strategy (or a dominant strategy), see Game I.

[39] Note: the search for external information in order to be able to solve the problem at hand is quite similar to the (philosophical) debate about rationality, where the difference is that the search for information stops when a certain aspiration level is reached in the bounded rationality idea, while in hyper rationality all applicable information is gathered.

Game I Game with strongly stable equilibrium

		Column player	
		C_1	C_2
Row player	R_1	(3 ; 3)	(4 ; 1)
	R_2	(1 ; 4)	(2 ; 2)

Given that the game is a symmetric 2×2 game it does not make a difference for either player whether they are the row player or the column player.[40] To reduce possible labelling by making one player the row and the other the column player, both players see the game from the perspective of the row player. Both players have a dominant strategy that is R_1; the corresponding outcome for this game is (3, 3). In the explanation of the different possible association, Game I is always played in this manner.

The coordination game that the players play after the game with strongly stable equilibrium is depicted in Game II.

Game II Coordination game

		Column player	
		C_1	C_2
Row player	R_1	(3 ; 3)	(0 ; 1)
	R_2	(1 ; 0)	(2 ; 2)

Traditional game theory states that in this coordination game there are three Nash equilibria: two equilibria in pure strategies and one in mixed strategies. The two Nash equilibria are (R_1, C_1), and (R_2, C_2); the Nash equilibrium in mixed strategies is where both players mix their strategies with a probability ½. On average the outcome of this game, if played by a large population of players, will be the mixed equilibrium (see Kreps, 1990; pp.103−104 footnote).

The associative approach states that players can incorporate information from the first game (the game with strongly stable equilibrium in this case) into the second game (coordination game) to help them solve the problem. When the players are able to find extra information from the first game, this can help them establish a higher payoff in the latter game compared to the outcome predicted by traditional game theory (the mixed strategy equilibrium).

Within the combinations played in the following sections Game I will not change; that is, the structure, the payoffs, the possible strategies, etc. all stay the

[40] It does, of course, make a difference for the perception of both players to the game. In other words, they label the strategies differently according to their being either the row player or the column player.

same. The second game the players will play in the combination, a coordination game, will be changed each time however, to see what kind of associations are possible. In the following sections only three different kinds of associations will be analysed. There can, however, be more associations, but for clarifying the idea of the associative approach the three different association examples will suffice. The different possibilities will be analysed in the following sections, with the emphasis on one association in each section, even though several different associations might be available in one combination of games.

Association of payoffs

The coordination game that the players play in this section is only changed in the possible actions: the action possibilities are *a* and *b* instead of R_1 (C_1) and R_2 (C_2). This change is made to delete the possibility for both players to make an analogy from the first game actions to the second game actions based on identical names for the actions. By deleting this option from the game the players are no longer able to associate between the actions available to them. The first game the players have to solve is Game I, and the second game they play in the combination is depicted below in Game III.

Game III Coordination game

		Column player	
		a	b
Row player	a	(3 ; 3)	(0 ; 1)
	b	(1 ; 0)	(2 ; 2)

The players will play the dominant payoff equilibrium in the first game, the resulting outcome belonging to this equilibrium is (3, 3). If the players realise that the payoff they received from play in the first game is also a possible payoff in the second game, they can use this information to coordinate their actions and receive the payoff of 3 each, which is, of course, higher than the mixed strategy equilibrium payoff[41]. The perception of the players of the latter game changes because of former play between the two players; that is, the play of Game I influences the outcome of Game III.

Given the structure of Game III the association of payoffs is not the only possible association available. From the former play of the combination one cannot conclude that association between the payoffs was the dominant one, because there was also a possible association between the two structures (left top

[41] The expected payoff of mixed strategy is: $\pi ex = 1½$ (= (½)(½)3 + (½)(½)(1 + 2))

cells) of the game (which is the subject of analysis in the next section). The outcome (3, 3) was in the same place in the matrix for both games.

Association of structure

In the first combination of the former section it was not clear whether the association is between payoffs or between the structures of both games, because both sorts of associations point in the same direction. The two players, now, play a combination of Game I and Game IV, which game is exactly the same as Game III, except that payoffs belonging to the two actions are interchanged. This combination creates different outcomes depending on which association both players see, and act upon.

Game IV Coordination game

		Column player	
		a	b
Row player	a	(2 ; 2)	(1 ; 0)
	b	(0 ; 1)	(3 ; 3)

In this combination, both players will play the dominant strategy in Game I, resulting in a payoff of 3 for both players. When the players act upon the association between payoffs, they will play action *b* in the coordination game (Game IV), and end up with a payoff of three, which is, of course, the same as in the first game of the combination. If, however, the players see the association between the structure of both games and act upon this association, the outcome will be different.[42] When both players act upon this association they will play action *a* in the second game, based on the fact that in the first game of the combination the outcome was in the top left cell of the matrix. In the second game of the combination they want to end up in this left top matrix, because of the association of structure made by the players. To end up in this cell of the matrix both players have to play action *a*, resulting in a payoff of two to each, which is still higher than the payoff belonging to the mixed strategy equilibrium (see footnote 41). In other words, even though this outcome is inferior to the outcome generated by following the association of payoffs, the outcome generated by incorporating external information from the former game (the association of structure) is still better than without incorporation of any external information.

[42] When it is not obvious which association is the more 'prominent' of the two, players can mis−coordinate. However, as in the discussion in section 2.3, the scenario described here is the most positive description.

Two players will now play a different combination. The players first play Game I, and then Game V, depicted below. The only difference between Game V and Game IV is that the strategies are not *a* and *b* anymore, but the same as in Game II. However, the structure of Game V is the same as in Game IV.

Game V Coordination game

		Column player	
		C_1	C_2
Row player	R_1	(2 ; 2)	(1 ; 0)
	R_2	(0 ; 1)	(3 ; 3)

Assume, now, that from all possible associations between the two games, because of the shared background, both players see the association of structure as most prominent. This means that if both players act upon this association they want to coordinate on the top−left cell in the matrix; i.e., they will play action R_1, resulting in a payoff of 2 each.

There are, however, many possible associations players can make in this combination. The possible associations in the combination can point in the same direction, but also in different directions. In the last combination, for example, the associations of payoffs and structure point in different directions ((3, 3) vs. (2, 2)). The associations of structure and strategies point in the same direction, however. The association of strategies will be the subject in the next section.

Association of strategies

The two players play a combination of first Game I, and then Game II. In Game II the players can incorporate information from the first game into the second. Again, there are several associations the players can make from past behaviour. Assume that the association of strategies is the most prominent association for both players. Taking this association into consideration for playing the second game, both players will play the same strategy, that is R_1, resulting in a payoff of 3 each. In this case both the association of structure and the association of payoffs point in the same direction as the association of strategies.

Now, the players play the last combination of the former section, that is first Game I, and then Game V. The difference between Game II and Game V is that the payoffs belonging to the two strategies are interchanged. Of the different possible associations that the players can make between the two games, assume that the most prominent one is the association of strategies. Both players will play the same strategy in the latter game as in the first game, because of the association the players make between the strategies. The outcome belonging to this play is that both players receive a payoff of 2. As in the former section and paragraph there is more than one association possible with the same end result; in this case, both the association of structure and strategies point in the same direction, while the association of payoffs points in a different one.

2.4.3 Two games in combination

The intuitive idea of the associative approach will now be applied to the two games in combination of section 2.2.1. The result of the hash–mark game creates information that players can incorporate when solving the battle–of–the–sexes game. As discussed in section 2.3.2 there are many different approaches to analyse this incorporation of external information, but none of them takes the information from a previously played different game. The associative approach takes the information generated by the play of the hash–mark game, because this is the only (and most prominent) extra information the players have when entering the BOS–game. The history players have built up when starting the BOS–game is just the hash–mark game.

The players can make many associations between games. However, players perceive some information from the hash–mark as more relevant than other information. Players also think about what the possible information is that the other player will see and/or process. In other words, if several associations come to mind between the hash–mark and the battle–of–the–sexes game, what association is more likely to be processed by the other player? The shared background of players may make it easier for them to think about which associations the other players may see. If players think other players have a high chance of having a certain association in their vocabulary or mind–set when entering the second game, it makes that particular association more prominent than others.

The underlying Lockean convention makes players connect the result of the hash–mark game with the BOS–game. Players will think of each other, because of the shared background, that he will make the same connection between the two games. That is, both players will think of each other as having the Lockean principle of distributive justice in their vocabulary when entering the BOS–game, and hence will act accordingly. This availability of associations players have, and the beliefs they have about the other player having the associations in her vocabulary (by building up history together), can be formalised. The formal framework makes the link between two (or more) games explicit and better analysable. The formalisation of the associative approach will be done in the next chapter.

2.5 Conclusion

The behaviour observed of the players in the Hoffman and Spitzer (1982, 1985) experiments cannot be explained by the different theories and approaches discussed in this chapter. The information from the first game in the experiment triggered different (unexpected) play in the second game. Players in the battle–of–the–sexes game acted according to the Lockean principle of distributive justice, where more 'selfish' behaviour by the winner of the hash–mark game is expected. In this chapter the intuitive idea of the associative approach is given to make an attempt to explain the behaviour in the two games. To see how the associative approach is developed related theories and approaches were discussed in order to show where they succeed and fail to explain the behaviour in the BOS–game and what the associative approach can borrow from these theories. In other words, the first research question "where, in existing literature, is the idea of players playing different games in combination to be positioned" has been answered in this chapter.

In the first section of the chapter different approaches and/or theories on how external information may relate to the games people are playing have been discussed. It is discussed what the associative approach borrows from and how it is positioned in the relevant literature. All the ideas are more or less related to each other. Combined together and extended they form the basic idea of the associative approach. The common idea of people incorporating external information in order to solve the problem at hand is something that is used in the associative approach. None of the theories discussed, however, deal with the idea that players who try to solve a problem at hand can look for external information in an analogous (different) game, which the associative approach does. Given the limited cognitive capacities of players a preceding different game can be more prominent than a repeated game (with large time intervals of play). Players can make many different associations between two different games. However, because players draw from a shared background, common culture, established conventions, they may make the same associations and hence are able to solve the problem at hand better than traditional game theory predicts.

The general line of reasoning for the associative approach has been given in this chapter, based on the different perspectives that exist in (or co–exist with) traditional game theory. The example in section 2.4.2 is still very inconclusive and unspecific, the reason being that only the general intuitive idea of the associative approach is given there. The idea of players associating is also discussed in the analysis of the combination of hash–mark and battle–of–the–sexes game. However, it is still the intuitive idea that is applied. In the next chapter this intuitive idea will be refined, as well as formalised. There the inconclusiveness of the associative approach will be dealt with and clarified.

CHAPTER 3

FORMALISATION OF THE ASSOCIATIVE APPROACH

3.1 Introduction

When players incorporate external information created by play of the first game into the play of the second game in a combination they make associations between the two games. This idea is discussed in the previous chapter. There it also became clear that players can make many different associations depending on what external information they process, and in which manner they do so. If several associations come to the mind of a player, what association will he choose for the problem at hand? What is the reason to act according to one and not to another association, i.e., is one of the associations more prominent? Why does a player think one association is more 'prominent' than another? Does prominence in this case have to do with a shared background and/or culture? Does this shared background make one association more prominent than another, and is this common knowledge? All these questions cannot be answered by the associative approach. However, the associative approach is able to show how players will behave when they think one association is more prominent than others. The associative approach assumes that prominence is 'created' by players having certain associations in their vocabulary, while not having others. In this chapter concepts, based on the ideas of both Bacharach (1993), and Janssen (2001), are used.

The key idea of both Bacharach and Janssen is "that the different labels that are attached to different strategies induce asymmetries between the strategies and that players can use these asymmetries in a rational way" (Janssen, 2001; p.120). The associative approach states that external information from a previous game makes players act in a certain way, because the external information triggered by an existing convention or rule of thumb makes an action more focal or conspicuous. The associations players make between games induce asymmetries between strategies. Given a shared background players are 'programmed' to automatically act in a certain way (evolution has 'programmed' them in thinking this way). The associative approach tries to model this behaviour and thus states how players, by and large, act in combinations of games.

The problem that is going to be tackled in this chapter is the problem of which association players will use for solving a problem at hand. Bacharach (1993) introduces the concept of availability to formalise the idea of conspicuousness of Lewis (1969) or prominence of Schelling (1960). The notion of availability is the starting point for the associative approach. Players can make different associations between two games, i.e., they have different associations 'available'. The more available a certain association, the more prominent it is.

The associative approach tries to model how a representative player would act in a combination of games. A player thinks he makes all possible associations between the two games, because he cannot think about the existence of other associations that are not in his vocabulary. A player can only optimise his behaviour based on the action types he thinks are possible. A player also has beliefs about the associations the other player can use: they are the same, or a subset of the associations he can use. In the combination of games players have certain associations available, and think about what the (conditional) probabilities are of the other player having these associations. The thinking about the associations does not have to be done consciously.[43] When the possible associations and related availabilities are defined (the formal framework of) the associative approach is able to show what the best action is for players in a particular combination of games.

In section 3.2 the general idea of both Bacharach and Janssen will be explained. The formal theory of Janssen will be analysed in this section as well. The general idea of both Bacharach and Janssen is the building material for the formalisation of the associative approach. Some ideas of the formal theory of Janssen will be extended in the formalisation on how associations between games work. The (construction of the) formal theory of the associative approach will be illustrated by analysing two different problems. These problems help to see how the concepts of the formal theory work and how they can be applied. First in section 3.3.1, the formal framework of the associative approach will be applied to the combination of games as sketched in the previous chapter (see section 2.2.1).

[43] Thinking about the other player seeing certain associations need not be done consciously. Players know they belong to a community without consciously thinking about it. Belonging to a community, players (unconsciously) know they have similar (not always exactly the same) availabilities given their shared background or common culture. The associative approach needs to define them, however, in order to be able to explain the behaviour of players in a combination.

The behaviour observed in the experiment by Hoffman and Spitzer (1985) is explained using the formal framework. Next in section 3.3.2, the example of the previous chapter (section 2.4.2) will be (shortly) analysed using the formal framework to show how the framework can be applied to three (instead of two) associations. A discussion will end the chapter.

3.2 Defining availability

Since Schelling's 1960 book *The Strategy of Conflict*, it has been recognised that individuals playing a (pure) coordination game are able to coordinate much better compared to the mixed strategy equilibrium outcome predicted by traditional game theory. The focal point approach of Schelling takes into account that individuals use external information to coordinate their actions. Both the articles of Bacharach (1993) and Janssen (2001) show that "the use of focal points can be consistently incorporated into a framework of rational choices" (Janssen, 2001; p.119) The incorporation of focal points into a framework of rational choices is tested in an experiment by Bacharach and Bernasconi (1997). The idea of Bacharach is extended by Janssen (2001). The refinements of the approach by Janssen make the approach applicable to more problems (games). The associative approach builds on both Bacharach and Janssen, but most concepts in the formal framework of the associative approach will be borrowed from Janssen.

3.2.1 Variable universe games

As said in the former chapter (section 2.3.2) Bacharach (1993) introduces a new way of representing multi−person decision problems, which he calls 'variable universe games.' The main novelty that he introduces with the concept of variable universe games is that

> one specifies *the way players conceive their situation* and how this varies. By contrast, in standard representations such as the extensive and normal forms the way players conceive their situation is not treated as a variable, and indeed is not explicitly specified at all. (emphasis in original, Bacharach, 1993; p.256)

The perception of situations varies across individuals. Some individuals may think of some questions when faced with a certain decision problem, while other individuals in the same situation may not think of them, or the individuals may not think of the same questions in resembling situations. In terms of Bacharach (1993; p.257): "it is the set of propositions about what she has beliefs at all –her *belief−space*— that varies. Variable universe games model such variations."

Traditional game theory assumes that, when an individual is faced with a decision problem, all the rules for the problem are given, and that the players know them. When faced with a decision problem, however, most individuals have to derive the rules for the problem and formulate this problem into the terms of a game based on their (first) perception of the problem and the contextual situation. "In a given problem situation there are multiple possibilities as to how they may do so" (Bacharach, 1993; p.257).

If players think of a certain problem in different ways, i.e., players have various belief–spaces, they also have some idea of the belief–space of other players. In the theory of games a strategic interaction and/or encounter between two or more individuals is the central point of analysis; the modelled interaction is the game. Given that the interaction is between two or more players, when faced with a game a player does not only have his own belief–space that plays a role, but also the belief–space he thinks the other player has. There are clusters of concepts, and if one of the members of a concept comes to mind (is available), other members of that same cluster (may) also come to mind (are also available). In other words, the concepts are related to one another.

> The process revolves around the fact that different thoughts involve common concepts, and the broad hypothesis that when one thought involving given concepts occurs to someone, related thoughts involving the same concepts are likely to, also. (Bacharach, 1993; p.258)

Players belonging to the same community have, by and large, the same conceptual competences, and the members of these communities also know this of each other.

3.2.2 Rationalising focal points

Bacharach (1993), and Bacharach and Bernasconi (1997) analyse and test the variable frame theory particularly for coordination games. Janssen (2001) extends the idea of Bacharach not only by refining the idea of framing, but also by extending its applicability to more than only coordination games.

Bacharach's idea that different labels are attached to different strategies and that these different labels induce asymmetries between the strategies which the players can use in a rational way, is the key idea which Janssen's article builds upon. Janssen uses two principles in order to be able to assure that individual strategies are uniquely determined and that they together form a Nash equilibrium. Players, when employing the two principles, can do better than pure randomisation. The first principle is the principle of Insufficient Reason (IR), which "says that a rational choice cannot discriminate between two strategies if they have the same characteristics" (Janssen, 2001; p.120). The second principle is the principle of Team Member Rationality (TMR), which "says that if there is a unique strategy combination that is Pareto optimal, then individual players should do their part of that strategy combination" (Janssen, 2001; p.120). TMR can be seen as an optimisation rule, while the principle of IR acts as a constraint on the set of feasible mixed strategies.

In this section an example will be used to show how the concepts and definitions of Janssen work. The example is based on example 1 and 2 of Janssen (2001; pp.123−125/130−132).

> Example: Two players play a matching game. A game in which coordination on the same object (match) leads to a positive payoff, and otherwise the payoff is zero. The players have five objects, and the players can only observe two distinguishing features, colour and shape. The colours are as follows: green (no. 1), yellow (no. 2), red (no. 3), red (no. 4), and blue (no. 5). The shapes are as follows: pyramid (no. 1), pyramid (no. 2), cube (no. 3), rectangle (no. 4), and ball (no. 5).

The idea of IR combines the notions of *description* symmetry and *payoff* symmetry. Description symmetry "says that players should treat objects they cannot distinguish from each other in the same way" (Janssen, 2001; p.124). In other words, a player who chooses between the five objects based on colour, has five act descriptions. Because objects three and four cannot be distinguished from each other, they have to be treated in the same way. That is, a player i ($i = 1, 2$), who chooses a $p_i = (p_{i1}, p_{i2}, p_{i3}, p_{i4}, p_{i5})$, where (p_{ij}) receives a positive probability and the five probabilities together add up to 1, should treat the distribution of the strategy space over objects three and four symmetrically: $p_{i3} = p_{i4}$. "Two act descriptions are payoff symmetric if the players receive the same expected payoff by interchanging the probabilities assigned to these act descriptions and leaving the other probabilities unaffected" (Janssen, 2001; p.125). The payoff to the players when they choose a strategy combination $p = (p_1, p_2)$, is defined as $\pi(p)$. In the example, the payoff over objects one, two, and five are payoff symmetric,, because the expected payoff for these three objects stay the same when interchanging the assigned probabilities, and should thus be treated as such: $p_{i1} = p_{i2} = p_{i5}$. For players there are now three objects (of different colours) that are treated as symmetric (where x_i is total probability give to this set) and two red objects that can be treated symmetric (where y_i is the total probability given to the set). The permissible strategies for a player i then are $(\frac{1}{3}x_i, \frac{1}{3}x_i, \frac{1}{2}y_i, \frac{1}{2}y_i, \frac{1}{3}x_i)$, with $x_i + y_i = 1$. The expected payoffs to both players is equal to $\frac{1}{3}x_1x_2 + \frac{1}{2}y_1y_2$. Both players can calculate that there is a unique Pareto efficient outcome, where $y_1 = y_2 = 1$. TMR tells the players they should do their part of this particular strategy combination (note: the players have only observed colour so far)

> Note that the solution that I arrive at tells the players to randomise over two red objects. […] it is interesting to note that doing one's part

> in an optimal strategy combination does not guarantee coordination. In particular, in the example the chance of coordinating on the same object is equal to ½. (Janssen, 2001; p.125)

The idea of the focal points, as given above, is formalised in the rest of Janssen's article. This formalisation is not explicitly necessary for the associative approach. However, the formalisation of the concept of availability is fundamental for the associative approach. So for the complete (formal) line of reasoning of availability, and the complete set of concepts and definitions for the formalisation of availability see Janssen (2001). In the following paragraph the basic concepts and definitions of Janssen will be given. The concept of availability is the main concept the associative approach borrows from Janssen. Other (minor) concepts related to the idea of availability are also used in the associative approach, but will not be discussed extensively.

The set of actions for a player is finite and given by $\Sigma = \{1,\ldots, m\}$. "There is an arbitrary number of different dimensions (concepts) that may be used to describe the actions. Each of these dimensions induces a partition of Σ." (Janssen, 2001; p.126) In other words, the set of action(s) can be divided using the dimensions to 'categorise' the actions. A basic partition is a partition of Σ induced by a single dimension. B denotes the set of the basic partitions. A typical element of B will be denoted β.

A player may think of some dimensions of the actions, while not thinking about others, because some dimensions come more easily to mind than others. The notion of availability (of these dimensions) is already introduced in section 3.2.1. The way a player looks at a problem is different because of the different dimensions that may come to mind. The different dimensions that come to mind may be thought of as the frame through which a player looks at the problem. The frame will be denoted by F, which is an arbitrary subset of B. "A strategy for player i is a function of the set of possible frames to the set of (random) actions. The randomisation player i chooses is denoted by p_i and $p_i \in \Delta$, $i = 1, 2$. For each pair $p = (p_1, p_2)$ let the expected payoff be denoted by $\pi(p)$." (Janssen, 2001; p.126)

Players think that they consider all dimensions that are possible to distinguish. However, a player is not capable of thinking about dimensions that are outside his frame F, because he has no idea about the existence of dimensions not contained in F. In other words, players optimise their behaviour on the possible actions that they think are possible. "The probability that all dimensions in F and no dimensions outside F come to mind of player i is denoted by $V(F)$: the availability of F. A player of type F has no idea about the existence of dimensions outside F. He has beliefs about the dimensions the other player can actively use." (Janssen, 2001; pp.126–127) He can only believe that the other player has at the maximum the same dimensions as himself, or less, i.e., if the other player is said to be type G, $G \subseteq F$. Given that the player is of type F, the conditional probability that the other player is of type G is denoted by $V(G|F)$. The availability of dimension β is denoted by v_β , hence a dimension β that is not available is denoted by $(1 - v_\beta)$.

"Suppose $F = \{\beta_1, \ldots, \beta_k\}$ and define $C(F) = \beta_1 \vee \beta_2 \vee \beta_k$, where $\beta_j \vee \beta_k$ is the join of partitions $\beta_j \vee \beta_k$. A player of type F perceives all the sets of possible actions that are elements of $C(F)$. A typical element of $C(F)$ is a perceived class and will be denoted by C. It is clear that $C(F)$ is a partition of Σ." (Janssen, 2001; p.127) The first constraint on the set of feasible randomisation implied by IR for a player of type F is that randomisation is only feasible if all the members of a perceived class C receive the same probability (description symmetry).

> Example continued: the availability of shape is denoted as v_s, and the availability of colour as v_c. Player one observes both shape and colour. He thinks that the conditional probability of player two perceiving colour but not shape is equal to $v_c(1 - v_s)$, and vice versa for shape but not colour: $v_s(1 - v_c)$. And the conditional probability of player two perceiving neither shape nor colour is $(1 - v_s)(1 - v_c)$.
>
> A player who only observes colour should randomise over the red objects, i.e., $p_i^\star(C) = (0, 0, ½, ½, 0)$; similarly for only observing shapes, $p_i^\star(S) = (½, ½, 0, 0, 0)$. Player one expects player two to choose the above probabilities when player two is of type C, respectively type S. Let us consider the choice made by player one: $C(F) = (\{1\}, \{2\}, \{3\}, \{4\}, \{5\})$.

"The expected payoff for a player of type F is given by

$$\pi_i(p(\cdot) \mid F) = \Sigma_{G \subseteq F} V(G|F)\pi(p_i(F), p_{-i}(G)),$$

where $p_i(F)$ denotes the randomisation chosen by type F, $p_{-i}(G)$ denotes the randomisation chosen by type G, and $\pi(p_i(F), p_{-i}(G))$ denotes the players' expected payoff when these randomisations are chosen." (Janssen, 2001; p.127)

The frame players have is a subset of all the possible basic partitions. A fixed family of mixed strategies is now denoted by $q(G)$, where G is a subset of F. Two sets are payoff symmetric relative to the frame and the set of mixed strategies, $(F, q(G))$, if the expected payoffs for two sets are the same given interchangeable probabilities assigned to them, while leaving the probabilities of the other sets unaffected.

> Example continued: Reminder: $C(F) = (\{1\}, \{2\}, \{3\}, \{4\}, \{5\})$. $\{1\}$ and $\{2\}$ are payoff symmetric relative to $(F, q^\star(G))$ for all v_c and v_s. The same holds true for $\{3\}$ and $\{4\}$. Using payoff symmetry makes this clear:

$$\pi_1(p(\cdot)\,|\,F) = (1 - v_c)(1 - v_s)\,{}^1\!/_5 + {}^1\!/_2 v_s(1 - v_c)(p_{11} + p_{12}) + v_c(1 - v_s)(p_{13} + p_{14}) + v_c v_s(p_{11}p_{21} + p_{12}p_{22} + p_{13}p_{23} + p_{14}p_{24} + p_{15}p_{25}).$$

This expression remains unaffected if both players interchange the probabilities given to the first two objects, while leaving all the other probabilities unchanged. Hence, objects {1} and {2} are payoff symmetric relative to (F, $q^\star(G)$) for all v_c and v_s. A similar argument applies to objects {3} and {4}.

The constraints on the set of feasible mixed strategies has now been set by the use of the IR principle. The optimisation rule, formed by TMR, serves two purposes now. "First, it helps to determine the expectations a player has about his opponent's strategy." (Janssen, 2001; p.129) TMR determines the strategy a player will choose when the subset G of F is realised. "Second, it assures that players do their part of a strategy combination that is uniquely Pareto superior given these expectations." (Janssen, 2001; p.129)

Example continued: it follows that player one may choose any p_1 such that $p_1 = (½x, ½x, ½y, ½y, z)$, $x + y + z = 1$, where x is the total probability given to the set of pyramids and y is the total probability given to the set of red objects. For any $p_1(F) \in P_i^\Gamma(F)$,

$$\pi_1(p(\cdot)\,|\,F, q^\star) = (1 - v_c)(1 - v_s)\,{}^1\!/_5 + ½v_s(1 - v_c)x + ½v_c(1 - v_s)y + v_c v_s(½x^2 + ½y^2 + z^2).$$

For different values of v_c and v_s the expression has a unique maximum at either x, y, and z. It follows that the choice implied by both IR and TMR depends on the availabilities v_c and v_s.

The availabilities of the different dimensions (like colour and shape in the example) can have different values, which create different constraints (implied by IR) and different optimisation results (implied by TMR). Janssen shows, graphically, how these different values of the availabilities have their effect on the choice (result). Given the three different combinations of values for v_c and v_s, there are three unique maximums. That is:

Example continued:

If $v_s > v_c$ and $v_c < ½$, the former expression reaches a unique maximum at $x = 1$.

If $v_s < v_c$ and $v_s < ½$, the former expression reaches a unique maximum at $y = 1$.

If $v_c > ½$ and $v_s > ½$, the former expression reaches a unique maximum at $z = 1$.

3.2.3 Conclusion

The arguments of both Bacharach and Janssen in the former sections are very well summarised by Janssen:

> The general argument is that in coordination games players try to use the information they have in such a way that they have a reason to choose one particular strategy and not another. For the approach to yield a coordinated outcome players have to start from some common background: a common set of dimensions and a shared understanding of the likelihood that the other player considers other sets of these dimensions. (Janssen, 2001; p.141)

3.3 How does availability work with or in associations?

In the former section several ideas and concepts of Bacharach and Janssen are discussed. Not all these concepts are relevant to the associative approach. The concepts relevant to the associative approach are the notion of availability and payoff symmetry. The formal approach of associations between games given in this chapter is based on these concepts. When faced with a combination of problems (games), players use external information created by the play of the first game when entering the second game. There are several associations players can make between two games. When the perception and incorporation of the external information of the first game triggers, or is triggered by, an existing convention (as in the combination of two games in the Hoffman and Spitzer (1985) experiment) the association is relatively easy to define. Given shared background a certain piece of external information is processed as more relevant for making an association in the combination than others. The players are predetermined by "nature[44]" whether they see certain associations. The different associations that can be defined as relevant in the combination are said to be in the frame of a player; i.e., they are available. By definition a player cannot think about associations that are not in his frame, but can have beliefs about the associations that the other player can have in her vocabulary conditional on

[44] Nature has no relationship with the notion 'state of nature' that is used by evolutionary theories. Nature only determines for one game (or combination) what the availabilities are of the associations in a player's frame.

which associations he has available in his frame (i.e., conditional probability).[45] Players may learn from past play and incorporate this into their approach of later games. If players have learned that there is a possible association they can make between the games, this means that in a later combination (not necessarily between the same two players) nature assigns different availabilities to the players. Using the aforementioned concepts, the associative approach shows how players can find an optimal rule in a combination of games depending on the availability and the respective conditional probabilities of the different associations.

The formalisation of the associative approach, based on the former concepts, will be realised using an example of associations that are rooted in conventions. The idea of players making associations based on existing conventions was introduced in the former chapters by referring to Hoffman and Spitzer (1985). They introduced two principles of fairness that are common in western culture: the Lockean principle of distributive justice and the egalitarian principle. One could say that evolution has favoured these specific principles, and that they are thus rooted in society: they are conventions. Players can make two associations in the combination of the hash–mark game and battle–of–the–sexes game based on the external information of the first game (hash–mark game) triggered by the existing conventions. They do this by (un)consciously using the aforementioned principles, that is, they can make an entitlement or an egalitarian association. When the associations and their availabilities are defined the associative approach can show why players (will) act according to one of the two associations. After that, the associative approach will be applied to problems where there is no shared convention that players can rely on. This will be illustrated by analysing the example from section 2.4.2 where only the formal structure of the games can create the information searched for by the players. The formal framework of the

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[45] Availabilities are defined between zero and one, which needs some explanation because a dimension or association is in the frame of a player, or not. However, the idea of availability can be seen, for instance, as nature programming the player to (unconsciously) 'assign' probabilities to other players about the possibility of these players having certain associations in their frame. In other words, nature determines the player's beliefs about the cognitive capacities of other players. That is, for instance, nature determines the following thinking for a player: *I think that there is a 70% chance that the other player makes and uses this particular association*. In other words, for this player it would mean that the availability of this particular association would be $v = 0.7$. Another way of looking at the idea of availability is that in a population the average probability of members of this population making a particular association is, for instance, 0.7. In other words, given shared background, players have this particular association available with 0.7, and not available with 0.3.

Apparently, an association can be called, or be perceived as, more prominent when it is more available. However, when the availabilities of, for instance, two associations are 0.6 respectively 0.7, one cannot say that the second is more prominent than the first: they are both prominent. Intuitively thinking, when the difference in availability is large one can say that one of the two is more prominent. But this does not prevent the possibility that players can coordinate by using a less available association.

associative approach will show how players can or will behave given the availabilities and the conditional probabilities of the associations.

3.3.1 Winner takes all, or not?

Consider two players, with no prior history together, playing two consecutive games. The first game they play is the hash–mark game, followed by a battle–of–the–sexes game. Within this combination of two games there are many associations possible, depending on the external information of the first game and the relation that can be drawn with this information when looking at the second game. However, only two associations will be defined, because these are the most "conspicuous" ones.[46] One association is the "entitlement" association and the other is the "egalitarian" association. The entitlement association is based on the Lockean principle of distributive justice (see also former chapter).

> Natural law/desert theories assert that, as a matter of natural law, someone or other *deserves* resources. […] The Lockean theory posits that an individual deserves, as a matter of natural law, a property entitlement in resources that have been accumulated or developed through the individual's expenditure of effort. The individual deserves the entitlement because he has "mixed his labour" with the resource. A subject who holds a Lockean theory of distributive justice will behave in a self–regarding manner whenever he perceives that he has "mixed his labour" with a resource. (Hoffman and Spitzer, 1985; pp.264–265)

In other words, the entitlement association states that the winner of the hash–mark game is entitled to the larger share in the BOS–game, and the loser should settle with the smaller share. That is, the winner gets three euro and the loser receives two euro (see section 2.4.2). The availability of the entitlement association is denoted by v_1, where $0 \leq v_1 \leq 1$.

The egalitarian association is (in a way) the opposite association of the entitlement association.

> Egalitarian theories all posit that a just distribution gives everyone an equal share of resources. The theories differ over *what* exactly should be equalised. (Hoffman and Spitzer, 1985; p.263)

46 Actually, I could not think of any other associations than the two mentioned. But as I am a product of the western society evolution has 'programmed' me in such a way that my frame only incorporates these two associations. The other possible associations do not come to mind, because they were never favoured by evolution. One cannot exclude the possibility of there being more associations, however.

The egalitarian association that the players can make in the combination, states that the winner from the hash−mark game should settle for less in the BOS−game, because he already won the first game and now should give the winning position to the other player. For the loser it is exactly the opposite. The availability of the egalitarian association is denoted by v_2, where $0 \leq v_2 \leq 1$.

A player can have none, one, or both associations available in his frame. The availabilities of the associations are relevant for the possible strategies a player can choose. A player has beliefs about the (conditional) probabilities of the other player having the same frame or a subset of the frame. The associative approach shows how players can find an optimal rule depending on the availabilities (and the conditional probabilities), given the shared background.

Possible plays for the players

Nature can say that either the winner or the loser of the hash−mark game sees no association, only the entitlement association, only the egalitarian association, or both. The best strategy for a player to play depends on where nature places him, and thus what he thinks the conditional probabilities are of the other player perceiving the association(s).

> Some associations come more easily to mind than others, a player may think about one association, but not about the other... *Availability* formalises this idea. The different associations a player may think of may be thought of as the *frame* through which he looks at the combination of games at hand.

This quote has been revised from Janssen's original (2001; p.126), with the terms 'dimension(s)' and 'coordination' replacing the terms 'association(s)' and 'combination of games at hand' respectively. A player with a certain frame is not able to think of any associations outside this frame. In other words, the player does not have any idea about the existence of other player types with a frame that contains associations not contained in his frame, i.e., the player thinks he is taking into account all the associations possible.

If the players have one association in their vocabulary the strategy they adopt depends on what association they see and with what probability they think the other players see the same association or not. In the case where players see both associations, the best strategy depends on what they think the probabilities are that the other player sees the associations.

No association

If a player does not perceive, or is incapable of incorporating, the external information of the hash−mark game when entering the battle−of−the−sexes game, it means that he is not able to make any association between the two games. Because a player does not have any association available in his frame, he also cannot hold any beliefs about the other player having any. In other words, both v_1 and v_2 are 0.

As said before, in the BOS−game there are three equilibria (see also appendix A.5). There are two Nash equilibria, where one player chooses two euro and assigns the other player three euro, while the other player chooses three euro and assigns the other two euro. And there is an equilibrium in mixed strategies, where a player will play the first alternative with probability $3/5$, and the second alternative with probability $2/5$, resulting in an expected payoff of $6/5$. This is the same for any player that makes no association, regardless of whether he was winner or loser in the hash−mark game, because in this case there is no distinction between winner and loser.

Entitlement association

If the information from the first game only triggers a player to think about the Lockean principle of distributive justice, he can only make the entitlement association. In other words, only the entitlement association is available; i.e., $0 < v_1 \leq 1$. Because the player has only the entitlement association is his frame, he cannot think of the other player perceiving another association than the entitlement association. The player cannot think about other associations outside his frame, and thus cannot think about the other player having another association. That is, the player thinks of the other player seeing the entitlement association, or not. No matter with what probabilities the player thinks the other player has the entitlement association, he has a dominant strategy: act according to the entitlement association. The specific definition of the strategy depends on whether you are the winner or the loser of the hash−mark game.[47]

Consider the winner of the hash−mark game. The winner has two options: claim the larger share, that is three euro, or claim the smaller share, that is two euro. To see what is rational for the winner one has to calculate what the expected payoffs are for the two claims given what he thinks the probabilities are of the other player having the entitlement association. The expected payoff for the winner when claiming three, is defined as follows (where $(1 - v_1)$ means the probability of the other player not having the entitlement association available):

$$\pi^{w}(3) = (1 - v_1)\tfrac{6}{5} + v_1 3$$

The same line of reasoning is applicable for the winner claiming two:

[47] The game is asymmetric because the players are loser or winner of the hash−mark game, and they make associations from the different perspectives of either loser or winner.

$\pi^{w}(2) = (1 - v_1)\frac{6}{5} + v_1 0$

When the winner thinks the probability of the loser having the entitlement association is zero, he will mix his strategies, because the expected payoffs for claiming three or two are the same ($v_1 = 0$). He will mix his strategies, because this case is exactly the same as when the winner does not see any association at all (see the former paragraph). When the winner believes the probability of the loser having the entitlement association is larger than zero it is obvious that claiming three always gives a higher payoff than claiming two, that is for any $v_1 > 0$ the winner should claim three. This line of reasoning is also applicable for the loser of the hash–mark game, with opposite claims compared to the winner.

Hence, the expected payoff for the winner is three when both players act according to the entitlement association. In this case the expected payoff for the loser is two. The expected payoffs for both the winner and the loser are higher compared to the case in which they both would not act according to the association and mix their strategies.

Egalitarian association

The line of reasoning in the former paragraph is also applicable to the case of the egalitarian association. Based on the information of the hash–mark game the player links the games on the egalitarian principle: winning games should be (more) equalised. In other words, the player makes an egalitarian association between the two games. A player, having only the egalitarian association, can think of the other player having either the egalitarian association or no association at all, that is, the probability that the other player also has the egalitarian association ranges from 0 up to and including 1. Given that for player one the entitlement association is outside his frame, he cannot think about this association being available (to him or the other player). By ways of the same calculation method as in the former paragraph it becomes obvious that any player, being winner or loser, has a dominant strategy. The expected payoff for the winner when claiming three, is defined as follows:

$\pi^{w}(3) = (1 - v_2)\frac{6}{5} + v_2 0$

The same line of reasoning is applicable for the winner claiming two:

$\pi^{w}(2) = (1 - v_2)\frac{6}{5} + v_2 2$

The winner will act according to the egalitarian association, because the expected payoff for this strategy is always higher than mixing the strategies. The expected payoffs for acting according to the egalitarian association are exactly the opposite[48] for the winner and the loser compared to the expected payoffs when acting according to the entitlement association (see above).

Both associations

If the information of the hash−mark game and the underlying conventions make a player see both the entitlement association and the egalitarian association in the combination of games, he can think of the other player having no, one, or both association(s) in her frame. The availability of the entitlement associations is defined as v_1 and the availability of the egalitarian association as v_2. Given that a player can make both the entitlement and the egalitarian association, he thinks that the conditional probabilities of the other player having the entitlement but not the egalitarian association is $v_1(1 - v_2)$, and vice versa having the egalitarian but not the entitlement association is $v_2(1 - v_1)$. The conditional probability of the other player having neither association is $(1 - v_1)(1 - v_2)$. The product of both availabilities defines the conditional probability of the other player perceiving both associations. In short, the conditional probabilities are:

- no association → $(1 - v_1)(1 - v_2)$
- entitlement association → $v_1(1 - v_2)$
- egalitarian association → $v_2(1 - v_1)$
- both associations → $v_1 v_2$

$0 \leq v_1,\ v_2 \leq 1$

To see what is the rational solution given the defined associations and their availabilities, one has to calculate the expected payoffs for both players when they "claim" either the larger or the smaller share of the money. This is depicted in the following equations, where π^i is the expected payoff for player i $(i = w, l)$, where w is the winner and l is the loser of the hash−mark game.

$$\pi^w(3) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)3 + v_2(1 - v_1)0 + v_1 v_2 X$$

$$\pi^w(2) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)2 + v_1 v_2 X$$

$$\pi^l(3) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)3 + v_1 v_2 X$$

$$\pi^l(2) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)2 + v_2(1 - v_1)0 + v_1 v_2 X$$

To understand what these claims mean, the first equation of the winner will be clarified.[49] When claiming three the expected payoff for the winner is

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[48] They are exactly the opposite because the BOS−game is symmetric.

[49] The other equations have a similar line of reasoning.

dependent on the conditional probabilities of the other player having certain associations available. The first term represents that the other player has no association available, i.e., the player will mix his strategies. If the other player mixes her strategies, this means for the winner claiming three, there is $\frac{2}{5}$ probability that he will get the payoff of three, i.e., an expected payoff of $\frac{6}{5}$. The second terms says that based on the conditional probability of the other player having the proper association (in this case, the entitlement association) and not the other, i.e., $v_1(1 - v_2)$, he will receive three when claiming three. In other words, when following the association the player should claim three (and the loser two, but that is another equation). The third term says that if the winner would claim three based on the conditional probability of the available association for the other player being the egalitarian association only (i.e., $v_2(1 - v_1)$), he would receive nothing, because the other player will act according to the egalitarian association. The last term is unspecified and denoted X, because one is not able to determine what the outcome will be; it depends on what the player believes the conditional probabilities are of the other player having both associations. The winner thinks that the loser has both associations available, and can thus act according to either.

The term X can be specified by calculating what the minimum or maximum possible outcome of a specific claim is. That is, when claiming three as the winner the minimum expected payoff for X is 0 in the case of mismatching, while the maximum expected payoff is 3 in the case of matching alternatives. It is always rational for a player to play a particular strategy if it is a dominant strategy, because no matter what the opponent will do the player is always better off. If the minimum expected payoff of one claim (c_1) always exceeds the maximum expected payoff of the other claim (c_2), given that the player only has two possible claims, it is always rational to claim the one with the higher expected payoff (i.e., c_1). In this way the X's can be specified by calculating for what conditional probabilities the minimum of one claim (where X is set to 0) is equal to or exceeds the maximum of the opposing claim (where X is set to the maximum payoff of the specific claim). The specification of the X's and the calculation of the different claims will be done in the following paragraph. The strategies will be shown for the winner and the loser separately. In this section the complete calculation of the first case will be given, and only the results of the other cases. The calculation of the other cases, which is done in exactly the same manner (only the values of X, and the minima and maxima of the claims are different), is shown in appendix B.1.

Both associations for the winner of the hash–mark game

Case 1: Claiming 3

It is rational for the winner to claim three (act according to the entitlement association) when the minimum of claiming three is larger than or equal to the maximum of claiming two. The minimum ($X = 0$) the winner of the hash–mark game can get when claiming three is:

$$\pi^{w}(3) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)3 + v_2(1 - v_1)0 + v_1 v_2 0$$

The maximum ($X = 2$) the winner of the hash–mark game can get when claiming two is:

$$\pi^{w}(2) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)2 + v_1 v_2 2$$

To see for what values of v_1 and v_2 it is rational for the winner to claim three, the minimum of claiming three has to exceed or be equal to the maximum of claiming two. In a formula: $\min \pi^{w}(3) \geq \max \pi^{w}(2)$, which is satisfied if the following equation holds:[50]

$$v_2 \leq \frac{3v_1}{2 + 3v_1}$$

Case 2: Claiming 2

It is rational for the winner to claim two, i.e. act according to the egalitarian association, when the maximum of claiming three is smaller than or equal to the minimum of claiming two, which is the case if:

$$v_2 \geq \frac{3v_1}{2 - 2v_1}$$

Based on the conditional probabilities for the loser having associations, the equations of v_2 expressed in v_1 for the winner can be plotted graphically as follows (remember v_1 is entitlement association, and v_2 is the egalitarian association):

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[50] Calculation of min πw (3) ≥ max πw (2):

$\Rightarrow (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)3 + v_2(1 - v_1)0 + v_1 v_2 0 \geq (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)2 + v_1 v_2 2$

$\Rightarrow v_1(1 - v_2)3 \geq v_2(1 - v_1)2 + v_1 v_2 2$

$\Rightarrow 3v_1 - 3v_1 v_2 \geq 2v_2 - 2v_1 v_2 + 2v_1 v_2$

$\Rightarrow 3v_1 \geq 2v_2 + 3v_1 v_2$

$\Rightarrow 3v_1 \geq v_2(2 + 3v_1)$

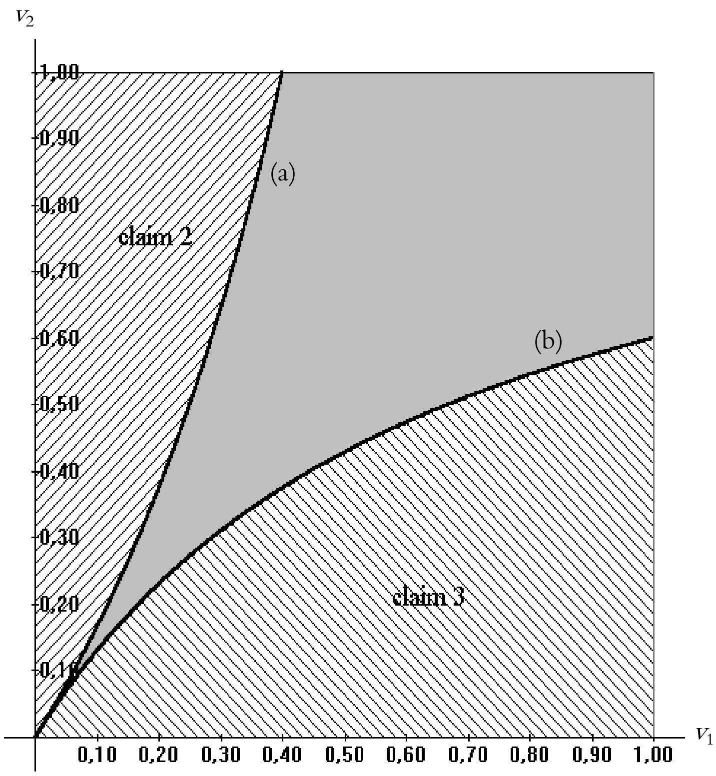

Figure 3−1 Strategies in the BOS−game for the winner

The shaded area enclosed by line *a* (equation $v_2 = 3v_1/(2 - 2v_1)$), and the v_2−axis is the area in which it is rational for the winner of the hash−mark game to always claim the smaller part in the BOS−game for himself and assign the larger share to the loser, because the minimum expected payoff for claiming three is always higher than the maximum expected payoff for claiming two. That is, given the more "prominent" role of the egalitarian association, it is better for the winner of the hash−mark game to act according to this association.

The shaded area enclosed by line *b* (equation $v_2 = 3v_1/(2 + 3v_1)$), and the v_1−axis shows the area in which it is always rational for the winner to claim the larger share of the money in the BOS−game and assign the smaller share to the loser of the hash−mark game. Here, the minimum expected payoff of claiming three exceeds the maximum expected payoff if the winner would claim two.

In the "no−association" point ($v_1 = v_2 = 0$) the winner of the hash−mark game has no conclusive reason to claim either two or three, that is, the winner of the hash−mark game has no extra information to give him a reason for either of the two pure strategies in the BOS−game. In other words, the winner will mix his strategies in this point.

In the solid shaded area the winner of the hash−mark game has no conclusive reason, again, to claim either three or two based on his own expected payoffs. In this area the expected payoffs of the minimum claims do not exceed the expected payoffs of the opposing maximum claims. Here, as in the "no−association" point, the winner will mix his strategies as predicted by traditional game theory.

Both associations for the loser of the hash−mark game

Case 3: Claiming 2

It is rational for the loser of the hash−mark game to claim two (act according to the entitlement association) when the maximum of claiming three is smaller or equal to the minimum of claiming two. This is the case if:

$$v_2 \leq \frac{2v_1}{3 + 2v_1}$$

Case 4: Claiming 3

It is rational for the loser of the hash−mark game to claim three, i.e., act according to the egalitarian association, when the minimum of claiming three is larger or equal to the maximum of claiming two. In a formula: $\min \pi^l(3) \geq \max \pi^l(2)$, which is satisfied if:

$$v_2 \geq \frac{2v_1}{3 - 3v_1}$$

Regarding the winner, the equations of v_2 defined in v_1 for the loser of the hash−mark game can be depicted graphically (see figure 3−2, where v_1 is availability of entitlement association and v_2 is the availability of the egalitarian association).

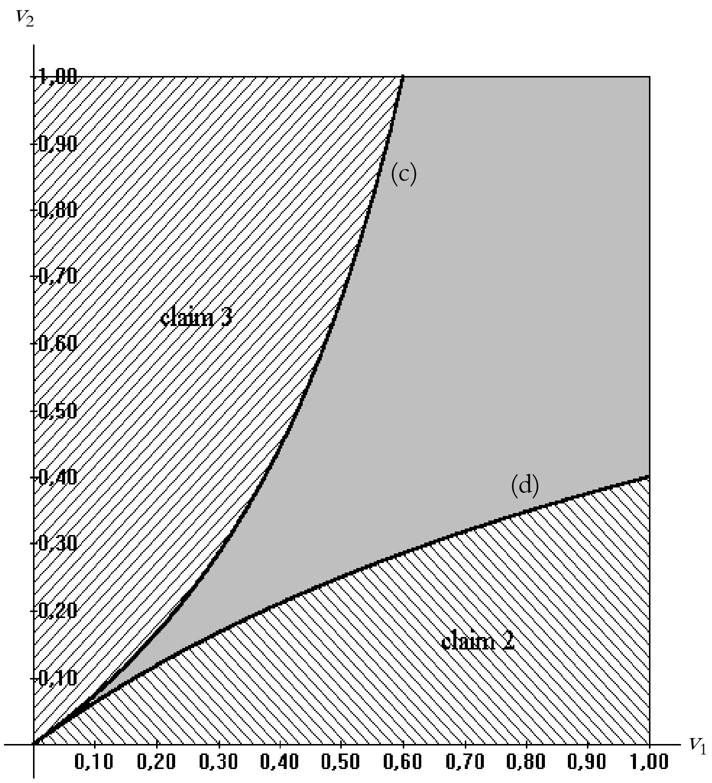

Figure 3–2 Strategies for in the BOS–game for the loser

Again, the same explanations used for the winner of the hash–mark game can be used to explain the shaded areas for the loser. She has exactly the same reasons for claiming three in the area enclosed by line *c* (equation $v_2 = 2v_1/(3 - 3v_1)$), and the v_2–axis (the "egalitarian" area) as the winner has for claiming three in the "entitlement" area. Vice versa, for the area enclosed by the v_1–axis, and line *d* (equation $v_2 = 2v_1/(3 + 2v_1)$).

In the "no–association" point the loser of the hash–mark game has no reason to claim three instead of two or vice versa, in other words she will mix her strategies. In the solid shaded area the loser, just as the winner of the hash–mark game, has no conclusive reason to claim either three or two based on her own expected payoffs, again because there is an overlap in the expected payoffs of the opposing claims: the expected payoff of a minimum claim is not larger than the expected payoff of the opposing maximum claim.

Both associations for both players

To see what the different outcomes of the combination of the hash–mark game and the BOS–game are, one has to map the two availability sets for both the winner and the loser on top of each other (see figure 3–3). The different shaded areas show the result, given the actions of both the winner and the loser of the hash–mark game, based on the defined associations and their respective probabilities. Note that the different areas in the graph are not realised outcomes, but possible outcomes.

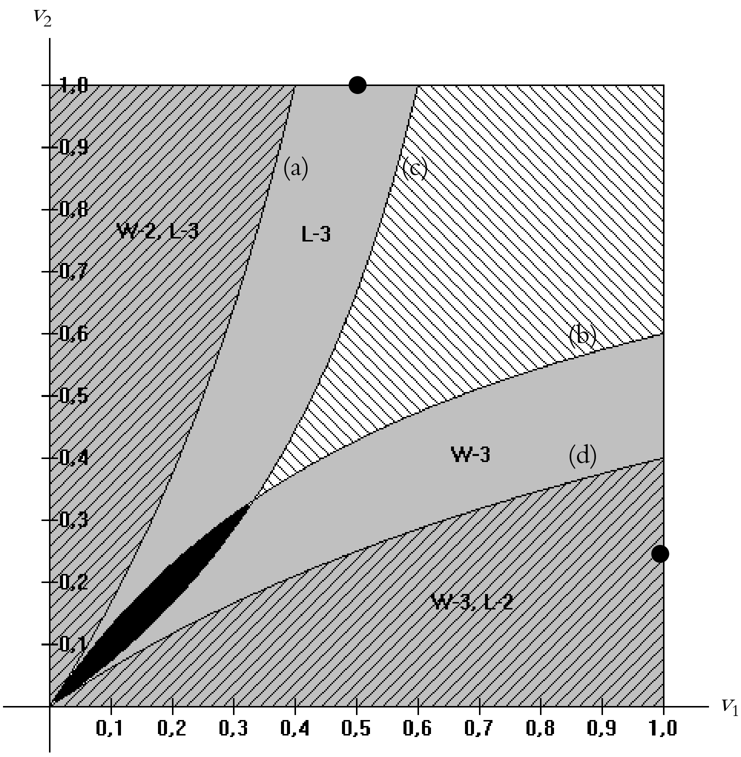

Figure 3–3 Possible outcomes in the BOS–game

The dark grey diagonal shaded areas show the two areas in which both the winner and loser will act according to one of the two (more "prominent") associations. Given the availabilities of these "prominent" associations players will always have a higher expected outcome by acting according to the relevant associations compared to the mixed strategy equilibrium. Acting according to the "prominent" association will result in one of the Nash equilibria of the BOS–game, i.e., expected payoffs of (3, 2) or (2, 3).

The solid grey shaded areas show the areas in which either the winner or the loser of the hash–mark game has a pure strategy of claiming three (given the more "prominent" association), while the other player, based on his availabilities and his beliefs about the associations the other player has, has no conclusive reason to prefer one pure strategy over another. The other player will mix his strategies resulting in an expected payoff of $^6/_5$. This outcome is also valid for the player claiming three, because of the mixing of the opponent: his claim of three will match the claim of the opponent in $^2/_5$ of the cases. The player will claim three, because claiming three is still a dominant strategy.

In the first explanation of the solid grey area, a player has beliefs about the other player having the same associations in her frame; the availabilities and the conditional probabilities are in the same point and/or region. This assumption is defendable on the ground that in a shared background people have similar ideas on how other people look at problems they are dealing with. If it is common knowledge that the availabilities of the associations are quite similar for all players, the players can deduct an extra area of coordination; that is the solid grey shaded area where one player will always claim three. In case of similar availabilities, which is common knowledge given the shared background, it is for the other player rational to claim two knowing that his opponent will claim three.[51] In other words, the areas of coordination ((3, 2) and (2, 3)) are larger, that is the dark grey diagonally shaded area and the solid grey shaded area can be added up.

The light diagonal shaded area and the point of no associations ($v_1 = v_2 = 0$) show the range of availabilities in which both have no conclusive reason to play one strategy instead of another. In this situation both players have beliefs (the conditional probabilities) of the other player having the associations in such a way that the expected outcomes of the possible claims overlap each other; that is, the minimum and maximum claim have regions where they generate the same result. Hence the players will act according to traditional game theory: the players will mix their strategies, resulting in an expected payoff for both the winner and the loser of the hash–mark game of $^6/_5$.

In the black shaded area both players will claim three based on the expectations resulting from the defined availabilities and the conditional probabilities of the opponent. Because both players will claim three they will not coordinate.

As was shown in section 2.3.2 by referring to Young (1993, 1996, 1998), people have different and limited cognitive abilities, and may therefore have

[51] This is similar to the idea of iterated dominance, which is the successive elimination of dominated strategies. That is, one does what is optimal given the behaviour of others.

different beliefs about what is in the frame of the other player. 'Smart' people may think 'ignorant' people have smaller probabilities of seeing certain associations. In other words, the availabilities assigned by nature and the related conditional probabilities can differ across players. For instance, the winner and the loser "are" in different areas; the winner of the hash–mark game thinks that the conditional probability of the loser having the egalitarian association is 1, and the entitlement association ½, while the loser thinks that the conditional probability of the winner having the entitlement association is 1, and the probability of having the egalitarian association is ¼. This will result in the winner claiming the smaller share and giving the larger share to the opponent, and the loser will do exactly the same thing. In other words, there will be no coordination between the two players in this example (see the black dots in figure 3–3).

3.3.2 Several associations available

In section 2.4.2 of the former chapter an example was given of what associations can be without a clear underlying convention. In the example, the associations were based on the formal structure of the games, that is, the example is more in line with traditional game theory than the previous example. Another value added of the example is that there are more than two associations, namely three. Also these associations are not opposing associations as in the former example with the entitlement and egalitarian associations, but two of the three associations point in the same direction. In this section the example of the former chapter will be further analysed by means of the formal approach. In the example there are two players who play two games against each other, which are distinctively different from one another. As in the former chapter, it is assumed that two players playing the combination at hand have no prior history together, i.e., they play against each other for the first time.

In this case, the players are confronted with games in matrix form instead of written stories as in the former section. The first game the players will play against each other is a game with a strongly stable equilibrium followed by (three different versions of) a coordination game. According to the associative approach players will incorporate information from the first game (the game with strongly stable equilibrium in this case) into the second game (coordination game) to help them solve the problem. When the players are able to find extra information from the first game, this can help them establish a higher payoff in the latter game compared to the outcome predicted by traditional game theory (the mixed strategy equilibrium). For the explanations of the games they play and the different associations, see section 2.4.2.

The frame of a player can now consist of no, one, two, or three associations (as there are only three more 'prominent' associations). The player has beliefs about what the different associations are in the frame of the other player based on the associations in his own frame. There are in total eight possibilities that need to be analysed when a player has all three associations in his frame. That is, no association available (traditional game theory), one of three associations available (three possibilities), two out of three associations available (three possibilities), or all three associations available. A player will mix his strategy in the first case where there is no association in the frame of a player (same as traditional game theory). In the cases where there is one association in the frame of a player, the strategy a player will adopt depends on what he believes he holds about the other player's frame. In the last two cases, where a player sees two or all associations, the best strategy depends on what the player thinks the conditional probabilities are of the associations in the other player's frame.

No association

As in the example of section 3.3.1, if a player does not have any association in his frame this means that that he sees no extra information (from the combination) that he can use for solving the game at hand. Because the player is not able to distinguish any association, he also cannot think about this dimension outside his own frame. In this case a player has no specific reason to play one strategy instead of the other, that is, the result is the traditional game theoretic prediction of the Nash equilibrium in mixed strategies in which a player plays strategy R_1 and R_2 with probability ½, with an expected payoff of 1½.

One association

Association on structure

When a player makes an association on structure this means he sees a resemblance between the (formal) structure of the first and second game. Both games are written in a matrix of 2×2, in which the four cells have the same shape and position. Given this similarity in structure the player sees the structure of the first game and incorporates this in his approach of the second. In other words, in the first game both players were able to 'coordinate' on the first cell of the 2×2 matrix. If both players associate on structure it means that they will try to coordinate on the same cell of the matrix again, in this case with a corresponding payoff of two.

Association on payoffs

When a player makes an association on payoff this means the player sees a similarity between payoffs of the first game and the second. In this first game, players coordinate on a payoff of three, the same payoff is present in the second game. When both players act according to the association, it would mean coordination on the equilibrium (R_2, R_2) resulting in an expected payoff of three to both players.

Association on strategies
The reasoning for the association on structure is also applicable for the association on strategies. When a player makes an association on strategies this means the player sees a similarity between the strategies in the first game and the second. In this case the action or strategies available to both players are exactly the same in both games. In the first game the players 'coordinated' by playing R_1, and by repeating this (if both act according to this association) they can coordinate in the second game, resulting in a payoff of two to both.

Two or all associations
If a player has two associations available in his perception of the combination of games, he can think of the other player having available no, one, or both association(s). If a player has all associations in his frame, he has beliefs about the other player having the same amount of associations, or less in his frame. The availability of the association on structure is defined as v_1, the availability of the association on payoffs as v_2, and the availability of the association on strategies as v_3 ($0 \leq v_1, v_2, v_3 \leq 1$). The strategy that a player will adopt depends on the conditional probabilities with which he believes the other player has certain associations available. The list below is for a player who has all three associations in his frame and is thus able to think about the three different associations and about how the other player can look at the game (formulation of probabilities is done in same manner as in former example, see section 3.3.1).

- no association → $(1 - v_1)(1 - v_2)(1 - v_3)$
- association on structure → $v_1(1 - v_2)(1 - v_3)$
- association on payoffs → $v_2(1 - v_1)(1 - v_3)$
- association on strategies → $v_3(1 - v_1)(1 - v_2)$
- associations on structure and payoffs → $v_1 v_2(1 - v_3)$
- associations on structure and strategies → $v_1 v_3(1 - v_2)$
- associations on payoffs and strategies → $v_2 v_3(1 - v_1)$
- all three associations → $v_1 v_2 v_3$

To see what is the rational solution given the conditional probabilities of the different associations, one has to calculate the expected payoffs for both players when they play either of the strategies R_1, or R_2. This can be depicted in the following equations, where π_i is the expected payoff for a player i ($i = 1, 2$) seeing all associations (no distinction has to be made between the two players: because the games are symmetric the players can be analysed as being the same).

$$\pi_i(R_1) = (1 - v_1)(1 - v_2)(1 - v_3)\,{}^{3}\!/_{2} + v_1(1 - v_2)(1 - v_3)2 + v_2(1 - v_1)(1 - v_3)1 + v_3(1 - v_1)(1 - v_2)2 + v_1 v_2(1 - v_3)X + v_1 v_3(1 - v_2)2 + v_2 v_3(1 - v_1)X + v_1 v_2 v_3 X$$

$$\pi_i(\mathrm{R}_2) = (1 - v_1)(1 - v_2)(1 - v_3)\,{}^{3}\!/_{2} + v_1(1 - v_2)(1 - v_3)0 + v_2(1 - v_1)(1 - v_3)3 + v_3(1 - v_1)(1 - v_2)0 + v_1 v_2(1 - v_3)X + v_1 v_3(1 - v_2)0 + v_2 v_3(1 - v_1)X + v_1 v_2 v_3 X$$

There are three cases in each of the two equations where the payoff is unknown, because of opposing associations. As in the former section (3.3.1) the undefined X's can be specified by showing the cases in which the minimum expected outcome of one claim exceeds the maximum of the other. In order to do this, X will be set equal to 0 in the equation for the 'minimum' strategy (or 1 in some cases, as long as X is at its minimum). This equation will then be compared with the other strategy in which X is at its maximum, which is either two or three (the maximum expected payoff). The way of calculating is the same as in the former section; (see appendix B.2 for the calculations) and the result for a player is depicted in graph figure 3–4 (where v_1 is association on structure, v_2 is association on payoffs, and v_3 is association of strategies).

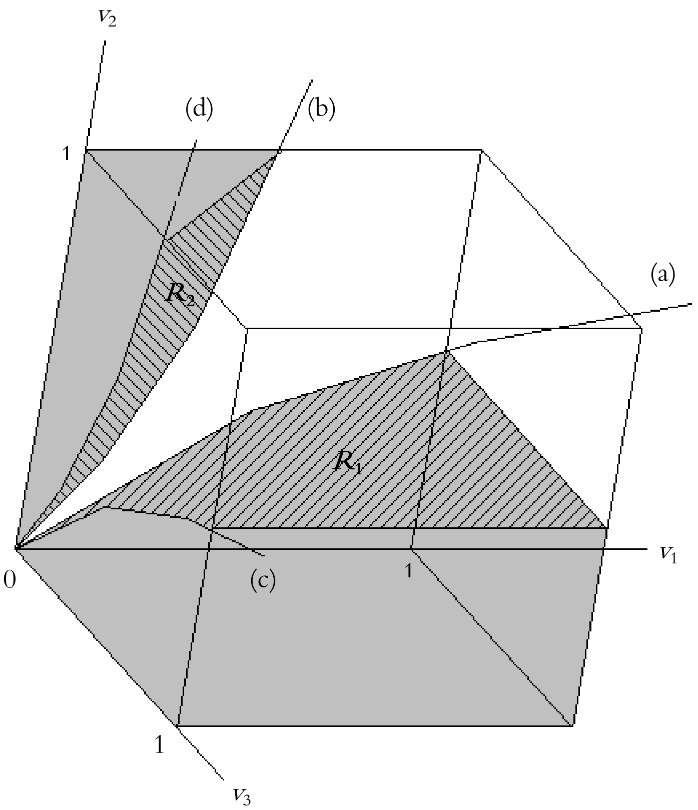

Figure 3–4 Strategy space for a player

The equations where the player only has two of the three different associations and has beliefs about the conditional probabilities of the other player having (a subset of) his frame, are plotted a fraction longer than they are supposed to be, that is, the equations are extended past the points for which the equations are valid, which is $v_i \in (0, 1]$. They are fractionally extended for clarity reasons: the four equations, (a) $v_2 = v_1/(1 + v_1)$, (b) $v_2 = v_1/(1 - v_1)$, (c) $v_2 = v_3/(1 + v_3)$, and (d) $v_2 = v_3/(1 - v_3)$, are exactly on the borders of the two equations for three different associations[52] and if the graphs were not extended they would be impossible to distinguish from the three dimensional graph.

The areas enclosed by the equations and the axes are the areas in which it is rational for a player to play a pure strategy, i.e., either R_1 or R_2 depending on his

[52] This is logical, considering that if one takes the equations with three variables and assumes one variable equal to zero, the result will be an equation with just two variables; i.e., (a), (b), (c), and (d).

availabilities and the conditional probabilities of the other. The top left shaded area, enclosed by $v_2 = (v_1 + v_3 - v_1 v_3)/(1 + v_1 + v_3 - v_1 v_3)$ and $v_2 = 1$, is the area in which it is rational for a player to act according to the most "prominent" association available, which is the association on payoffs. Hence, if both players act on this association, they will coordinate on R_2 in this whole area, resulting in a payoff of three to both. For a player it is rational to play strategy R_1 when he believes (i.e., the conditional probabilities) the frame of the other player is in the bottom right shaded area, enclosed by $v_2 = (v_1 + v_3 - v_1 v_3)/(1 - v_1 - v_3 + v_1 v_3)$ and the v_1– and v_3–axis, because in this area the association on structure and the association on strategies are the more "prominent" associations. As in the example in the previous section, when a player believes the conditional probabilities of the other player are in the shaded areas, he is always better off following the more "prominent" association, given the shared background, and thus establishing coordination.

In the area not shaded no rationalisation can be given to prefer one strategy to another, which, however, not always means that the players will mix their strategies. It might be that if a player believes the conditional probabilities for the opponent are very close to one of the borders it will still be reasonable (not rational) to play the strategy belonging to that border. The associative approach, however, cannot say anything about this.

3.4 Conclusion and discussion

In this chapter the formal theory of the associative approach is developed. It builds on the ideas of both Bacharach (1993) and Janssen (2001). Their idea is that labels attached to strategies create asymmetries between these strategies and that players are able to use these in a rational way. The formalisation is clarified by analysing two cases. In the first case there are two 'more prominent' associations, where the external information from the first game triggers two different conventions, that players use to get to an equilibrium in the battle–of–the–sexes game. Western cultural background is relevant for the motivation of the two possible associations in this case. It might be that in other cultures other more prominent associations also apply to this combination of games. In contrast to the first case, the associations in the second case are only based on the formal structure of the games, that is the payoffs, strategies, and position of cells. These two cases show how the intuitive idea of the associative approach works and how the formal framework of the associative approach can be applied.

At the beginning of the chapter several questions were asked. The first question is, "if several associations come to the mind of a player, what association will he choose for the problem at hand?" In the process of the formalisation of the associative approach it has become obvious that this question cannot be answered without looking at what this player thinks his opponent has in her frame. That is, if a player has frame *F* and all the belonging associations (dimensions) in it, he has beliefs about the other player having frame *G*, which is a subset of *F*. Depending on what the player thinks these conditional probabilities of the other player having certain associations (dimensions) in her frame *G* he will act according to the more prominent association.

The former already answers parts of the second and third questions: "What is the reason to act according to one and not to another association, i.e., is one of the associations more prominent? Why does a player think one association is more prominent than another?" Given shared background and/or culture, nature assigns higher availabilities to certain associations, which are then prominent in this shared culture, and that everybody knows this of everybody, and expects everybody to know this of everybody: it is common knowledge. This line of reasoning is applicable to all players coming from a shared background and thus the players believe the frame of the other player is similar (or close to equal), in other words, that the other player has the same associations in her vocabulary. As is obvious, the next questions are clearly answered by the argument above, that is "Does prominence in this case have to do with a shared background, culture?" And "Does this shared background make one association more prominent than another, and is this common knowledge?"

The associative approach tries to model behaviour of people interacting. In real life people are not consciously thinking about their own frame, let alone the frame of the other player. In the abstract model of the associative approach the availabilities and the conditional probabilities of the different associations are necessary in order to show how people with a common background are on average able to coordinate their behaviour better than traditional game theory predicts. The associative approach is able to say in which (abstractly modelled) decision area of the former graphs the players will on average make their (unconscious) decisions.

Discussion

A relevant question to raise for the associative approach is why only two or three associations are analysed and not more. Of course, it is possible that players see more associations than assumed and analysed by the theory. The assumption of limited amounts of associations is made for two reasons. First, taking more than three associations into account makes the analysis more complex and complicated. In order to show how the approach works two associations suffice. Another reason is that players can make an unlimited amount of associations. Assume, for instance, that a player has six associations in his frame, and can think the opponent has the six associations in his frame as well. Nature will have assigned low availabilities to the players to, for instance, four of the six associations (based on the common background of the players). The two remaining associations receive higher availabilities. For solving the problem at hand the more prominent associations come to the mind of the players, while the more latent associations do not. Evolution has forced people to solve problems at hand quickly (survival of the fittest) and thus people draw from a shared pool of knowledge (culture, conventions) in order to solve the problem. Players can think of more associations but only the most prominent are relevant, because that gives the highest chance of solving the problem at hand. In other words, taking into account more associations, that only have an insignificant role, would complicate the approach and the value added would be small (if it even outweighs the value reduction caused by the complexity).

What makes an association prominent? What can the associative approach explain? Where is the associative approach applicable? In this chapter an attempt has been made to answer these questions. The attempt is a first theoretical step, and thus one cannot conclude anything definite yet. If the associative approach has any explanatory value then it is possible to go into more detailed answers. For now the relevant question to raise first is: How, where, and when is the associative approach applicable in real life situations, and what can it explain in those cases? One way of checking applicability, explanatory power, and relevance of the associative approach is by running an experiment to test the approach. The combination of hash–mark and BOS–game discussed in the previous chapters will be the point of departure for an experiment (in the next chapter) to test whether the associative approach has any validity, or not.

CHAPTER 4

THE ASSOCIATIVE APPROACH EXPERIMENT

4.1 Introduction

The idea of the associative approach is that people try to solve a problem they are faced with by incorporating information that is 'readily' available. This means that if what they perceive as the most relevant information comes from a previous different game, they will also use it. That is, players will incorporate the information of the first game to help them solve the second; they make associations in the combination of games. To test whether or not people make associations in combinations of games one can investigate their behaviour in the controlled environment of a laboratory. In the controlled environment of a laboratory people still take their home–grown characteristics, like their culture and conventions, into the experiment, while the experimenter can control the games and the rules of the game they play in the experiment. In other words, one is able to reduce the amount of different information players receive in order to be able to test certain hypotheses without taking them too far out of 'real life'. To test whether the associative approach has any validity, it needs to be tested in a controlled environment where real people take their history with them, but where they play games (and adhere to rules of the games) controlled by the experimenter.

> While laboratory processes are simple in comparison to naturally occurring processes, they are real processes in the sense that real people participate for real and substantial profits and follow real rules in doing so. It is precisely because they are real that they are interesting. (Plott, 1982; p.1486; in Friedman, *et al.*, 1994; p.16)

The (hypothetical) illustrations of the former chapters will be the basis for an experiment. The methodology used for setting up the experiment is based on many different articles and books[53], but mostly on Friedman and Sunder (1994)[54]. They show all the methodological steps for setting up an experiment, together with all the pitfalls and benefits of experiments compared to, for instance, field data.

In section 4.2 the reasons to test the associative approach via an experiment are given together with the general expectations of the experiment. These general expectations will be separated into two different versions, dealt with in sections 4.3 and 4.4, with the specifications and expectations for each version in the respective subsections. Section 4.5 shows the problems that have to be solved in order to set up the associative approach experiment, and the pilot studies necessary to get to the finalised version of the experiment are in the following section. A conclusion and discussion will end the chapter.

4.2 The associative approach experiment

Theory organises our knowledge and helps us predict behaviour in new situations. The connection between theory and data is twofold. First, theories point in the direction of what kind of data to gather and in what ways to analyse it. And as the theory progresses, it guides us in refining the use of data and the questions relevant for analysing the data. Second, data collection and analysis often turn up regularities that are not explained by existing theory, and hence spur the refinement of theory.

> The alteration of theory and empirical work, each refining each other, is the engine of progress in every scientific discipline. (Friedman*, et al.*, 1994; p.3)

There are several different methods for gathering data as the basis of empirical work. A key distinction is one between *experimental data*, which are deliberately created for scientific purposes under controlled conditions, and *happenstance data*, which are a by–product of ongoing uncontrolled processes. Another distinction can be made between *laboratory data*, which are gathered in an

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[53] Bacharach and Bernasconi (1997), Bastable (1987), Brandts and Holt (1992), Camerer and Weigelt (1988), Carter and Irons (1990), Cooper, et al. (1989, 1990), Costa–Gomes, et al. (1998), Crawford (1997, 1998), Davis, et al. (1993), Friedman (1996), Friedman and Sunder (1994), Güth, et al. (1996) , Güth and Huck (1997), Hoffman and Spitzer (1985), Holm (1997, 1998, 2000), Huck and Oechssler (1999), Huyck, et al. (1990), Kagel and Roth (1995), Keser, et al. (1998), Knez (1998), McKelvey and Palfrey (1992), Mehta, et al. (1994a, 1994b), Prasnikar and Roth (1992), Roth (1987a, 1987b, 1988, 1991a, 1994), Shubik (1962), Smith (1982, 1987, 1989), Sopher and Zapater (1993), Stahl and Wilson (1995), Starmer (1999), Zizzo (2000a), Zizzo and Oswald (2001).

[54] Throughout section 4.5 many quotes from their book are used to give theoretic arguments for choosing certain aspects in the set–up, while not choosing others. For a general methodological overview on how to set–up an experiment, and not specifically game theoretic, see their book.

artificial environment designed for scientific purposes, and *field data*, which are gathered in a naturally occurring environment. There are, of course, several combinations of data gathering possible. Roth (1991a), for instance, gives a nice and extensive overview on how game theory and experiments are connected in economics. The following quote from Vincent Crawford also gives an idea of the why and how of experimenting in game theory.

> Most strategic applications raise questions about the principles that govern behaviour that are not convincingly resolved by theory, in addition to questions about preferences and the environment like those encountered in non–strategic applications. Further progress in understanding those principles now seems likely to depend as much on systematic observation and careful empirical work as on further advances in theory. Experiments will play a leading role in this empirical work. […] More generally, I believe that there is much to be gained by supplementing conversations among theorists with a dialogue between theorists and experimentalists, in which theoretical ideas are confronted with observation as well as intuition. (Crawford, 1997; p.207)

An experiment can be designed to pursue realism, i.e., the laboratory environment is designed to resemble the real–world environment as closely as possible, or an experiment can be designed to replicate the assumptions of a formal model as closely as possible. The goal is to find a design for the associative approach experiment that offers the best opportunity to answer the questions that motivated it. That is, the associative approach experiment is set–up in such a way that real people (the subjects in the experiment) make decisions when faced with strategic interaction problems.

4.2.1 Purpose of the experiment

The purpose of the associative approach experiment is to test whether (the intuition of) the approach is valid in claiming that players make associations between games in certain combinations of games. In the experiment only two games in a combination (hash–mark and battle–of–the–sexes game) will be analysed, which is of course only a small fraction of all possible combinations of two games, let alone when combinations of more than two games are permitted. However, the experiment still provides some basis for checking the validity of the associative approach. If the experimental results confirm the associative approach it can show where the approach is applicable. More experiments can, then, show whether or not the approach has general validity, or only in some special contingent cases. If the results show that there are really strong associations in the experiment they give an indication that the theory might have explanatory value. In both cases of confirmation[55], the confrontation between the data and the approach may refine the approach (to a more general level). If the approach is rejected (disconfirmed) by the experimental data, the data might point in a certain direction in which the approach has to be amended and then tested again, or, in the worst–case scenario, the approach has to be abandoned.

As stated above, only one combination of two games will be tested. The reasons for this are time limitation and financial constraints. The two games in combination will be tested in two different versions in order to be able to say a little more about the validity of the associative approach. However, to be able to show whether or not the associative approach has validity in general and for better refinement of the associative approach, additional experiments have to be carried out besides the one in this dissertation.

4.2.2 General hypotheses

The general idea of the associative approach is that players see (make) connections between different games: they make associations. This idea is not present in traditional game theory. The clear difference between the two 'approaches' is the starting point for the definition of the hypotheses that need to be tested in the experiment. In all cases the null hypotheses are defined as what is expected by traditional game theory; they reflect the already accepted approach. The alternative hypotheses will be defined as the expected divergence from traditional game theoretic predictions towards the associative approach expectations; i.e., players make associations between the two different games, based on information in the first game.

The experiment will consist of two games played after each other. The first game is the hash–mark game, followed by a distribution game (see appendix C.5, and the former chapters). The combination of the two games will be analysed in two different versions: in version one there is no financial reward for winning the hash–mark game, while there is a financial reward in the second version, and the amounts to distribute in the second game also differ.

As shown in section 2.3.1, traditional game theory analyses games without making connections between different games. In the experiment this would mean that whether a subject is either winner or loser of the hash–mark game,

[55] The term *confirmed* should actually be *not disconfirmed*. "Scientific hypotheses are supposed to be testable, and testable hypotheses must be falsifiable. A testable hypothesis cannot be logically consistent with all conceivable observations. […] This widely held view of what makes a hypothesis scientific stems from the enormously influential work of the philosopher Karl Popper (1959)" Sober and Wilson (1998); p.289). So one can never conclude that a hypothesis is confirmed, just that it hasn't been falsified (yet).

should not make a difference for the behaviour of the subjects in the second game. In other words, the behaviour of the winners and the losers will be the same in the distribution game. The associative approach, however, states that players will behave differently when they associate games in a combination. This can be restated as there being a difference in behaviour in the second game based on the first: players will use the winning or losing part in their approach of the second game. The general hypotheses can now be defined as follows:

H_0: Players behave according to traditional game theoretic analysis: winners and losers of the first game show the same behaviour in the second game.

H_1: Players make associations between the two games in a combination: the winners and losers of the first game behave differently compared to each other in the second game.

If the null hypothesis is rejected another set of hypotheses can be analysed. In that case, the behaviour of the players is different compared to what traditional game theory predicts. Is this the case in all the stages, or is there a difference at the beginning of the experiment compared to the later stages; in other words do the subjects learn through the process of play? The experiment will consist of several stages in which subjects will play a combination of the two aforementioned games with a different opponent in each stage. The amount of stages depends on the amount of subjects that show up for the experiment. The relevant question to ask now is, will subjects learn that associating can help them solve the distribution game?[56]

[56] In his paper, Daniel Zizzo (2000b) theorises how players can learn to become more rational in (economic) problems. "Neural networks are treated as psychological models of how agents actually face, and learn to face, problems never encountered before… Neural networks coupled with an evolutionary mechanism can be used to stimulate learning processes in economic decision−making in a more sophisticated way: an example of this (the learning of conventions) already exists (e.g., Hutchins and Hazlehurst (1991)) … The behavioural learner learns how to behave better in an economic situation, but will be completely naïve as soon as it faces a new one: knowing how to perform well in a coordination game tells me nothing on how to perform optimally in, say, a Prisoner's Dilemma. Instead, given enough exposure to examples, the neural network learner is able to find a set of connection weights that enables it to perform optimally a majority of times even in economic situations never encountered before. In other words, it learns how to generalise its economic know−how. (Zizzo, 2000b; pp.5−9).

Subjects facing (new) problems use implicit knowledge in the form of conventions and associate these with the (new) problem they are facing in order to solve the problem more optimally. Given the repetition of the combination the subjects can learn how to use this implicit knowledge in a more 'rational' manner. The subjects put more weight on the usage of a certain convention and/or association in order to solve the new combination of games (more optimally) against a new player. (For a more elaborate study of the concept of neural networks see Hutchins and Hazlehurst (1991), and Zizzo (2000b).)

The way certain conventions may have established themselves is that in the initial stages of certain strategic interactions players found a way (by trial and error) that helped them solve these interactions in an efficient manner. Other players seeing this start copying that behaviour. The behaviour is persistent because the players can reach a higher outcome (payoff) when following the convention compared to what they could reach without the coordinating device (the convention). (See Young (1993, 1996, 1998))

The following two hypotheses will be tested to see whether subjects learn that there is an underlying convention (association) that can help them achieve a higher outcome in each combination of two games:

H_0: Players will use the relevant association in each combination as much in every round of the experiment.

H_1: Players will use the relevant association in each combination more in the course of repetition.

To be able to state the exact hypotheses they have to be specified according to the two different versions of the experiment, because the expected associations in the two versions differ. In both versions of the experiment some people will be asked to fill out a post–questionnaire. Even though one cannot conclude anything definite from the answers of the post–questionnaire[57], it can add some useful information on why some subjects behaved in a certain manner. The specified hypotheses and the related expectations for the two different versions are discussed in the following two paragraphs.

4.3 Version 1 of the experiment

4.3.1 Design and association

In this version the financial gain in the hash–mark game for the participants is zero. The money that has to be agreed upon for distribution is ten guilders[58], specified in two alternatives, which are alternative 1: “You get 3 guilders and your co–player gets 7 guilders,” and alternative 2: “You get 7 guilders and your co–players gets 3 guilders.” The expectation of the associative approach is that the players may attribute a dominant position to the winner of the hash–mark

[57] The answers of the subjects in a post–questionnaire can give a slightly biased perspective of the subjects, because if they do very well or very bad (financial wise) in the experiment, they can start rationalising their behaviour in the answers they give. The second reason why one cannot conclude anything definite based on the post–questionnaire is that only a small fraction (maybe 10–15%) of the subjects will fill out the post–questionnaire. This is too small a group to be able to make valid conclusions for the population.

[58] Ten guilders is about 1 4.60.

game and a subservient position to the loser of the hash–mark game in the distribution game (as discussed in the former chapter). This means that the players think it is 'normal' for the winner to claim the larger share in the distribution game, and they also think it is normal for the loser to agree with this. In other words, the loser values his behaviour in the hash–mark game less than the behaviour of the winner, and vice versa. If the players see this convention as being relevant to the play of the game they will make the entitlement association. In western culture it is common that people think it is 'morally' right to get a larger share if you work hard(er) for it.[59] John Locke says the following in his 1690 book "The second treatise on civil government" about the nowadays–called Lockean principle of distributive justice:

> Though the earth and all inferior creatures be common to all men, yet every man has a "property" in his own "person". This nobody has any right to but himself. The "labour" of his body and the "work" of his hands, we may say, are properly his. Whatsoever, then, he removes out of the state that Nature hath provided and left it in, he hath mixed his labour with it, and joined to it something that is his own, and thereby makes it his property. It being by him removed from the common state Nature placed it in, it hath by this labour something annexed to it that excludes the common right of other men. For this "labour" being the unquestionable property of the labourer, no man but he can have a right to what that is once joined to, at least where there is enough, and as good left in common for others. […] And it is plain, if the first gathering made them not his, nothing else could. That labour put a distinction between them and common. That added something to them more than Nature, the common mother of all, had done, and so they became his private right. […] The labour that was mine, removing them out of that common state they were in, hath fixed my property in them. (Locke, 1986; p.20)

Also several observations in experiments have shown that subjects have a certain fairness consideration in the sense that if another subject worked harder, for instance, she also has the right to a larger share in the dictator game, as was observed in the following experiment:

> Winning recipients are rewarded by their paired Allocators: offers to winning recipients are significantly higher than offers to lucky ones. (Ruffle, 1998; p.252)

[59] To be able to say something about the differences of cultural influence on the associations players make, the same experiment has to be conducted in other countries, for instance in Japan or Peru.

The Lockean principle also holds for the combination of the hash–mark game and the distribution game (see Hoffman and Spitzer (1985), and section 2.2): the players think that the winner of the hash–mark game earned the right for claiming the larger share in the distribution game more than the loser has. In other words, the subjects will make an entitlement association between the hash–mark game and the distribution game in which the winner of the hash–mark game is entitled to the larger share and the loser to the smaller share.

4.3.2 Specifying claims and hypotheses

The general hypotheses of the former section, where H_0 is the null hypothesis based on traditional game theory, and the alternative hypothesis H_1 is based on the associative approach, refined by the Lockean argument, creates the following hypotheses, where μ_{win}, respectively μ_{lose}, stands for the expected behaviour of the winner, respectively loser (that is, the Nash equilibrium in mixed strategies):

H_0: Behaviour winners = behaviour losers: $\mu_{win} = \mu_{lose}$.
H_1: Behaviour winners ≠ behaviour losers: $\mu_{win} >> \mu_{lose}$.[60]

The behaviour of the winners compared to the losers is different in the claims they will make, given the associations in the frame of a player and the conditional probabilities he holds for the other player's frame. The way to calculate the different claims players can make is exactly the same way as in the former chapter (section 3.3) with the only difference being that the payoffs are fl. 7.– and fl. 3.–. As in the former chapter, the players can have two "prominent" associations available, which we can define as the availability of the entitlement association being v_1, and the availability of the egalitarian association being v_2. The strategy that a player will adopt depends on the associations in his frame and the conditional probabilities of the other player having (a subset of) his frame, which can be specified as follows:

- no association → $(1 - v_1)(1 - v_2)$
- entitlement association → $v_1(1 - v_2)$
- egalitarian association → $v_2(1 - v_1)$
- both associations → $v_1 v_2$

$0 \leq v_1,\ v_2 \leq 1$

If a player has both associations available in his perception of the combination of games, he can think of the other player having available no, one, or both association(s). To see what is the rational solution given the availabilities and the

[60] The associative approach states that winners will claim the larger share, which means that the null hypothesis can be tested one–sided. This means that $\mu_{win} \neq \mu_{lose}$ can be replaced by $\mu_{win} >> \mu_{lose}$. That losers will claim the smaller share a lot more than the winners ($\mu_{lose} << \mu_{win}$) is exactly the same analysis, hence does not need any extra hypotheses or analysis.

conditional probabilities of the different associations, one has to calculate the expected payoffs for both players when they claim either the larger or the smaller share of the money. This can be depicted in the following equations, where π^i is the expected payoff for player i ($i = w, l$), where w is the winner and l is the loser of the hash–mark game.

$$\pi^w(7) = (1 - v_1)(1 - v_2)\tfrac{21}{10} + v_1(1 - v_2)7 + v_2(1 - v_1)0 + v_1 v_2 X$$

$$\pi^w(3) = (1 - v_1)(1 - v_2)\tfrac{21}{10} + v_1(1 - v_2)0 + v_2(1 - v_1)3 + v_1 v_2 X$$

$$\pi^l(7) = (1 - v_1)(1 - v_2)\tfrac{21}{10} + v_1(1 - v_2)0 + v_2(1 - v_1)7 + v_1 v_2 X$$

$$\pi^l(3) = (1 - v_1)(1 - v_2)\tfrac{21}{10} + v_1(1 - v_2)3 + v_2(1 - v_1)0 + v_1 v_2 X$$

The last term denoted by X is unspecified, because one is not able to determine what the outcome will be: the outcome depends on what the player believes the probabilities of the other player having the associations are. To be able to specify the claims, the last term (X) of the equations can be specified by showing the cases in which the minimum of one claim (i.e., $X = 0$) exceeds the maximum of the other ($X =$ claim maximum). In these cases it is always rational to act according to the claim, because the expected payoff of following it is always higher, i.e., it is a dominant strategy. It is rational for the winner to claim seven if the minimum expected payoff of claiming seven is equal to or exceeds the maximum expected payoff of claiming three. In formula: $\min \pi^w(7) \geq \max \pi^w(3)$, which is satisfied if:[61]

$$v_2 \leq \frac{7v_1}{3 + 7v_1}.$$

It is rational for the winner of the hash–mark game to claim the smaller share in the distribution game, if $\max \pi^w(7) \leq \min \pi^w(3)$, which is satisfied if:

$$v_2 \geq \frac{7v_1}{3 - 3v_1}.$$

For the loser of the hash–mark game it is rational to claim the smaller share when $\max \pi^w(7) \leq \min \pi^w(3)$, and the larger share when $\min \pi^w(7) \geq \max \pi^w(3)$, which are satisfied if

[61] The equations are calculated in exactly the same manner as in the former chapter (section 3.3.1). Hence, only the resulting (final) equations are given.

$$v_2 \le \frac{3v_1}{7+3v_1}\text{, respectively} \qquad v_2 \ge \frac{3v_1}{7-7v_1}.$$

The following graph shows the different action regions for both the loser and the winner of the hash–mark game in the distribution game in session 1 (where v_1 is entitlement association, and v_2 is egalitarian association).

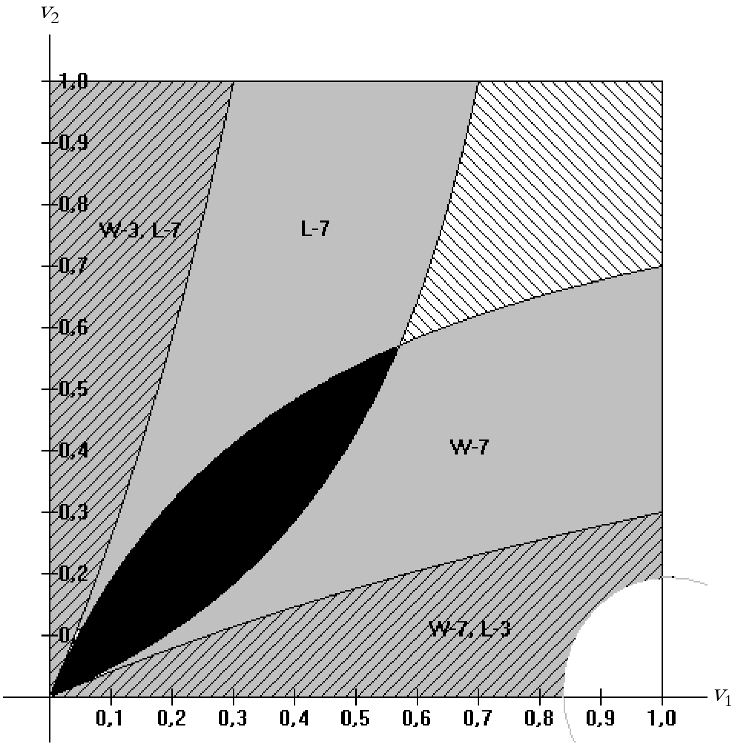

Figure 4–1 Action regions for distribution game in version 1

The explanations in the former chapter concerning the shaded areas are still valid here, so they need no further explanation. The only difference with the former chapter is that the decision regions are larger. Also the non–coordination area is larger, because both players are more 'eager' to get the higher payoff (compare seven with three). That is, players will claim seven if they believe (with a small conditional probability) that the entitlement association is in the other player's frame.

If subjects behave as expected by the associative approach, the decisions of the subjects in each combination are that they will act according to the entitlement association. In this case, it may be that a large part of the subject pool do not see any other association than the entitlement association and can thus not think about other associations (i.e., $0 \leq v_1 \leq 1$, and $v_2 = 0$). The strategy a player will adopt depends on the conditional probability with which he believes the other player has the entitlement association available. The part of the subject population that see both associations have beliefs about the associations that are in the other players' frame. The conditional probability for the other player having the egalitarian association in her frame will probably be small, while the conditional probability of the other player having the entitlement association will be large. The associative approach expects the decisions by the subjects, based on the availabilities and the respective conditional probabilities (given the shared background of the western culture of the subject pool), to be in the white region in the bottom right corner of the graph. In other words, the expectation of the associative approach is that in the experiment the subjects will claim the larger share in the distribution game if they were the winner of the hash–mark game, and claim the smaller share if they were the loser.

4.3.3 Difference between winner and loser

When (if) the null hypothesis in the former section is rejected and the alternative hypothesis is accepted, a set of sub–hypotheses can be tested. A relevant question to raise for the associative approach is, if players associate in the sense of the two hypotheses above, how far do the players deviate from traditional game–theoretic predictions when associating? The former hypotheses already test this question in a way. However, it might be that one group, say the winners, behave according to traditional game–theoretic predictions, while the losers do not. This means that the behaviour of the two groups can be significantly different even though one group does not associate. p_{W0} (p_{L0}) is defined as the proportion/chance of winners (losers) choosing alternative 2 in the distribution game under the null hypothesis, and p_{W1} (p_{L1}) as the proportion/chance of winners (losers) choosing alternative 2 in the distribution game under the alternative hypothesis.

The outcome in the distribution game expected by traditional game theory is that players will mix their strategies. Or, in other terms, in a large population of players the average outcome will be the Nash equilibrium in mixed strategies. That is, alternative 2 will be played 70 percent of the cases and alternative 1 in 30 percent of the cases. To test whether the group behaviour deviates from traditional game theory the following hypotheses will be tested:

H_0: Players (read winners) will play according to traditional game–theoretic prediction: $p_{W0} = 0.7$.
H_1: Winners will claim the larger share a lot more than traditional game theory predicts: $p_{W1} >> 0.7$.

and

H_0: Players (read losers) will play according to traditional game–theoretic prediction: $p_{L0} = 0.7$.
H_1: Losers will claim the smaller share a lot more than traditional game theory predicts: $p_{L1} << 0.7$.

The alternative hypotheses are defined as one–sided testing (illustrated by the >> sign in the hypotheses), because the associative approach predicts that the behaviour of the winner and/or loser will deviate from traditional game–theoretic prediction in one direction only.

4.3.4 Do they learn?

Will the participants be able to match their alternatives better in the last round than in preliminary rounds? In other words, during the process of playing combinations of games, will the subjects learn that making an association between the two games in a combination can help them solve the distribution game? To see whether subjects do indeed learn, the following hypotheses will have to be tested, which are a specific version refinement to the hypotheses in section 4.2.2:

H_0: To solve the distribution game subjects will use the entitlement association (in each combination of games) as much in every round.
H_1: To solve the distribution game subjects will use the entitlement association (in each combination of games) more in the course of repetition.

If the associative approach is correct, a certain amount of subjects will already follow the associations in the first round, and thus be able to solve the distribution game when the opponent acts according to the association. The subjects that do not follow the association in the first round can learn by trial and error that there is an association in the sense of entitlement that can help them solve the game, and will therefore switch to the association as well. In other words, there will most likely be more people following the association in the last round than in previous rounds.

4.4 Version 2 of the experiment[62]

4.4.1 Design and association

The difference in this version compared to the first version is that the winner of the hash–mark game receives four guilders, the loser still receives nothing, and the money that the players can share in the distribution game is seven guilders in total instead of ten. Alternative 1 says "You get 3 guilders and your co–player gets 4 guilders," and alternative 2 says "You get 4 guilders and your co–players gets 3 guilders." Because the winner of the hash–mark game receives four guilders and the loser nothing, the winner is immediately awarded for putting in the effort. If the subjects play the distribution game, the entitlement of the winner to the larger share is not so prominent anymore, because subjects already see the payment for the hash–mark game as the reward that the winner is entitled to. However, if one looks at the possible financial rewards for both the hash–mark game and the distribution game together, the difference in payoff in the second game is smaller than the payoff in the first. In most western cultures people will think that overall the winner of the hash–mark game should still receive more than the loser. However, in the combination of the hash–mark and the distribution game the total payoff to both players should be less unequal, i.e., the division of the payoffs should be more egalitarian. This egalitarian thought is rooted in society ("For equal distribution is of the law of nature; and other means of equal distribution cannot be imagined" Thomas Hobbes (1996; p.103)), and has also shown up in many experiments[63] investigating bargaining games.

> Also if *a man be trusted to judge between man and man*, it is a precept of the law of nature, *that he deal equally between them…* The observance of this law, from the equal distribution to each, of that which is reason belongeth to him, is called EQUITY, and distributive justice… And from this followeth another law, *that such things as cannot be divided, be enjoyed in common, if it can be; and if the quantity of the thing permit, without stint; otherwise proportionally to the number of them that have right.* For otherwise the distribution is unequal and contrary to equity. (Emphases in original, Hobbes, 1996; p.103).

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[62] Terms and definitions applied in the former section also apply in this section.

[63] For instance, Andreoni (1990), Camerer and Thaler (1995), Dijk and Wilke (1996), Fehr and Schmidt (1999), Güth, et al. (1982), Hoffman and Spitzer (1985), Huck and Oechssler (1999), Levine (1998), Palfrey and Rosenthal (1988), Prasnikar and Roth (1992), Ruffle (1998), Schotter, et al. (1996).

This was one of the first real substantial definitions on equal distribution and the problems surrounding it. Now, three hundred years later, scientists (and people in general) are still struggling with the subject matter, especially since in economic experiments subjects behave "irrationally" according to the rationality assumption of neoclassical economics. It turns out that people let their behaviour be affected by equity (fairness[64]) motivations.

> By now we have substantial evidence suggesting that fairness motivations affect the behaviour of many people. The empirical results of Kahneman, et al. (1986), for example, indicate that customers have strong feelings about the fairness of firms' short–run pricing decisions which may explain why some firms do not fully exploit their monopoly power. There is also a lot of evidence suggesting that firms' wage setting is constrained by workers' views about what constitutes a fair wage (Blinder and Choi (1990), Agell and Lundberg (1995), Bewley (1995), Campbell and Kamlani (1997)). According to these studies, a major reason for firms' refusal to cut wages in a recession is the fear that workers will perceive pay cuts as unfair which in turn is expected to affect work morale adversely. There are also many well–controlled bilateral bargaining experiments which indicate that a non–negligible fraction of the subjects do not care *solely* about material payoff (Güth, et al. (1990), Roth (1995), Camerer and Thaler (1995)). (Italics in original, Fehr and Schmidt, 1999; pp.817–818)
>
> Experiments on non–repeated ultimatum games by Güth, *et al.* (1982), Kahneman, et al. (1986), Forsythe, et al. (1994), Roth, et al. (1991b), and others show that first mover proposers in such bargaining games offer more to their counterparts than non–cooperative game theory leads one to expect. This tendency towards an equal split is described as being due to "fairness" considerations or to "social norms" of distributive justice. (Hoffman, *et al.*, 1994; p.348)

This egalitarian thought creates the possibility of players making an association between the two games in which they think the loser of the hash–mark game should receive the larger share in the distribution game and the winner the smaller.

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[64] In the former section, the Lockean principle of distributive justice is also considered as fair. But the following quote was taken from an article that discusses more the egalitarian principles than the Lockean principle.

4.4.2 Specifying claims and hypotheses

As in the section 4.3.2, the null hypothesis H_0 is based on traditional game theory, and the alternative hypothesis H_1 is based on the idea of players making associations between the two games: The egalitarian association creates different behaviour between the group of winners and the group of losers. This can be defined as follows:

H_0: Behaviour winners = behaviour losers, i.e., $\mu_{win} = \mu_{lose}$.
H_1: Behaviour winners ≠ behaviour losers, i.e., $\mu_{win} << \mu_{lose}$.

The definitions of the associations (availabilities) and the equations (claims) are exactly the same as for version one, with the exception that the financial rewards are fl. 4.− and fl. 3.−, instead of fl. 7.− and fl. 3.−. To see what the rational solution is given the availabilities and the conditional probabilities of the different associations, one has to calculate the expected payoffs for both players when they claim either the larger or the smaller share of the money. The procedure is exactly the same as for version 1. Hence, for the winner of the hash−mark game it is rational to claim the larger share when $\min \pi^w(4) \geq \max \pi^w(3)$, and it is rational to claim the smaller share when $\max \pi^w(4) \leq \min \pi^w(3)$, which are satisfied if:

$$v_2 \leq \frac{4v_1}{3+4v_1}, \text{ respectively } \qquad v_2 \geq \frac{4v_1}{3-3v_1}.$$

For the loser of the hash−mark game it is rational to claim three when $\max \pi^w(4) \leq \min \pi^w(3)$, and claim four when $\min \pi^w(4) \geq \max \pi^w(3)$, which are satisfied if:

$$v_2 \leq \frac{3v_1}{4+3v_1}, \text{ respectively } \qquad v_2 \geq \frac{3v_1}{4-4v_1}.$$

These claims do not incorporate the reward for the hash−mark game. The players are expected to take this payment into consideration however. If they do not take this into consideration the expected area where the decisions will take place will be in a completely different region (see former section). The four claims are depicted in the following graph (where v_1 is entitlement association, and v_2 is egalitarian association).

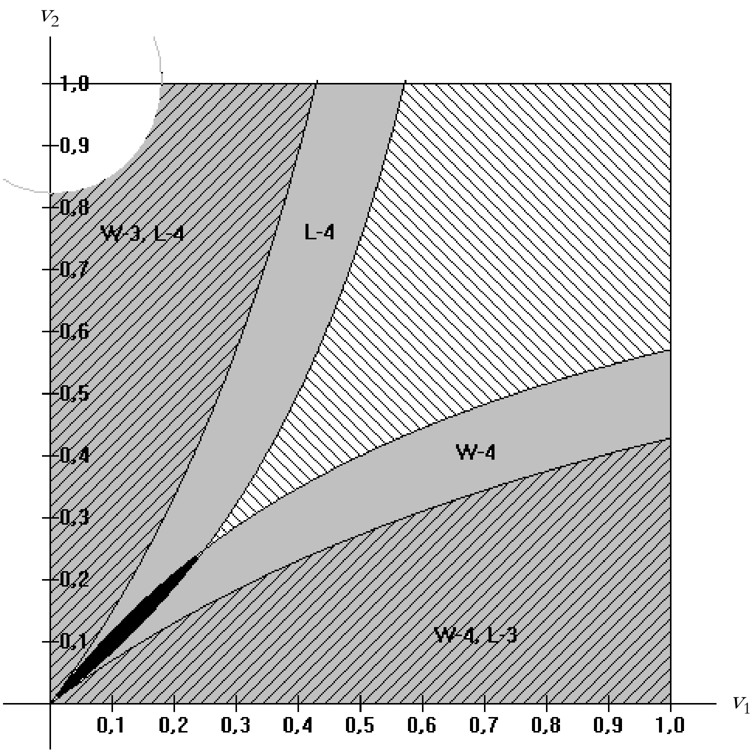

Figure 4–2 Action region for distribution game in version 2

If the participants behave as expected by the associative approach, the participants will make their decisions in the egalitarian "corner" of the graph, i.e., the white shaded area in the top left corner. In this case, a large group of subjects in the subject pool might not have any other association in their frame than the egalitarian association (given the prominence of the egalitarian thought in western culture) and would not be able to think about other associations outside their frame (i.e., $v_1 = 0$, $0 \leq v_2 \leq 1$). The strategy a player will adopt depends on the conditional probability with which he believes the other player has the egalitarian association in her frame. The part of the subject population that see both associations have beliefs about the conditional probabilities that these associations are in the other players' frame, which will probably be small for the entitlement association, and large for the egalitarian association. In other words, the expectation of the associative approach is that in the experiment the subjects will claim the smaller share in the distribution game if they were the winner of the hash–mark game, and claim the larger share if they were the loser. The payment to the players in each single combination of the hash–mark game and the distribution game, if they both follow the egalitarian association, is fl. 7.– to the winner and fl. 4.– to the loser. This means that the winner still receives a larger share over the two games (but she is perceived as having put more effort into it).

4.4.3 Difference between winner and loser

As in the former section, a relevant question for the associative approach is how far the subjects do deviate from traditional game–theoretic predictions when they associate. In this case the losers of the hash–mark game claim the larger share a lot more than traditional game theory predicts, and vice versa. To test whether the group behaviour deviates from traditional game theory the following hypotheses will be tested:

H_0: Players (read winners) will play according to traditional game–theoretic prediction: $p_{W0} = \frac{4}{7}$.
H_1: Winners will claim the larger share a lot less than traditional game theory predicts: $p_{W1} << \frac{4}{7}$.

and

H_0: Players (read losers) will play according to traditional game–theoretic prediction: $p_{L0} = \frac{4}{7}$.
H_1: Losers will claim the larger share a lot more than traditional game theory predicts: $p_{L1} >> \frac{4}{7}$.

4.4.4 Do they learn?

The learning hypotheses for this version are practically the same as for the former version. Only the hypotheses will be stated here, for explanation see the explanation for the former version.

H_0: To solve the distribution game subjects will use the egalitarian association in each combination as much in every round.
H_1: To solve the distribution game subjects will use the egalitarian association in each combination more in the course of repetition.

4.5 Setting up the experiment[65]

All experiments take place in a controlled environment, which consists of individual agents together with an institution through which the agents interact.

[65] Several experiments are used as a foundation for the associative approach experiment by using parts of their (methodology of) experimental set–up. Some of these are used more extensively than others, of which the most important ones are Costa–Gomes, et al. (1998), Hoffman and Spitzer (1985), Holm (1997, 2000), McKelvey and Palfrey (1992), Mehta, et al. (1994a, 1994b), and Sopher and Zapater (1993).

The institution specifies the actions available to agents and the outcomes resulting from each possible combination of agents' actions. A standard problem in experiments is that all the individual agents have their own individual (home–grown) characteristics, like preferences, technology, attitudes, etc., that they take into the laboratory.

In order to be able to say something useful about the outcomes of experiments, the agents' and institutional characteristics must be controlled (at least to a certain degree). Within the associative approach experiment, controlling the institution is straightforward: all the rules are explained and enforced by the experimenter. The experiment has a twofold problem in controlling the individual characteristics, however. Vernon Smith (1982) introduced the induced–value theory, which identifies sufficient conditions for experimental control over the individual characteristics that are relatively easy to satisfy in practice. The key idea of this theory is that proper use of a reward medium allows an experimenter to *induce* prespecified characteristics in the subjects, and the subjects' innate characteristics become largely irrelevant.[66]

The associative approach, however, cannot do without all the individual characteristics. That is, the approach is based on (or assumes) certain conventions rooted in societies that help players (subjects) in solving the games at hand. The basis for an association is a convention, even though the relation between these two is not a one–to–one relation; there is a similarity or correspondence between the two (see former chapters). This means that in certain relatively similar situations players make the same association(s) between two or more games in order to help them solve the games. The origin of these associations is not the subject matter of the associative approach: however, how these associations influence the outcome of games is.

The conventions rooted in society are active on a very subconscious level only. People are not constantly thinking about which convention is the proper convention at the time of, for instance, a strategic interaction between several individuals.[67] The associative approach experiment is set–up in such a way that

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[66] For a clear definition and overview of the induced–value theory see Smith (1987; p.248) or Starmer (1999; pp.13–14).

[67] In psychology the concept of conventions (or any knowledge) that are only active in the subconscious level is called implicit knowledge, implicit memory or implicit retrieval, which is defined as "occurring when information from some prior episode can be retrieved and can hence influence current processing, but in the absence of conscious recollection of that prior episode" (Shanks and St.John, 1994; p.372). (For a more elaborate study of the concept see Schacter (1987), Shanks and St.John (1994).)

prespecified characteristics are induced in the subjects, while keeping access to all conventions (associations) open for all individuals.[68]

> A one–shot game in the laboratory is part of a life–long sequence, not an isolated experience that calls for behaviour that deviates sharply from one's reputational norm. (Hoffman*, et al.*, 1998; p.350)

The assumption of the associative approach that needs to be maintained is that of a certain degree of rationality[69]. This means that individuals prefer more to less, and that they try to optimise their behaviour. A convention can be a medium that helps individuals satisfy their needs with low search costs. In other words, the experiment must be able to *induce* the individual characteristics of wanting more over less, while keeping the option open of using (unconscious) associations (conventions) in helping them satisfy this need.

4.6 Pilots of the experiment

To get a first impression of whether or not players do indeed make associations between games a first exploring pilot is conducted. Initially several combinations of games are tested on some colleague Ph.D.–students at the Erasmus Institute for Philosophy and Economics. These Ph.D.–students all know the material of both game theory and of the associative approach, which most likely makes them more biased towards making associations. The result is that they indeed make associations between games.[70]

Based on the explorative pilot the experiment has to be more specific in order to be able to test the associative approach and say something about the validity of the approach. The second pilot study consists of three different combinations of games that are relatively easy to understand. The combinations are: (1) hash–mark game and a coordination game, (2) coordination game and a

[68] The means to control these individual characteristics can be found in many different articles and books on experiments. Again for an overview see Starmer (1999) or Smith (1987).

[69] There has been a major discussion for many years now concerning the different forms of rationality. There are many forms of rationality that range somewhere between hyper rationality and irrationality. The two extremes are not relevant for the associative approach (or for anything in life, in my opinion). What form of rationality is the "real" form of rationality is still an open debate. The rationality assumed in the associative approach is a form of rationality that is somewhere between the two extremes; maybe it is closest to Herbert Simon's bounded rationality.

[70] Two subjects who played one combination together are both Turkish and know each other very well. The result of play in that one combination was that they made an association that was completely opposite of what was expected by common western European culture. Important was, however, that they did make an association (based on their common history, common knowledge, and their shared cultural background).

battle–of–the–sexes game, and (3) hash–mark game and battle–of–the–sexes game.

The pilot is tested on family. The result of the pilot study is that the subjects do make associations. However, there are several problems in the set–up of the experiment. Some remarks by the participants make clear that the three different combinations in total confuse the participants a little bit, because they start mixing up the rules of the respective games (note that no participating member in this pilot study has any background in game theory). The result is that many questions are asked during the process, because they want to know how the game works. A question from one of the participants makes clear that he does not only make associations between the games in one combination, but also between the different combinations. Another reason why there is cross contamination may also have been that the family members know each other very well, and that they can think about the way the other family members will play, because of the closely shared background. And yet another factor that caused problems is that the participants are playing face to face. In this way the participants can tell by the reactions and facial expressions from other players what they are likely to play, given the experience of former play in a game or a combination.

The most important result of the pilot studies is that only one combination should be played. However, to be able to say something about the validity of the associative approach the combination has to be repeated several times. The repetition is necessary, because in real life some behaviour of people is learned through trial and error over many years. In experiments the time span is very short compared to real life. If the combination of games would not be repeated this would mean there is no way subjects can learn how to play the games . In order to keep the parallel with "real life" the combination has to be repeated. What is important when repeating the combination is that for every combination the participants will play another unknown player (based on the experience of playing face–to–face in the second pilot study). After having played one combination with the same unknown opponent, every player will be assigned a new unknown opponent. The players of one type will be in one room while the players of the other type will be in another. That is, all the subjects of one type will play all the subjects of the other type exactly once without knowing whom they are playing at that time.

The first session of the actual experiment is supposed to generate the data for testing the associative approach (together with the other sessions). It turns out, however, that there are still some problems in the experimental set–up, which causes this first session to be the third pilot study. In this pilot study, as in the actual experiment, players play one combination of two games, which are a hash–mark game followed by a distribution game. To see whether or not players associate between the two games it is very relevant that the players realise that they play one and the same opponent for that combination of two games. Some questions raised during the first session, as well as comments after the session, make clear that a lot of subjects do not realise that they are playing one opponent for a combination of games, and that for each combination they switch opponents. Most subjects discover or realise that they are playing the same opponent for one combination after a couple of stages.[71] In the instructions it is clearly stated that they will play one and the same opponent for one combination, but it turns out that students read quite carelessly. This careless reading also shows itself in the understanding test. The understanding test is a test before the actual experiment to see whether students understand the rules on how to play games (see appendix C.5).

About half the subjects give the correct answers, but the other half give answers based on the recruitment story, which the first year students were told at the beginning of lectures stating that, if they participate in an experiment, they can earn between twenty and fifty guilders depending on their performance. Some subjects answer the questions in the understanding test using the twenty and fifty guilders mentioned in the recruitment story instead of the amounts mentioned in the understanding test, even though the experiment is conducted a fortnight after the recruitment.

The last part that shows that subjects read carelessly is that one subject asked one of the monitors after the experiment: "How much did I earn by winning the hash–mark game?". Nevertheless, it is clearly stated in the instructions of this version that there is no payment for the hash–mark game.

Based on all the questions and comments by the subjects a lot of alterations are made in the instructions and the set–up in order to make them more clear to the subjects in the next sessions. The basic condition for the experiment is that the subjects, even if they do not associate, at least know that they are playing the same opponent for one combination of two games. Because some subjects do not realise this in the first session, the session is designated a pilot study, and the set–up of the experiment is altered so that the basic conditions to be able to test associations are satisfied (see Appendix C for the final result of the set–up and instructions).

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[71] Most students find out after the second or third stage. There was one student who knew it from the first round, while there was also one student who found out in the very last round.

4.7 Conclusion and discussion

In this chapter the set–up of the associative experiment, and all the hurdles that had to be taken, have been given. When following all advices on how to construct a proper experiment, there will always remain questions or objections that can be raised. Some of the problems that can arise in the associative approach experiment will be discussed. As will become obvious after reading the questions and/or objections, the associative approach experiment is set–up in such a way that the results will be able to 'verify' or falsify the approach. In the next chapter the results of the experiment will be analysed.

4.7.1 Repetition vs. association

In traditional game theory it is quite common to analyse repeated games. In the associative approach experiment there is a repetition of combinations of hash–mark and distribution games. Traditional game theory can analyse the repeated distribution game. In traditional game theory when analysing repeated games there are meta–strategies possible (for instance, as more or less done by Bhaskar (2000), see also section 2.3.2). In the associative approach the combination of the two games creates the opportunity for players to make associations as assumed in the former sections. In traditional game theoretic analysis the interruption of the repeated distribution game by the hash–mark game should not make a difference. An interesting question is which of the two procedures is 'stronger', that is, which of the two analyses is better in explaining behaviour (in the aforementioned experimental set–up). In other words, does repeating the distribution game several times have more influence on how to play the game, or does the preceding game in the combination (the hash–mark game) have more influence on the play of the distribution game? What is stronger, repetition or association?

To answer this question it is possible that the experimental set–up for the associative approach is not appropriate, because in order to be able to analyse the possible existence of meta–strategies in an experiment the repetition of the game should be for two fixed players. That is, the history between two players caused by the repetition of the distribution game creates the possibility of meta–strategies. The experimental set–up should be that combinations of the hash–mark and the distribution game are played against the same opponent for a number of rounds. If in an experimental set–up there is the possibility for players to make associations between different games (hash–mark and distribution game), but also to make meta–strategies over the repeated distribution game (interrupted by the hash–mark game), maybe a proper comparison can then be made to see whether repetition or association is 'stronger'.

In this dissertation the answer to this question will not be given for the above–mentioned reason (no fixed opponents) and because the super and/or meta–strategies can be very complex and diverse. Above that, it is not (very) relevant for the argumentation and testing of the validity of the associative approach. If it is shown that people do make associations between two games, that is if the validity of the associative approach is proven, then the trouble of answering this question will only be distracting for the general line of this dissertation. The question does remain interesting, however.

4.7.2 Suspicion

An objection that can be made to the experimental set–up is that by confronting subjects with two successive games there is suspicion induced to the subjects that these games have something to do with one another. One of the results of the third pilot study is that the subjects do realise they are playing two games in one combination after each other. What they do not realise is that they are playing one combination against one and the same opponent. The behaviour of the subjects in this pilot is that they do not make connections (associations) between the two games, even though they know they are playing two games after each other. In other words, the fact that two games are played in combination by itself does not induce a suspicion to the subjects that they are somehow related.

CHAPTER 5

EXPERIMENTAL RESULTS

5.1 Introduction

In this chapter the data generated by the experiment will be analysed. First, a general overview (section 5.2.1) of the subject pool is given, including all sessions, followed by an introduction on how the experiment is conducted (section 5.2.2). The two different versions of the experiment will be analysed in separate sections (5.3 and 5.4). The two versions are almost similar in analyses, but will still be analysed separately for clarity reasons. The two different sections have a similar set–up, however. In each version, first an introduction will be given, followed by the analyses of the main hypotheses. The third part deals will different sub–hypotheses (e.g., controlling for effects of additional variables). A separate section is devoted to test whether subjects learn, and a conclusion will end each version. For those who do not like or do not understand statistical analyses, a summary of the results and their consequences is given in section 5.5.

5.2 The experiment

5.2.1 General information

Students from different faculties were recruited to participate in the experiment. Based on a short talk, held in front of several classes, students signed up for participation in the experiment. In total (the pilot, version 1, and version 2) there were 110 student participants in the experiment[72]. The total amount of participants for each session varied depending on the number of students that

[72] In total 133 students were recruited, i.e., 17% of the students did not show (some students gave notice that they would not be able to show, however most did not.

actually showed. For each session 15 students were recruited[73]. In some sessions five or more students did not show, while in others everybody showed. Given the set–up of the experiment an even number of subjects are always required. So in some cases people in the hallways were asked to participate (as long as they did not have any experience with game theory), and in other cases people were asked to come back on another date, or were sent away.

The total population of subjects consists of 35 women and 75 men (variable *Sex*), who are quite evenly divided over the different sessions. In total 83 students have a Dutch cultural background, while 27 have another cultural background (variable *Cultural background*). These students are present in practically the same proportion in all sessions.

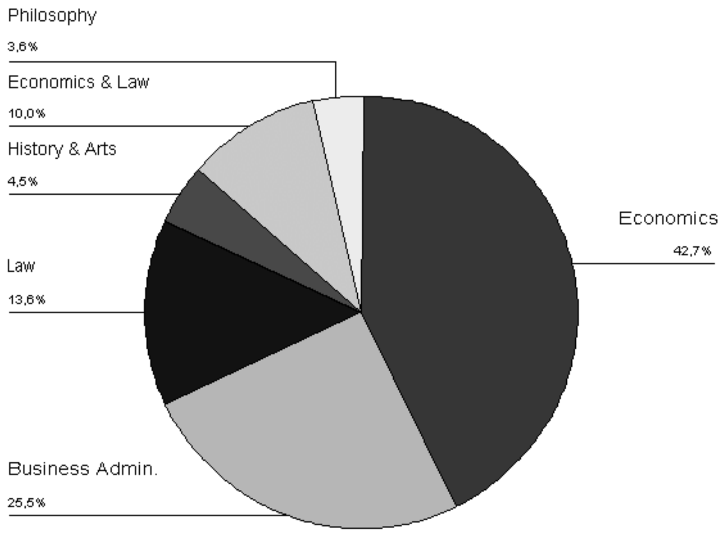

Figure 5–1 Different faculties represented in the experiment

Students are recruited from several faculties of the Erasmus University Rotterdam (variable *Faculty*). As Carter*, et al.* (1990) show, for instance, if only economic students are recruited different behaviour might show compared to say a group of only art students. The set–up of the experiment is already such that behaviour differences between subjects in a population are reduced by following the induced value theory restrictions. As an extra safeguard, a mixture of students

[73] Except October 27, and November 3. At these dates only 14 students applied; Fridays are unpopular days at the university, because most first year students do not have classes on Friday, and therefore participate in other activities.

from different faculties is recruited to exclude similar forms of behaviour (see figure 5–1).

The experiment starts with an understanding test, where the last question subjects have to answer is to see whether subjects are risk–averse (variable *risk–averse behaviour*). If a subject is (very) risk–averse it might be that he will only choose the alternative that gives her the smaller share of the distribution game; the idea behind it is that the chance the players match when offering the lower share to the other player is larger than the chance when offering the smaller share. This would mean that if the subject's behaviour is risk–averse, the behaviour can possibly override the association in the combination, and hence needs separate analysis. In total 13 participants (which is 11.8%) filled out that they wanted "fl.3.– for sure" instead of a "fair coin toss which pays you fl. 0.– for heads and fl. 20.– for tails", and thus show risk–averse behaviour.

5.2.2 Conduct of the experiment

The experiment is conducted with pencil and paper. One reason for this is that the experimental laboratory is very mobile in this manner, and the experiment can thus be conducted in practically every classroom. In total 18 classrooms are used for the nine sessions. In the nine sessions there are six different combinations of two classrooms, and the sessions are also in two different buildings. Another reason for conducting the experiment with pencil and paper is that renting a computer lab is more expensive than university classrooms. There is hardly any experience at Erasmus University concerning experimenting and, hence, no software to run the experiment. To buy or (re)program software is very costly and difficult. The last reason for a pencil and paper experiment is that the associative approach experiment is not too complicated to do on paper; the only requirement is (a lot of) running around by the experimenters.

To reduce leakage of information through sight or voice, the experiment is conducted in two adjoining classrooms (or at least close to each other) for the two player type groups, which are spacious enough for the subjects to be seated sufficiently far apart. Easy walking access between the monitor workstations and each subject is realised in order to give individualised attention to subjects during the instruction phase of the experiment. In this manner the experimenter and/or monitors have easy access to both rooms for exchanging the worksheets of the first game and do not lose too much time in the process.

Given the nature of the games the subjects play, the outcome of the first game is public information for the two players in that game. However, the subjects do not know whom they are playing, just that they are playing an opponent in the other room. The outcome of the second game in the combination is privately revealed to every player, because the payment of the subjects is based on this outcome. The data is put into a (central) computer during the experiment in order to calculate the outcomes of the experiment and to be able to pay the participants their money based on their respective outcomes. The data is, in this way, immediately available for analysis by means of a computer.

When entering the laboratory the subjects, in all sessions, have to draw a ticket at random, which states whether they are of type A_i (i = 1,…, 7) or type B_i. The type A−players are in one room and the type B−players are in the other. The participants remain the player type and number for the whole duration of the session. One combination (of two games) is repeated six times (five in case of only ten participants) so that the type A−players play another type B−player each time. The random drawing is done first to break up any groups of friends, and second, to make sure all the participants know that they are playing a real opponent, but have no clue who that person might be.

The subjects are informed that the subject pool consists of volunteers from different faculties. The general information the subjects receive about the experiment is that the experiment concerns the study of behaviour in interaction problems in which they are paired with an anonymous co−player, who is randomly assigned (remember the A_i and B_i). This statement of purpose is necessary, because it helps satisfy the subjects' curiosity about why someone is willing to pay them money for playing games that they would gladly play without the additional incentive of cash. The statement is specific enough to satisfy the curiosity of the subjects, and, yet, broad enough to avoid any "demand effects". That is, if subjects are able to form a precise idea of the kind of behaviour the experimenter is looking for, this in itself may make such behaviour more (or less) likely. Hence, at no point is any reference made to issues relating to associations.

Because the outcome of the first game (the hash−mark game), and the outcome of the second game (the distribution game) determine whether or not players associate between these two games, these will be the focus variables in the experiment. The variables generated by the experiment are (some are already mentioned before, but for clarity are stated again):

sex	→	both males and females participate
faculty	→	the subjects are recruited from several different faculties of the Erasmus University Rotterdam
cultural background	→	both Dutch and non−native Dutch participate in the experiment
risk−averse behaviour	→	in the understanding test the subjects have to choose between two alternatives which show the subject's attitude towards risk

hash−mark game start	→	the computer randomly assigns the starting positions for the hash−mark game
hash−mark game result	→	the hash−mark game has both a winner and a loser
distribution alternative	→	the subjects can choose between two alternatives in the distribution game

The two versions are different: in version two, the winner of the hash−mark game will receive a financial reward for winning it, while there is no financial reward in version one. The two different versions have the same focus variables, however, and are distinguished by the constant variable of payment, or no payment, in the first game.

5.2.3 Analyses

The set−up of the experiment is so simple that all the relevant variables (except *Faculty*) are scale variables: they are either a combination of 0 and 1, or a

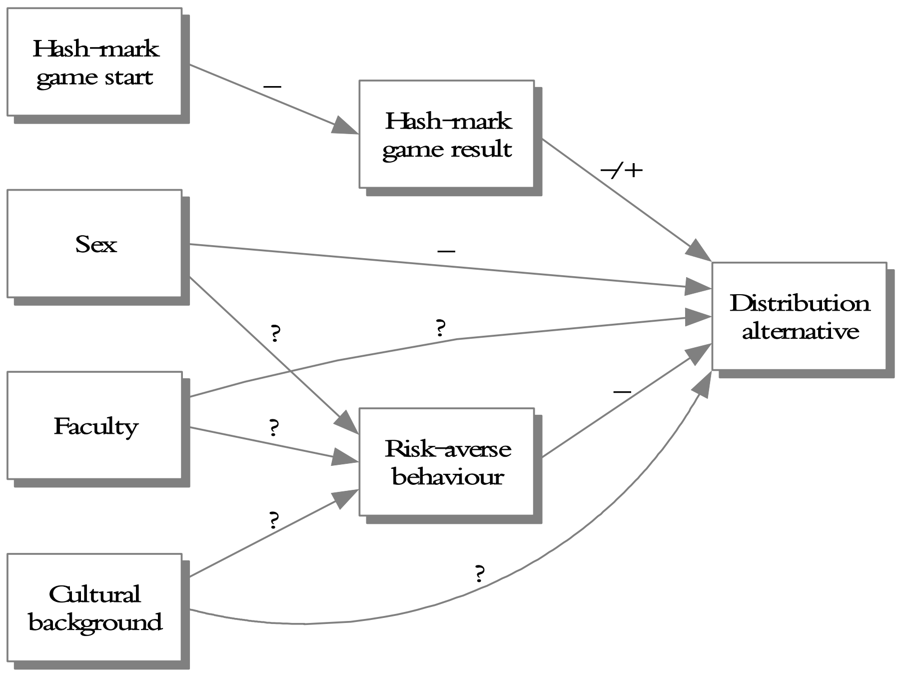

Figure 5−2 A priori relations between variables combination of 1 and 2[74]. SPSS 10.0 for Windows is used for analysing the data. The a priori assumed relations that need to be analysed are graphed in figure 5−2.

The a priori relations in the scheme are sometimes based on (common) intuition, and sometimes on logical structures. Other possible relations, for instance between *sex* and *hash−mark game result*, can be neglected because there is no reason to assume that females are better or worse at playing the hash−mark game than males. The relations in the scheme are the relevant relations to investigate.

hash−mark game start → *hash−mark game result*: the player that starts the hash−mark game can always win, while the second player can only win if the starting player makes a mistake (for details on how to play the hash−mark game, see footnote 10). Given the coding of the variables the expected relation between the two is a negative relation, because if the hash−mark game start variable goes up (from the starting to the second player) the result of the hash−mark game goes down (from winning to losing).

sex → *risk−averse behaviour*: this relation is unspecified, because men or women can have different attitudes towards risk, but the possible difference is unknown.

sex → *distribution alternative*: this relation is based on the intuition that females are more considerate than males (see Holm (2000), or Mason, et al. (1991), for instance) and are maybe more prone to accept the lower share (a negative relation).

faculty → *risk−averse behaviour*: it may be that people from certain faculties have a different attitude towards risk than members from other faculties. Because the variable *faculty* is a nominal variable and because one does not know which faculty students can be more risk−averse the relation between *faculty* and *risk−averse behaviour* is unspecified.

faculty → *distribution alternative*: this relation is based on the fact that it has been shown that economic students are more selfish than students of some other faculties (see Carter and Irons (1990), for instance). Economic students, then, might opt for the larger share in the distribution game more than students from other faculties. (Because *Faculty* is a nominal variable the relation is undefined).

[74] For the coding of the variables as applied in version 1 see appendix D.1.

cultural background → *risk–averse behaviour* and *cultural background* → *distribution alternative*: these relations are based on the intuition and experience that people with a different background can have completely different attitudes towards risk as well as about what they think is fair sharing (remember the two Turkish Ph.D. students in the explorative pilot study of the former chapter). The relations are undefined because if the behaviour of members with different cultural backgrounds differs, one cannot tell beforehand in which direction.

risk–averse behaviour → *distribution alternative*: people that are more averse to risk are maybe also more likely to settle for a smaller share in the distribution game. The chance of getting the smaller share is bigger than the chance of getting the larger share (the average expected outcome of traditional game theory in the distribution game). If a subject is risk–averse it might be that he puts more weight on the higher chance of getting something, regardless that the expected average payoff is the same, and thus opt for the smaller share more often than the larger share.

result hash–mark game → *distribution alternative*: this relation is the most important relation for the associative approach. According to the associative approach subjects will claim the larger share when they have won the hash–mark game, and settle for the smaller share if they lost in version 1 (positive relation), and vice versa in version 2 (negative relation).

If an observed relative frequency of certain (combinations of) variables is in the so–called confidence interval it means that the tested null hypothesis is not rejected. The boundaries of the rejection area are set by defining the chance that the observed relative frequency falls outside the confidence interval while the null hypothesis is true. A 95% confidence interval is the most commonly used confidence interval, especially when testing new hypotheses. The associative approach experiment will therefore use the 95% confidence interval, thus the rejection area is set to 5%.

5.3 Results version 1

In this version the hash–mark game has no financial reward. In the distribution game the subjects have to divide ten guilders, where the two alternatives are claiming either three or seven guilders.

5.3.1 Introduction

The subject pool in total consists of 48 participants over four different sessions (sessions 2 to 5). In this version 70.8% of the participants are male participants and 29.2% female participants (which is similar to the total subject pool distribution for the experiment; compare 29.2% with 31.8% for the whole experiment). 22.9% of the participants have a foreign cultural background, compared with 24.5% for the total experiment. In this first version quite a lot of subjects are risk–averse; 20.8% (total experiment: 11.8%). The representation of different faculties is given in table 5–1.

Table 5–1 Representation faculties in version 1

Faculty	Frequency	Percentage	% experiment
Economics	21	43.8	42.7
Business administration	11	22.9	25.5
Law	7	14.6	13.6
History & Arts	1	2.1	4.5
Economics & Law	8	16.7	10.0
Philosophy	0	0.0	3.6
Total	48	100.0	100.0

The aforementioned independent variables (*Sex*, *Faculty*, *Cultural background*, and *Risk–averse behaviour*) together with the starting position for the hash–mark game are analysed for possible relations. It turns out that all these variables show no relations (see appendix D.2.1) and therefore the expected theoretical relations in figure 5–2 between *Sex*, *Faculty*, *Cultural background*, and *Risk–averse behaviour* are not considered in further analyses of version 1. The four variables also do not have any relation with the position (start/second) in the hash–mark game (remember the random drawing of the starting player), and therefore no cross–checking needs to be done for the hash–mark game. The possible influence of the variables on the distribution alternative will be dealt with in section 5.3.3.

5.3.2 Hash–mark game

The structure of the hash–mark game is such that there will always be a winner and a loser. However, the player who starts the game can always win, and if you are second you can only win if your opponent makes a mistake. If all subjects find out that they can win if they start, this would mean that the winning of the hash–mark game does not entitle the winner to the larger share anymore, but the random device, which generates the starting players for each round, does. This means that it is not the players who have put in effort to win, but the random device, which means that in the combination of games there is no such thing as a Lockean principle of distributive justice anymore. On the other hand, if only a small amount of subjects do find out how they can always win, the Lockean principle still holds, because these subjects are perceived as having put in much effort to understand how to play the hash–mark game. The first relation that needs to be tested is whether or not the subjects realise that the starter can always win, and act upon that. Graphically this can be depicted as follows:

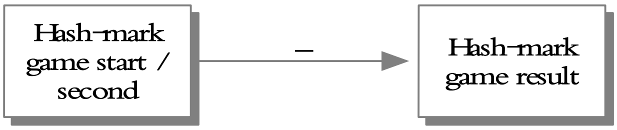

Figure 5–3 Relation between HM–start & HM–result

Both variables are scale variables. In order to analyse whether there is a relation between the two a Pearson correlation (one–sided significance test, because starter can always win) will be generated.

Table 5–2 Correlation HM start & HM result

		HM result
HM start	Pearson Correlation	−.079
	Sig. (1–tailed)	.094
	N	278

In the table two variables are tested for correlation[75]; that is, *HM Start* and *HM result*. The data generated 278 (*N*) valid entries to test this correlation. The one–sided significance (p) is 0.094; this means that in a 95% confidence interval the tested relation is not significant (i.e., 0.097 > 0.05). It is significant if a 90% confidence interval is used, but the relation is still very weak. The Pearson correlation shows that if the *HM Start* variable (which is coded 1 for starting and 2 for second) goes from 1 to 2, the other variable (*HM Result* which is coded 0 for losing and 1 for winning) goes down with 7.9%. In other words, the correlation shows that starting players win almost 8% more than players that go second (see figure 5–4). If the participants had found out that the starting player could always win, the Pearson correlation would have been much higher and would have been significant. The table can therefore be read as follows: the participants over the whole version did not figure out how to play the game in the sense that they knew they could always win if they started. This means that the winner of the hash–mark game is indeed recognised as having put in the effort to win, and that it was not the random device (unwinding of logical structure) that decided who would be the winner of the hash–mark game.

[75] In the following tables when two (scale) variables are tested for a correlation the same method and meaning applies as for this table.

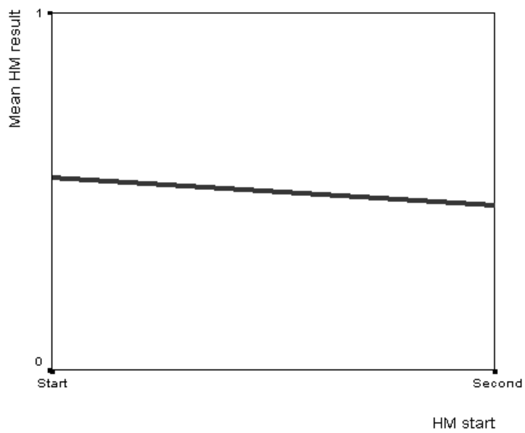

Figure 5–4 Pearson correlation between *HM start* and *HM result*

To see whether the participants figured out how to play the game in the process of play, the learning of the game has to be analysed over the different stages. To check whether the participants learned how to play the game the result of the hash–mark game has to be checked over the different stages for each player individually. The relation is not significant ($p = 0.499$; see appendix D.2.2). However, the possible learning behaviour of the players also depends on whether they are starting or second players. That is, if they are always second they can only win if the opponent makes a mistake. In other words, the result of the hash–mark game for both the group of starters and of the group of second players have to be tested separately, for each single player in such a group. Again a Pearson correlation (all the variables are scale or interval variables) will show whether there is a relation or not. It is a one–sided test in the case of starting players, because the players can only learn how to play the game by learning how to win when starting in each stage. The test is two–sided in the case of checking for correlation between the groups of second players and the hash–mark game result, because they either learn to take advantage of "dumb" starting players, or lose because of "smart" starting players.

Table 5–3 Learning in HM–game by starting players

Controlling for unique player		HM result
Stage	Partial Correlation[76]	.089
	Sig. (1–tailed)	.149
	N	136

Table 5–4 Learning in HM–game by second players

Controlling for unique player		HM result
Stage	Partial Correlation	.091
	Sig. (2–tailed)	.291
	N	136

It is obvious from table 5–3 that the starting players did not learn how to win the game during the process of play. It is also obvious from table 5–4 that the players who started second in the hash–mark game did not learn how to take advantage of the no–learning situation of the starters. The world is not so cruel that all participants did not learn. Quotes by the participants made clear that some did figure out that they had to let the other player cross out the sixth line from the right, some even figured out that they had to let the other cross out the twelfth line as well. However, from quotes, both from the post–questionnaire and the comment sheet of the experiment, it was obvious that only two players in the version figured out (after some rounds) how to play the entire hash–mark game.

The fact that only two participants figured out how to play the hash–mark game created an even larger entitlement to those players, because they were the only ones that put in so much effort to understand how to play the game. In other words, the relation of the starting position in the hash–mark game and the winning position does not influence the possible association that players can make between the hash–mark result and the distribution alternative.

[76] The partial correlation shows that if the *Stage* variable (which is coded 1 to 6) goes up *HM result* goes up almost 9%, when controlling for *unique player*. If the relation were significant this would have meant that per player, when starting, the result of the hash–mark game goes up with 9% while progressing through the stages.

In the following sections where a partial correlation is run between variables controlling for a specific variable, the methods, explanations and definitions of this table apply.

5.3.3 Association?

The most important relation that needs to be investigated is the possible association participants make between the HM result and Distribution alternative. From figure 5−5 many a priori relations have been checked and can be removed, because these relations do not exist. To see whether players associate, the following figure shows the possible remaining relations that need to be analysed.

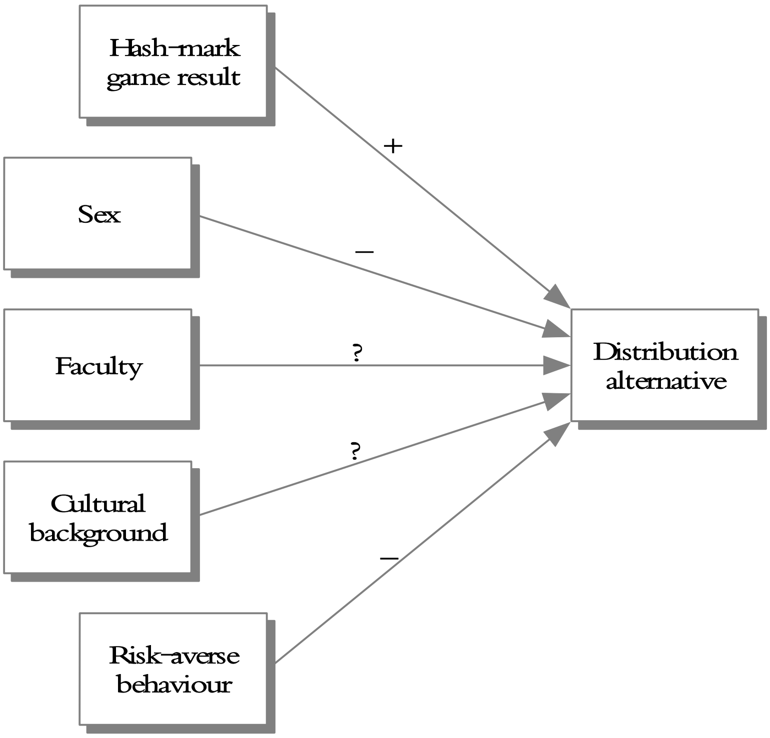

Figure 5−5 Remaining a priori relations between variables and distribution alternative

For all the variables, except *Faculty*, a Pearson correlation will show whether there is a relation between the variables. For the relation with *Faculty* a one−way ANOVA test is used[77]. The relations between the respective variables *Faculty*, *Cultural background*, *Risk−averse behaviour* and the variable *Distribution alternative* are not significant (see appendix D.2.3). The relation between

[77] The one−way ANOVA test (ANalysis Of VAriance) is used when a nominal variable with more than two outcomes is checked for correlation with one scale variable when the sample is large enough.

Cultural background and *Distribution alternative* might not be significant due to the fact that the only distinction made was native Dutch – not−native Dutch. First of all, the non−native Dutch group is not homogeneous: they stem from very different cultures (Turkish or Surinam for instance) with different characteristics. Furthermore, the non−native Dutch group is probably so blended into Dutch culture that there is no difference in the way they behave with regard to the choosing of an alternative. The relation between *Faculty* and *Distribution alternative* is not significant. This might be because all students were first−year students, and not so much influenced by their study yet, or that fairness perceptions or greediness of students of different faculties in the Netherlands are quite similar. The relation between *Risk−averse behaviour* and *Distribution alternative* is not significant, which means that probably other factors influence the choice of alternative more, or negate the influence of risk−averseness. The results of the other (significant) variables are given in table 5−5.

Table 5−5 (Significant) relations

		Distribution alternative
HM result	Pearson Correlation	.478
	Sig. (1−tailed)	.000
	N	278
Sex	Pearson Correlation	−.078
	Sig. (1−tailed)	.097
	N	278

As is obvious from the table the hash−mark game result is significantly connected (correlation is significant even at a 1% level) to the alternative chosen in the distribution game. The relation between *Sex* and *Distribution alternative* is not significant at the 5 percent level, but at a ten percent significance level there is a relation. However, the relation between *Sex* and *Distribution alternative* at the ten percent level is so small (−7.8%) that one can conclude that the relation is negligible. To check whether the influence of *Sex* is really negligible a partial correlation between *HM result* and *Distribution alternative*, controlling for *Sex*, is run. The partial correlation is run to see whether the relation between *HM result* and *Distribution alternative* exists without any possible influence of *Sex*. The correlation stays significant at the zero percent level, and the correlation is 0.482, where n = 275. In other words, the influence of *Sex* on the relation between *HM result* and *Distribution alternative* is negligible.

The (entitlement) association, that is, the relation between *HM result* and *Distribution alternative*, says that the player who won the hash−mark game is entitled to the larger share in the distribution game, and vice versa for the loser.

This means that the relation between the variables should have a positive coefficient, i.e., when the result of the hash–mark game goes up (remember the variable is coded as, 0 = lost HM, and 1 = won HM) the alternative chosen in the distribution game should go up (coding: 1 = alternative 1, and 2 = alternative 2)[78]. The corrected coefficient is 0.482: i.e., winners of the hash–mark game chose the larger share almost 50% more than losers, or, vice versa, losers chose the smaller share almost 50% more than winners.

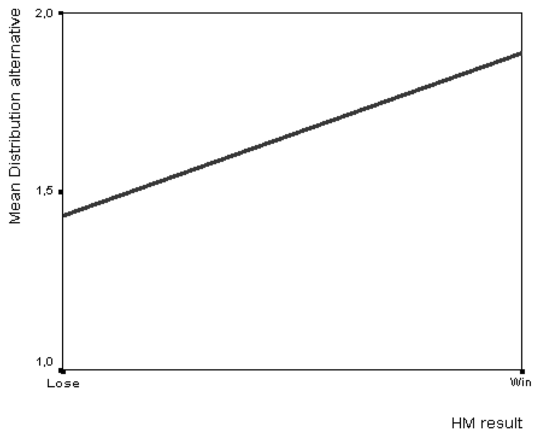

Figure 5–6 Correlation between HM result and Distribution alternative

The only significant relation remaining after removing all the insignificant relations is the following figure. That is, the two groups, winners and losers, behave differently when choosing an alternative: this is what the associative approach predicts.

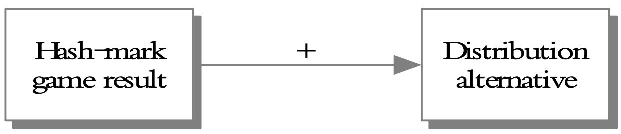

Figure 5–7 A posteriori relation in version 1

As said in the former chapter, analysing how much the choices made by the different groups deviate from traditional game theoretic predictions is also necessary, because it might be that one group behaves differently, while the other

[78] Alternative 1: You get fl. 3.– and your co–player fl. 7.–"; alternative 2: "You get fl. 7.– and your co–players gets fl. 3.–."

plays according to traditional game theoretic predictions. Table 5–6 shows the amount and percentages of participants who lost or won the hash–mark game and their respective alternatives chosen in the distribution game.

Table 5–6 Alternatives chosen based on losing/winning HM–game

			Distribution alternative		
			Alternative 1	Alternative 2	Total
HM result	Lose	Count	79	60	139
		% within HM result	56.8%	43.2%	100%
	Win	Count	16	123	139
		% within HM result	11.5%	88.5%	100%
Total		Count	95	183	278
		% within HM result	34.2%	65.8%	100%

As is obvious from the table there is a 45.3% difference in choosing alternatives 1 or 2 for the group of losers compared to the winners (respectively 56.8% – 11.5%, and 88.5% – 43.2%). The total percentages of alternatives 1 and 2 are almost the same as traditional game theoretic prediction, which is that on average alternative 1 will be played in 30% of the cases and alternative 2 in 70%. The choices made by the different groups do differ from the total percentages, and already point into the direction of the associative approach (see the graphical representation of table 5–6 in figure 5–8).

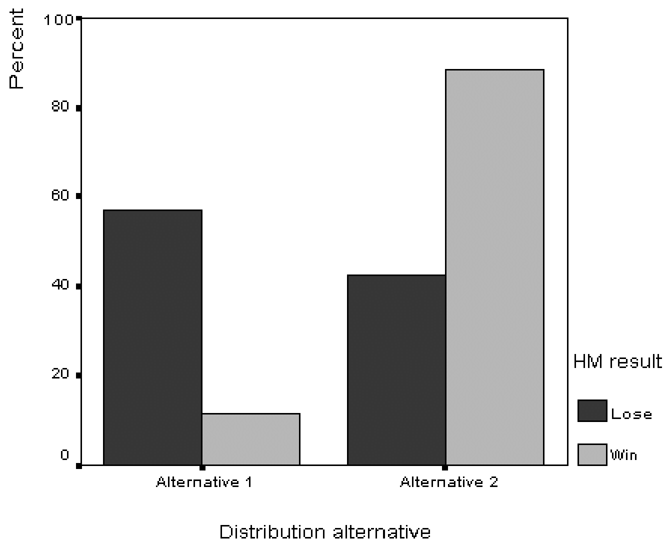

Figure 5–8 Percentages of losers/winners choosing alternative 1 or 2

To make sure whether the behaviour of the two groups is significantly different from the prediction of traditional game theory, the two hypotheses of section 4.3.3 will be tested. Does the behaviour of the group of winners (losers) deviate from traditional game–theoretic predictions?

H_0: Traditional game–theoretic prediction: $p_{W0} = 0.7$ ($p_{L0} = 0.7$)
H_1: Associative approach prediction: $p_{W1} >> 0.7$ ($p_{L1} << 0.7$)

The null hypothesis is rejected if the observed proportion of winners (losers) choosing alternative 2 falls outside the confidence area for the null hypothesis. To see whether this is the case, one has to check what the boundary is for the confidence area of the null hypothesis. If the observed proportion in the data exceeds the boundary, the null hypothesis is rejected. The significance level to test the null hypothesis will be set to 5%, i.e., $\alpha = 0.05$. $p_{s,winners}$ ($p_{s,losers}$) is the observed proportion of winners (losers) that chose alternative 2, p_0 is the traditional game theoretic proportion of players choosing alternative 2, and g is the boundary.[79]

$$P(p_{s,winners} > g_w \mid p_0 = 0.7) = 0.05 \quad \wedge \quad P(p_{s,losers} < g_L \mid p_0 = 0.7) = 0.05$$
$$g_W \approx 0.764 \qquad g_L \approx 0.636$$

The observed proportion of winners (losers) choosing alternative two is 0.885 (0.432), which is outside the respective boundaries. This means that in both cases the null hypothesis is rejected[80]: traditional game theory is not able to explain the observed alternative choices. The alternative hypothesis is accepted. In other words, the associative approach **is** able to explain the behaviour of the players (divided in losers and winners) better than traditional game theory is. Comments and remarks of participants in both the post–questionnaire and the comment sheets of the experiment make clear that some participants always claim seven when they win the hash–mark game and three when they lose. Some examples:

> According to me, the best way to do the analysis is as follows: if you win the hash–mark game, you are allowed to check the seven guilders. If you lose, you have to check the three guilders. This way you work together and yet against each other, but for both players it is the best result. (B5, session 1)
>
> Applied rule: 7 to winner, 3 to loser. (A1, session 2)

[79] For the total calculations see appendix D.2.4.
[80] The null hypotheses are also rejected if the boundary of the confidence area is extended to 99%, that is, if the significance level is set to 1%. The boundaries are then 0,79 and 0,61 respectively (see appendix D.2.4).

5.3.4 Did they learn?

Are the participants able to match their alternatives better in the last round compared to previous rounds? That is, do the subjects during the process of playing combinations of games learn that an underlying convention can help them in solving the distribution game? In one session the combination of games was repeated five times, because only ten participants showed, who, split up into two groups of five type A– and five type B–players, play each other once. In the other three sessions the combination was repeated six times, because either twelve or fourteen participants showed. A new variable called *Possible association*[81] has to be created to check whether the subjects learned. This variable is defined as 'possible association', because when players make a 'connection' in the combination of two games, one cannot tell whether this connection was coincidence or whether it was players associating. That is, the subjects may have acted according to an association, but it can also be that they randomised strategies and by coincidence acted as if they behaved according to the entitlement association. Over the whole experiment it is different, of course. When many players in many combinations of the games make the possible association, one can call this behaviour associative. The participants do not learn to make use of the association more in later rounds than in the first round, as can be seen in figure 5–9, where it is shown what the average amount of possible associations in each stage are.

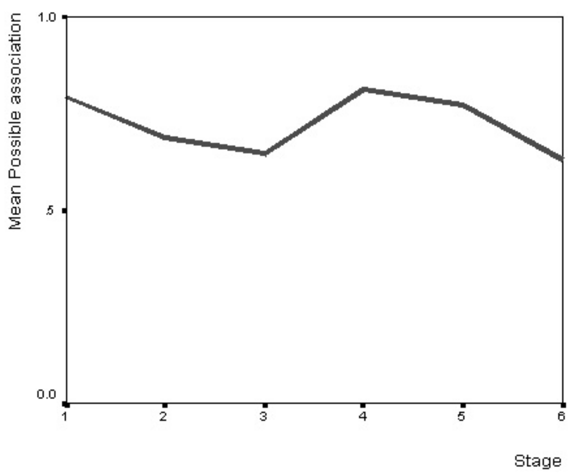

Figure 5–9 Possible associations over the stages for all participants

[81] For the coding of the Possible association variable see appendix D.1.

Because the group of participants as a whole do not make more associations over time this does not exclude that a large number of participants do learn while the rest do not. To check whether individual subjects learn, the following hypotheses have to be tested:

H_0: To solve the distribution game subjects use the entitlement association as much in every round.

H_1: To solve the distribution game subjects use the entitlement association more in the course of repetition.

A partial correlation test can be run to check whether the participants learn during the process of play, because *Stage* is an interval variable, and the other variables, *Possible association* and *Unique player*, are scale. The partial correlation checks whether the unique individual players make more associations in the later stages than in the earlier stages.

Table 5–7 Learning the possible association

Controlling for unique player		Possible association
Stage	Partial Correlation	−.031
	Sig. (1–tailed)	.303
	N	275

The result in the table shows that the participants do not use the association more in later rounds. In other words, there is no basis to reject the null hypothesis, that is, the participants use the association as much in every round. However, some quotes (from the post–questionnaire) make clear that, after a couple of stages, or in hindsight, some participants changed, or thought they should have changed, their tactics from always claiming seven or three to basing their alternative on the result of the hash–mark game. An example:

> First three stages I wanted the most, but I didn't win, but later I went to look at the result of the hash–mark games and then decided my choice. (B6, session 5)

5.3.5 Is the association rewarding?

The expected average outcome of traditional game theory is that in a large population players will select the higher share in 70% of the cases and in 30% of the cases the lower share in the distribution game. The fractions for the different possible outcomes in the distribution game, according to traditional game theory, are given in table 5–8.

Table 5–8 Fractions of outcomes

		Winner	
		Alt. 1	Alt. 2
Loser	Alt. 1	0.09	0.21
	Alt. 2	0.21	0.49

The subject pool in the experiment consists out of "associating" players and "non–associating" players. Their interaction, between groups, but also within groups, might have created a higher payoff to all players compared to traditional game theoretic predictions for the whole population. The following table gives the frequencies of the outcomes according to the way the participants played in the experiment.

Table 5–9 Fractions of outcomes (experiment)

		Winner	
		Alt. 1	Alt. 2
Loser	Alt. 1	0.065	0.504
	Alt. 2	0.050	0.381

Following from table 5–8, traditional game theory expects that in 42% of the cases the players will match their offers, and in 58% of the cases they will not match. Compare this to the result of the experiment in which there is a substantial amount of people that possibly associate. In 55% of the cases the participants are able to match their offers, and only in 45% they do not match their offers. Almost all the participants that match their offers matched on the equilibrium of the Lockean association (see the 50% of losers choosing alternative 1 and winners choosing alternative 2). Given that the two players in the distribution game have to agree on sharing ten guilders, one can say the financial reward per person predicted by traditional game theory is 2.1 guilders, while the actual payoff for the experiment is 2.77 guilders. Whether the group of "associating" players[82] have enough influence to raise the financial reward for all players has to be checked by analysing the following hypotheses, where p is the percentage of matches.

[82] Comparing the cell of the Lockean association (0,504) with the expectation of traditional game theory in that same cell (0,21), it turns out that the boundaries are 0,2502 (0,2668) at 5% (1%) significance level (see appendix D.2.5). The actual matching in the (Lockean association) cell is outside the boundaries, which means that traditional game theory cannot explain that behaviour. The outcome of the experiment confirms the associative approach, however.

H_0: Traditional game theory predicts that the expected payoff will be 2.1 guilders; in other words, $p_0 = 0.42$.

H_1: Associative approach predicts that the payoffs will be higher than 2.1 guilders; in other words, $p_1 >> 0.42$.

The 55% matching in the experiment has to be outside the boundary in order to be able to reject the null hypothesis. The boundary when using a 5 percent significance level is approximately 0.4687 (see appendix D.2.5). The actual matching result of the experiment is 0.55. This is higher than the boundary (it is even higher when taking a 1% significance level), in other words, the null hypothesis can be rejected. The substantial amount of associating players in the subject pool helps to create a higher payoff in the subject pool. The payoff is 0.67 guilder higher, which is 32% higher than what the players would earn according to the expectations of traditional game theory.

5.4 Results version 2

In this version there is a financial reward of four guilders for winning the hash−mark game. The subjects can choose from two alternatives in the distribution game in order to divide seven guilders: three guilders for yourself and four for the other, or vice versa.

5.4.1 Introduction

The same structure of analysis as in the former section will be used in this section. In total the subject pool consists of 48 participants divided unevenly over four sessions (sessions 6 to 9). In this version 69.8% of the participants are male and 31.2% female. Of the participants 75% have a Dutch cultural background, while 25% have a non−native background.

Table 5−10 Representation faculties in version 2

Faculty	Frequency	Percentage	% experiment
Economics	24	50.0	42.7
Business administration	12	25.0	25.5
Law	2	4.2	13.6
History & Arts	4	8.3	4.5
Economics & Law	2	4.2	10.0
Philosophy	4	8.3	3.6
Total	48	100.0	100.0

So far, the distribution is quite similar to the distribution of the total subject pool. There are four faculties with low levels of representation in this version. If the results or the variables for one of these disciplines deviate, it is not possible to attribute specific behaviour to that faculty. Assume, for instance, that behaviour is different in a group of only four students. *Faculty* could have caused the different behaviour, but just as well the difference might have been caused by other factors, such as some innate characteristics that are not filtered out by following the induced value theory. For this reason when checking the *Faculty* variable, only Economics and Business administration will be considered, because in those groups there are enough subjects to be able to deduce behaviour as a trait of faculty. There are only two people (4.2%) that are risk–averse, so the former line of reasoning is also valid for these people, and risk behaviour will hence be neglected.

As was to be expected, all the independent variables (*Sex*, *Faculty*, and *Cultural background*) are indeed independent, and have no influence on each other (see appendix D.3.1). They also cannot have a relation with the position (start/second) in the hash–mark game, because of the random device assigning the starting position.[83] Therefore, in the analysis of the hash–mark game interaction between these variables can be discarded. The possible influence the independent variables might have on the distribution alternative will be dealt with in the following section.

I could not help overhearing some students talk in the hallway before the start of session 7: they were discussing how to play the hash–mark game.[84] The data generated in this session is therefore contaminated, and for this reason only, data analyses of version 2 will exclude session 7. The differences between the data and the results of the total subject pool in version 2, the total subject pool without session 7, and session 7 by itself are shown in appendix D.3.[85]

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[83] The relations are also tested and are not significant, i.e., they are non–existing.

[84] Despite specific instructions, some students apparently talked with friends and/or fellow students about the experiment and specifically about how to play the game in the experiment. It was quite obvious that about half of the students knew version 1 of the experiment from friends (session 5 & 7 had by coincidence some students not only from the same faculty, but also from the same class), because they only glanced at the instructions, and did not really read them. When they received the hash–mark slips, they did not hesitate or think, they immediately crossed the "proper" amount of hash–marks. However, unfortunately for the experiment (as well as for their fellow students who did read the instructions) the subjects automatically wanted the larger share when they had won the hash–mark game. This caused a very low earning in the first rounds for lots of subjects, because interaction between not–knowing and knowing players caused a lot of mismatching. When it became clear that some of the subjects were playing version 1, the experimenter reminded all the subjects that there was a financial reward for winning the hash–mark game. Some participants reacted with words like: Why didn't I know this? Reply: Because you acted on the information of friends, not on the information of the instructions. Read the instructions!

[85] From now on when version 2 is mentioned, it means version 2 without session 7.

5.4.2 Hash–mark game

The first relation that needs to be tested is whether the subjects realise that the starting player can always win, and act upon that. Graphically this can be depicted as follows:

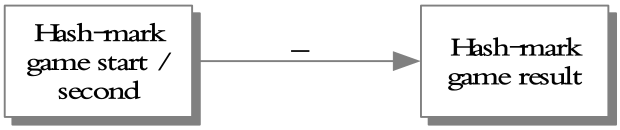

Figure 5–10 Relation HM–start & HM–result

Both variables are scale variables; in order to analyse whether there is a relation between the two, a Pearson correlation (one–sided significance test, because starter can always win) will be generated.

Table 5–11 Correlation HM start & HM result

		HM result
HM start	Pearson Correlation	–.087
	Sig. (1–tailed)	.106
	N	206

The participants in version 2 did not figure out how to win the hash–mark game when they started. In other words, the winner of the hash–mark game is entitled to the four guilder reward. To check whether the participants learned how to play the hash–mark game a partial correlation for each unique individual participant is run. It turns out that there is no relation (see appendix D.3.2). However, to be able to say that the players do not learn at all the results of both the winners and losers have to be analysed separately, for each single person in such a group.

Table 5–12 Learning in HM–game by starting players

Controlling for unique player		HM result
Stage	Partial Correlation	.022
	Sig. (1–tailed)	.412
	N	100

Table 5–13 Learning in HM–game by second players

Controlling for unique player		HM result
Stage	Partial Correlation	.023
	Sig. (2–tailed)	.821
	N	100

As in the previous version, the participants did not figure out how to win the game in the process of play, both when they are the starting or the second player. However, quotes from both the comment slips of the experiment and the post–questionnaire make clear that some students did figure out how to play the hash–mark game.

> The first stage there were too many sticks for me to think. From the second round, I divided the 17 sticks into 1, 6, and eleven: if I got those numbers I would win the game. (A2, session 9)

On the other hand, other quotes and remarks show that some participants never figured out how the hash–mark game works:

> I did not have a real strategy because I won the first time I thought I understood the game, but after that it went constantly wrong. (A6, session 8)

> Uneven when opponent did even. (A1, session 8)

The winners of the hash–mark game were immediately rewarded with four guilders, while the losers did not get anything. Putting in the effort for winning the hash–mark game is thus immediately rewarded, and does not undermine the possible egalitarian or entitlement position in the distribution game, where the players have to agree on distributing seven guilders (offering four guilders to the other and keeping three guilders yourself, or vice versa).

5.4.3 Association?

Many relations from figure 5–2 have been checked and could be removed, because there was no relation. To see whether players associate, that is, whether there is a relation between *HM result* and *Distribution alternative*, the following figure shows the remaining a priori relations that need to be analysed.

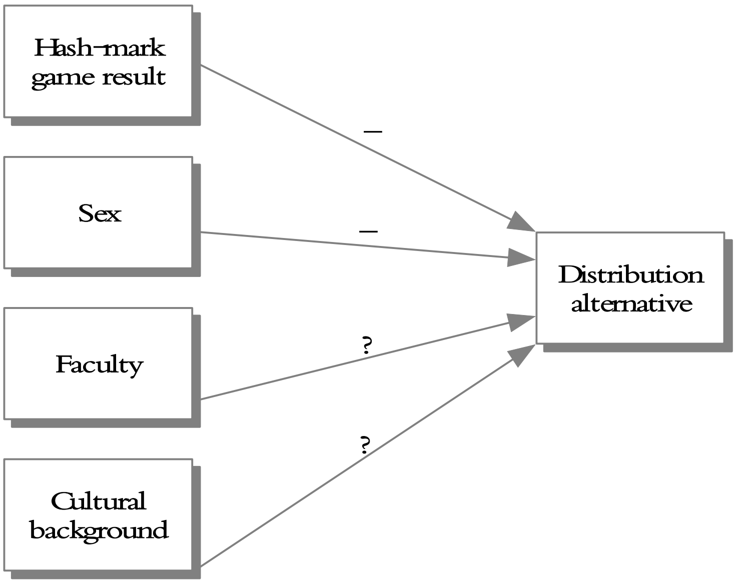

Figure 5–11 Remaining a priori relations between variables and distribution alternative

The relations between the respective variables *Faculty*, *Cultural background* and the variable *Distribution alternative* are not significant (see appendix D.3.4). The explanation in version 1 also applies here (see section 5.3.3). The results of the other variables are given in table 5–14.

Table 5–14 Correlations

		Distribution alternative
HM result	Pearson Correlation	−.208
	Sig. (1–tailed)	.001
	N	202
Sex	Pearson Correlation	−.097
	Sig. (1–tailed)	.084
	N	202

The relation between *Sex* and *Distribution alternative* is not significant at the 5 percent level, but it is significant at the ten percent level. However, at the 10 percent level the correlation is only very small (0.097), meaning that if one would use the 10 percent significance level (which is not used in the associative approach experiment) the relation between *Sex* and *Distribution alternative* is so weak that the relation can be neglected. The relation between *HM result* and *Distribution alternative* is significant at a 1 percent level. This means that the result of the hash–mark game, that is being a winner or loser, has a significant influence on the alternative chosen. The correlation is –0.208, which means that when the result of the hash–mark game goes up (that is from 0 for losing to 1 for winning) the other variable goes down (that is from alternative 2 to alternative 1)[86] by almost 21%. The associative approach implies that in this version the loser of the hash–mark game is more inclined to demand the larger share than the winner is, and vice versa. The correlation between the two variables confirms this. Again, to check whether the negligible influence of sex is really negligible a partial correlation between *HM result* and *Distribution alternative*, controlling for *Sex*, is run: the correlation is even stronger, namely −0.228, and stays significant at the 0.1 percent level, where n = 199.

The (egalitarian) association says that the player who won the hash–mark game, and already received a financial reward for winning it, should end up with the larger amount of money over the combination of the two games, and that for the distribution game the other player should receive the larger share so that in total the money is divided more equally, and vice versa for the loser of the hash–mark game. The result shows that the losers of the hash–mark game will choose the larger share almost 23% more than the winners, or, vice versa, the

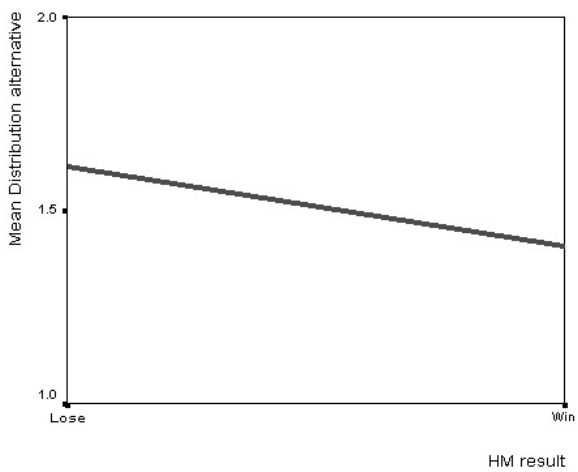

Figure 5–12 Correlation between HM result and Distribution alternative

[86] Alternative 1: You get fl. 3.– and your co–player fl. 4.–"; alternative 2: "You get fl. 4.– and your co–players gets fl. 3.–."

winners will choose the smaller share almost 23% more than the losers do, which supports the associative approach.

The only significant relation remaining after deleting all the insignificant relations is the following figure. That is, the two groups, winners and losers, behave differently when choosing an alternative: this is what the associative approach predicts.

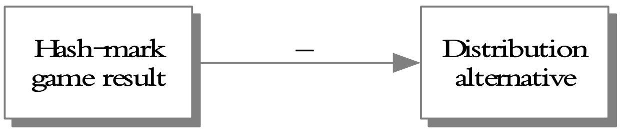

Figure 5–13 A posteriori relation in version 2

As said in the former chapter and section, analysing how much the choices made by the different groups deviate from traditional game theoretic predictions is also necessary, because it might be that one group behaves differently, while the other plays according to traditional game theoretic predictions. The following table shows the amount and percentages of participants who lost or won the hash–mark game and their respective alternatives chosen in the distribution game.

Table 5–15 Alternatives chosen based on losing/winning HM–game

			Distribution alternative		
			Alternative 1	Alternative 2	Total
HM result	Lose	Count	39	62	101
		% within HM result	38.6%	61.4%	100%
	Win	Count	60	41	101
		% within HM result	59.4%	40.6%	100%
Total		Count	99	103	202
		%within HM result	49.0%	51.0%	100%

The total percentages of the chosen alternatives in the experiment are similar to the expected average outcome of traditional game theory (i.e., approximately 43% will play alternative 1, and approximately 57% will play alternative 2). There is a 20.8% difference in choosing alternatives 1 or 2 for the group of losers compared to the winners (respectively 59.4% – 38.6%, and 61.4% – 40.6%). This difference in behaviour is already an indication that the behaviour of the two groups is deviating from traditional game theory (see the graphical representation of table 5–15 in figure 5–14).

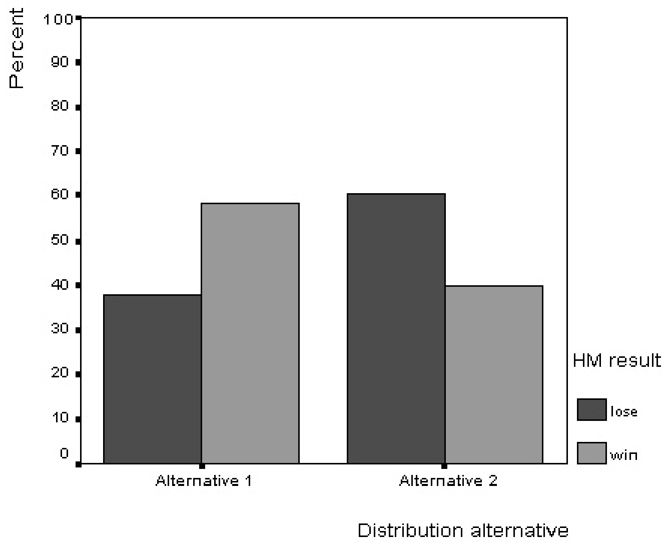

Figure 5−14 Percentages of losers/winners choosing alternative 1 or 2

To see whether this behaviour is significantly deviating from traditional game theory for the winners (losers) the following hypotheses will be tested:

H_0: Traditional game−theoretic prediction: $p_{W0} = 4/7$ ($p_{L0} = 4/7$)
H_1: Associative approach prediction: $p_{W1} << 4/7$ ($p_{L1} >> 4/7$)

To see whether the observed outcome of the experiment is significantly different from the outcome predicted by traditional game theory, the boundaries of the null hypotheses have to be calculated (see appendix D.3.5). The winners of the hash−mark game chose alternative 2 only 40.6% compared to the boundary of 49%. In other words, the frequency of winners choosing alternative 2 is outside the confidence area of the null hypothesis: the null hypothesis is rejected, and the alternative hypothesis accepted (even at the 1 percent significance level). Contrary to traditional game theory, the associative approach is able to explain the behaviour of the winners in the combination. The percentage of losers that chose alternative 2 is still within the boundary at a significance level of 5 percent, which means that the null hypothesis is maintained. The 5% difference between what traditional game theory and the associative approach predict about the behaviour of the losers is not large enough (or the experimental data is too small) to reject the null hypothesis.

Remarks of participants in the post−questionnaire and the comment slips of the experiment, make clear that some support the associative approach, and others support traditional game theory. Some examples:

> I choose in my advantage a lot (4 guilders for me), because I already performed lousy in the hash–mark game. (A3, session 6)
>
> If I won the hash–mark game, I choose to give myself fl. 3.–, if I lost fl. 4.–. (A7, session 9)
>
> My opinion was: I win → alternative 1 (i.e. fl.3.– for me)
> I lose → alternative 2 (i.e. fl 4.– for me)
> This was not the case with B5, B3 and B4 → quite illogical, I would say. (A5, session 6)
>
> I thought the opponents would always choose the higher amount. So I always chose the three guilders. (B4, session 6)
>
> Alternative 2 when opponent chose alternative 1 before. (A1, session 9)

A (hypothetical) reason for the difference between the behaviour of the losers and the winners, where the winners act according to the associative approach while the losers still act according to traditional game theory, can be that the winners are conscious of the four guilders they receive for winning the hash–mark game, while the losers only know this subconsciously. This consciousness about the reward for winning creates the 'feeling' for the winners that they should be 'nicer' to their opponent and ask the smaller share for themselves, and leave the larger to the opponent, i.e., the egalitarian principle. Because the losers are less conscious of the immediate reward to the winner of the hash–mark game they do not have this clue (extra information) in order to help them solve the problem at hand, and thus randomise between the two alternatives more than opting for alternative two.

5.4.4 Did they learn?

As before, it will be tested whether the participants were able to learn that the underlying convention could help them solve the distribution game. The following figure shows that the total group of participants did not learn that an association could help them in solving the distribution game (as in version 1, one session only had five stages, while in the other sessions there were six stages). The figure shows the average amount of possible associations subjects make in each stage.

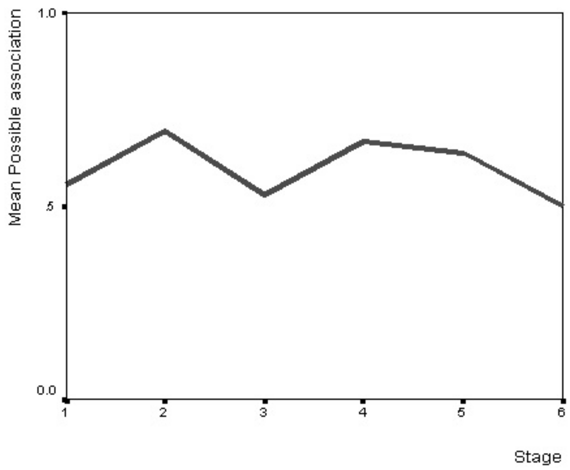

Figure 5–15 Association over the stages of all participants

Again, to check whether some individuals do make more associations in the process of play, the whole population has to be checked for whether each unique individual makes more associations over time (i.e., the different stages). In other words, the following hypotheses need to be tested:

H_0: To solve the distribution game subjects will use the entitlement association as much in every round.

H_1: To solve the distribution game subjects will use the entitlement association more in the course of repetition.

The test is one–sided because the alternative hypothesis is that the subjects deviate from the null hypothesis in one direction, that is, they make more associations, not less.

Table 5–16 Learning the possible association

Controlling for unique player		Possible association
Stage	Partial Correlation	–.000
	Sig. (1–tailed)	.498
	N	199

The results in the table show that the subjects did not start using the possible association more during play. The null hypothesis is maintained.

5.4.5 Is the association rewarding?

Traditional game theory predicts that on average players in the distribution game will in 57% of the cases select the higher share and for 43% the lower share. The following table shows the fractions for the different possible outcomes in the distribution game, according to traditional game theory.

Table 5−17 Fractions of outcomes

		Winner Alt. 1	Winner Alt. 2
Loser	Alt. 1	0.184	0.245
	Alt. 2	0.245	0.327

Following from the table, traditional game theory predicts that in 49% of the cases the players will match their offers, and in 51% of the cases they will not match. Although the subject pool in the experiment consists of a lot of "non−associating" players, there still are some "associating" players. The interaction between associating players with other players and amongst themselves might have created a higher payoff to the players compared to traditional game theoretic predictions for the whole population. Table 5−18 shows the frequencies of the different payoffs generated in the distribution game.

Table 5−18 Fractions of outcomes (experiment)

		Winner Alt. 1	Winner Alt. 2
Loser	Alt. 1	0.208	0.178
	Alt. 2	0.386	0.228

In 56% of the cases the participants were able to match their offers (as in version 1 most matches are in the equilibrium based on the relevant association), and in 44% they did not match their offers. The actual average money reward in the experiment is 1.98 guilders, which is almost 30 cents higher than the average payoff predicted by traditional game theory. To check whether or not the average payoff generated in this subject pool is better than traditional game theory would predict the following hypotheses have to be tested.

H_0: Traditional game theory expects a payoff of 1.7 guilders, because there is 49% chance of matching; in other words, $p_0 = 0.49$.

H_1: Associative approach expects the payoff to be higher than 1.7 guilders, because the expected percentage of matching is higher; in other words, $p_1 >> 0.49$.

To check whether the 56% matching in the experiment is outside the boundary to be able to reject the null hypothesis, again a 5 percent significance level will be used.

$$P(p_1 > g \mid p_0 = 0.49) = 0.05 \quad \rightarrow \quad g \approx 0.5478$$

The actual matching result of the experiment is 0.562. This is higher than the boundary, in other words, the null hypothesis can be rejected. Again, the substantial amount of associating players in the subject pool helps all the players in the subject pool create a higher payoff.[87]

5.5 Overview experiment and implications

In this chapter the data generated by the associative approach experiment has been analysed. There are two different versions in the experiment, namely a version in which there is no payment for playing the hash–mark game, and a second version where there is a four guilder reward for the winner of the hash–mark game. The second game that is played in the combination of hash–mark and distribution game is also different for the two versions because of the financial reward in the first game. In version one the participants have to agree on dividing ten guilders, i.e., a split of three and seven guilders. In the second version the subjects have to choose alternatives that split up seven guilders, i.e., a split of three or four guilders.

5.5.1 Summary version 1

This version in the experiment is set–up in such a way that the participants can make a connection between the first game, that is the hash–mark game, and the second game, that is a distribution game, without making the connection obvious to the players. The external information generated by the (play of the) hash–mark game is that there is always a winner and a loser. When the subjects see there is information from the first game that they can use to help them solve the second game they can make an entitlement association, which means that they see the winner of the hash–mark game as being entitled to the larger share of the distribution game, and hence the loser to the smaller share. Traditional game theory is not able to make a distinction between the loser and the winner of the hash–mark game when they play the distribution game: both players are the same.

Data generated by the experiment is tested for all sorts of relations. It turns out that all the variables expected to be independent, such as *Sex*, *Faculty*, *Cultural background*, and *Risk–averse behaviour*, are indeed independent and have no influence on either the play of the hash–mark game or the choices made in the distribution game. The hash–mark game is a game where the player that

[87] Is the matching in the 'egalitarian' cell significantly higher than traditional game theory predicts? The boundary for the result to be in the confidence areas of 5% is 0,2948 (see appendix D.3.8); so it is significantly higher (even at a 1% significance level). In other words, traditional game theory cannot explain the result of the experiment in that particular cell, which the associative approach is able to explain.

starts the game can always win, and the player that goes second can only win if the starting player makes a mistake. It is relevant for the associative approach that the participants feel that the winner is entitled to the larger share, and the loser to the smaller. Hence, the resulting positions of loser and winner have to be realised through the effort of the participants, not by the fact that they are randomly assigned as the starting player. It turns out that the subjects are not constantly able to win the hash–mark game when they start. Even over the play stages of the experiment, the subjects do not figure out how to win the hash–mark game when they start. In other words, the winner of the hash–mark game is indeed recognised as having put in the effort to win, that is, the winner is not generated by the random device assigning the starting players and just mere unwinding of logical structure.

The analyses of the data show that the participants do make an association between the two games. They incorporate the information of the first game, the fact that there is a loser and a winner, into the play of the second. The null hypothesis, which says that the players of the distribution game behave according to traditional game theory, is rejected by the data. It turns out that the alternative hypothesis, which states that players make an (entitlement) association between the games (i.e., v_1 is 1 or close to 1, while v_2 is small or 0), is accepted as the explanation of the behaviour of the subjects. In other words, the associative approach is able to explain the behaviour of the participants.

It is also checked whether the participants learned through the different stages in the experiment. That is, do the participants make an association more in the later stages than in the first stages? The result is that the subjects make, by and large, the same amount of associations in the beginning as at the end. In other words, the subjects do not learn over time. One can say that the Lockean principle of distributive justice is inherent in (some) people, and that these people make the entitlement association. This means, by and large, that people who do not have this principle in their vocabulary do not learn that the external information from the first game and the underlying convention can help them solve the problem at hand. On the other hand, when participants have mismatched in the beginning stages they want to make up in the later stages and always ask the larger share and thus reject using the information from the hash–mark game.

The total amount of money the subjects generate in the experiment is significantly higher than the outcome expected by traditional game theory. In other words, because the participants are able to incorporate external information from the first game into the play of the second, as a whole they are able to do 'better' than expected by traditional game theory, because the external information creates asymmetry in the distribution game. The associative approach is supported by this outcome, because the approach says that players that are able to make an association will be able to earn more, because of the 'common focal point'.

5.5.2 Summary version 2

In version 2 the winner of the hash–mark game is immediately rewarded for putting in the effort. After the hash–mark game the distribution game is played against the same opponent. The participants can make many associations between the two games, but the most obvious one would be an egalitarian association, i.e., the winner of the hash–mark game, who is already rewarded, gets the smaller share in the distribution game (three guilders) and the loser the larger share (four guilders). This means that the winner in total receives seven guilders, compared to four guilders for the loser. In other words, the winner of the hash–mark game will still earn more overall, because he has put in more effort, but the earnings will be equalised as much as possible. Again traditional game theory is not able to make a distinction between the loser and the winner of the hash–mark game; it predicts that they behave in the same way.

As in version 1, the variables expected to be independent are indeed independent and do not have any influence on the play of the two games. These variables are thus left out in the rest of the analysis. The participants in version 2[88] do not know how to win the hash–mark game beforehand. The starting position does not have any influence on the result of the hash–mark game for these participants. Hence, the players consider the reward for the winner of the hash–mark game fair. During the process of play, the subjects did not learn how to play the hash–mark game any better.

The data generated in this version points in both the direction of the associative approach and the direction of traditional game theory. There is a significant difference between the behaviour of losers and winners, which supports the associative approach. The behaviour of the winners of the hash–mark significantly deviates from what traditional game theory expects. The winners claim the smaller share in the distribution game a lot more than what traditional game theory predicts. In other words, traditional game theory is not able to explain the behaviour of the winners, while the associative approach is. However, the behaviour of the losers is still in line with traditional game theory. The deviation from traditional game theoretic prediction of the behaviour of the

[88] Session 7 is excluded from the data, because participants in this session had been talking to other participants and knew the rules of the hash–mark game, as well as the instructions of version 1 and acted accordingly until they found out this was a different version.

losers is too small to reject the null hypothesis. Hence, traditional game theory is able to explain the behaviour.

The difference between the behaviour of winners and losers may be explained by the idea that winners are more aware of the immediate financial reward for winning the hash–mark game than the losers, and thus perceive the information of the hash–mark game differently. That is, for the winner the availability of the egalitarian association is large (v_1 close to 1 or 1), while the availability of the entitlement association is small (v_2 close to 0 or 0). It may be that the losers act according to traditional game theory. However, another explanation may be that the losers as a group act on two different conflicting associations. One part may act according to the egalitarian association, in other words, the availability of the egalitarian association is large, while the availability of the entitlement association is small. The other part may act on the entitlement association, because they are less aware of the immediate reward for winning the hash–mark game, i.e., v_1 is large and v_2 is small (or at least smaller than v_1, otherwise the loser would act according to the egalitarian association). The aggregate result might be the same as the behaviour predicted by traditional game theory.

It is again checked whether the participants learned through the different stages in the experiment. As it turns out the subjects do not learn over time. That is, on average they make the same amount of associations in the beginning as in the end.

Even though not all participants make the egalitarian association, the total money amount generated in this version is significantly higher than the outcome expected by traditional game theory. That is, the group of associating players help make the total financial earnings higher than when all participants would behave as expected by traditional game theory. Again the associative approach is supported by this outcome, because the approach says that players that are able to make an association will be able to earn more.

5.5.3 Implications and future work

The whole experiment supports the associative approach: in both versions the theory of players making associations between different games is supported.

There are still some differences between the two versions: in the first version some comments of participants make clear that some participants did think about the possible association, but did not want to use it. In other words, these subjects support the idea of the associative approach that players make associations, without showing it in the experimental data. These participants wanted the larger share for the first couple of stages. After three or four stages they figured out that they possibly have a higher chance of matching in the distribution game by making an association between the two games. However, after these three or four stages they wanted to make up for the losses they had made in the first stages because of the mismatching, and they ask for the larger share. The result is that these subjects do learn that there is external information in the form of an association that can assist them, but do not use it when they are the loser of the hash–mark game because they want to make up for the money forgone in the first stages. In other words, the difference in payoff, seven compared to three guilders, is so large that they rather not gain three guilders if they have a chance of getting seven. The second version has different results than version 1. The difference between the three and four guilders in the distribution game is so small, that many participants, especially losers of the hash–mark game, offer the larger share to the winner. They may feel they do not give up a lot of money by settling for the smaller share. Also it might be that, despite the financial reward for winning the hash–mark game, they still feel they are 'lesser' players and should settle for less.

To see whether greediness is a factor or how different rules of thumb are used, other experiments have to be conducted. A possibility may be to set–up an experiment in such a way that the effects of large and small payoff differences between alternatives can be compared. It might be that players are more inclined to use an association if they do not have to make up for large forgone income, when the difference in payoff is smaller. To test the differences in perceptions of players as to what is fair, an experiment in line with Zizzo and Oswald (2001) can be set–up. In this set–up the subjects are given the opportunity to 'redistribute' or destroy money of the opponent after the distribution game. When the players have matched following an association, do they 'burn' less money compared to when money has been earned in an 'unfair' way? It is very probable that participants will leave most of the distribution intact when it is based on associative behaviour, while they will be more likely to destroy some money of the opponent if they feel the distribution is not fair; according to the player the opponent is not entitled. All the different questions that can be raised need to be tested in the form of new experiments, because until this moment they can only be answered hypothetically.

The validity of the associative approach has become apparent in this experiment. However, what happens if the set–up is changed to different games in combinations, or what happens if the combination is extended to more than two games? In Appendix A all 2×2 symmetric games are listed, among which many different combinations (of two games) are possible. Not all combinations of two games are meaningful, however. A very rudimentary check is done to see what combinations of two games have the potential for players trying to solve the last game in the combination based on information extracted from the first. From the rudimentary check it becomes obvious that especially coordination, hawk–dove, battle–of–the–sexes, and stag–hunt games can be used in future experiments, because all these games have the characteristic of players trying to coordinate or match their behaviour. People playing these games in combination are eager to find external information in order to help them solve the second game, and a first game can be essential for this information. It is very interesting to see whether the associative approach is applicable in other combinations, but also to see whether it is applicable when the combinations are extended to more than two games.

The first pilot of the associative approach run with colleagues at the Erasmus Institute for Philosophy and Economics shows that players with a different cultural background can make different associations than players from the Netherlands. The conventions that are rooted in different cultures create different ways of incorporating external information, in other words, external information triggers different behaviour because of different conventions. In order to see how applicable and robust the associative approach is, it needs to be tested in other countries. It is even an interesting idea to see what would happen if two different groups of participants were to play against each other without knowing that the others are from completely different cultures.

CHAPTER 6

CONCLUSIONS AND DISCUSSION

6.1 Introduction

In this chapter the conclusions of the study on association between games will be drawn. The initial motivation of this thesis is to contribute to the explanation of social interaction phenomena so far unexplained, or not properly explained, by existing theories, especially the interactions between two individuals playing different games. In the associative approach it is assumed that players use readily available information from a previous different game to help them solve the problem at hand. The associative approach as developed throughout this thesis tries to model and analyse people playing different games with each other. There are three main questions related to the development of the associative approach: In existing literature, where should the idea of players playing different games in combination be positioned? What kind of approach needs to be built in order to explain behaviour of individuals playing different games in combination, and what theories can assist in this? Is there any empirical support for the associative approach?

In section 6.2 the research questions will be answered while giving a short recapitulation of what has been done in this thesis. After showing what has been done in this thesis, it is pointed out what still needs to be done, or what can contribute to make the associative approach an even better model at explaining certain human behaviour in interaction situations. First, it will be discussed in section 6.3 what the contribution of the associative approach is, or can be, to the social sciences. Then some problems that most new theories or approaches have to deal with will be discussed. The suggestions for future work or research are given in section 6.4, in order to show how the associative approach can be refined to make the approach more applicable or to make it better at explaining behaviour in strategic interactions. An overall conclusion will end the chapter.

6.2 Recapitulation and research conclusions

The starting point of analysis is the experiment conducted by Hoffman and Spitzer (1985). To test fairness behaviour of the participants they have set–up their experiment in such a way that two games are played after each other. In this set–up subjects behaved differently in the second game based on information from the first game. Traditional game theory is not able to explain the behaviour observed in their experiment, because it does not incorporate external information into its framework. Other theories discussed all have in common that they do incorporate other information into the game at hand. The external information creates focal points for the players in the games, that is, the focal point makes one equilibrium or strategy more salient than others. Because all players know this and they know all players know it (common knowledge) they will play the salient strategy resulting in a higher possibility of coordinating than traditional game theory predicts. The associative approach also deals with incorporation of external information, but extends the idea to information coming from a different game played before the game at hand, which the players incorporate in order to help them solve the latter. Given conventions rooted in society players perceive the same sort of information from the preceding game, which they then incorporate into their perception of the game at hand. The idea of conventions and analogies playing a role in the perceptions of players is analysed by many scientists. The second chapter gives an overview. The chapter shows that the associative idea is a new idea that can be positioned in the game theoretic literature that deals with focal points, external information, conventions, and different perceptions of players.

Chapter 3 shows how the idea of association between games can be formalised by first explaining the theories of both Bacharach (1993) and Janssen (2001), and then showing which parts of their theories are incorporated into the formal framework of the associative approach. The key idea of Bacharach and Janssen is that "different labels attached to strategies induce asymmetries between the strategies and that players can use these in a rational way" (Janssen, 2001; p.120). The associations that players make between games induce asymmetries between strategies. The formalisation process is illustrated by showing how the observed behaviour in the Hoffman and Spitzer experiment can be analysed within the new framework. In other words, the third chapter is dedicated to answering research question 2: What theoretical and/or formal framework needs to be built in order to explain behaviour of individuals playing different games in combination, and what theories can assist in this?

One of the key ideas in this chapter is that players from a shared background (unconsciously) think of each other having on average the same sort of possible associations. The different associations that players can make, based on the information from the first game, are said to be in the frame of the players. Given the frames players have when entering the second game, they can think of the other player having part of their frame or the same frame. That is, in the perception of this player the possible associations that he can think of may all be in the frame of the other player as well, or the other player can have a subset of all associations in his frame. Players have beliefs about the conditional probabilities of the associations in the other player's frame. However, the availabilities and the conditional probabilities are (almost) similar when players come from a shared culture. When the players do have the same ideas about each other the chance of coordinating their behaviour in the interaction is bigger than traditional game theory predicts.

As the approach is developed throughout the thesis the main question that remains unanswered is whether or not it has any empirical support. Is the associative approach able to explain human behaviour any better than other theories, or is it even able to explain human behaviour at all? To be able to test whether or not a new theory has any explanatory value, or any predictive value, the theory has to be empirically tested. In other words, the research question remaining is research question three: Is there any empirical validation for the associative approach? In chapter 4 the design of the experiment is discussed by showing how an experiment should be set–up[89] in order to minimise the chance of contaminated results. The behaviour observed in the Hoffman and Spitzer experiment is the basis for the associative approach experiment designed in the fourth chapter. In the experiment the participants play two games in one combination against five or six different opponents. The first game in the combination is the hash–mark game, which always ends up with one loser and one winner, and the second game in the combination is a distribution game. Two different versions are designed for the experiment to be able to test whether participants make different associations depending on the information they perceive from the first game.

In chapter five the data generated by the associative approach experiment is analysed. The results of both versions in the experiment support the associative approach. There is a difference between the two versions though: the first version completely rejects the hypothesis that traditional game theory can explain the behaviour observed in the experiment in all different (sub)analyses, while the second version rejects traditional game theory in some (sub)analyses but not in all. However, the data supports the associative approach in both versions of the experiment: it is better at explaining the behavioural differences of the loser and

[89] As described by Friedman and Sunder (1994), Smith (1987), and Starmer (1999); see them for rules on setting up experiments (in economics).

the winners of the hash–mark game than traditional game theory. In other words, the associative approach is proven to be able to explain phenomena in the empirical (controlled) world.

6.3 Contribution of the associative approach

Traditional game theory is only capable of analysing one–shot games, repeated games, or sequential move games. People in real life interact much more than just one time; one–shot games are thus applicable in only a small number of cases. The people that interact, however, do not constantly play the same game over and over: they play different games mixed through each other. In other words, the applicability of repeated game analysis is small. What kind of framework is capable of explaining the behaviour of individuals interacting many times, but playing different games? It is too bold to say that the associative approach is the answer. However, the associative approach is able to explain at least a small fraction of the behaviour of individuals who play different games against each other, given the defined possible associations. In this thesis, the idea of the associative approach is shown. Furthermore, a formal framework is created to make the idea of the associative approach suitable for testing on empirical data. The approach is then confronted with the data generated by the experiment. As it turns out, the associative approach is able to explain the behaviour of the individuals interacting in the experiment.

One can say that the associative approach creates new insights into the possible explanation of human interactions. For the associative approach to become a fundamental explanatory theory, many more theories have to be looked into to check for their possible contribution to the theoretical framework of the associative approach, and the approach has to be checked by means of more experiments with different set–ups, different games in combinations, different amounts of games, different cultures, and many other factors. Some of the possible contributions and experiments will be discussed in the next section on future work.

Objections against new theories and their ways of testing can always be raised, and it is not different for the associative approach. But people making objections or having reservations about new theories are thinking about the subject matter. That is, people start conjecturing about the unexplained observations from which this study originated. That means that even if the scientific community would reject the associative approach, it does contribute to this specific community by making people aware of the lacking explanatory capacity of traditional game theory.

6.4 Future work

As has been indicated throughout the whole dissertation a lot of work still needs to be done, because the associative approach is only the first step on a long road. There are both theoretical and empirical exercises that have to be done, before there is a fundamental and robust theory able to explain (abstractly modelled) behaviour of individuals playing different games.

6.4.1 Theoretical

In chapter two the ideas of Young (1993, 1996) were introduced. The idea of human beings having limited cognitive capacities is implicitly assumed in the associative approach. That is, when playing a game people look at the easy way out, which can be provided by information from a different game that is played before the game at hand: their limited cognitive capacity creates the idea that the information from the previous game in the combination can have more importance than say the same (or very similar) game they played a week before. Young has a nice (formal) theory on how to model the behaviour of individuals that have limited cognitive capacities. These players sample from their memory and use that information to solve the problem at hand. The idea of Young may very well create value added for the associative approach. The incorporation of the idea is not that simple however, and should be thoroughly thought through before the complexity of adding the idea outweighs the benefits of a simpler associative approach.

The associative approach can borrow insights from other social sciences, and then especially anthropology. These insights can give more clarification on how the possible associations can be defined, because these theories are better equipped at defining underlying conventions. Cultural differences are not explained in the associative approach, they are assumed present and influencing the associations players make and thus their behaviour. Furthermore there are some inconclusive areas in the framework of the associative approach (see figure 4−1 and figure 4−2 for instance). Social sciences might help in rendering these areas less inconclusive by giving insight in the use of associations. The associative approach might be better at explaining the behaviour of individuals in social interactions if there is more knowledge about the prominent conventions or cultural background of these individuals.

Other refinements are both theoretical and empirical, and are mentioned here shortly and in more detail in the next section. A refinement is extending the approach by looking at more than just two games in combinations. The extension to more games can then also test whether repeated games have more influence than associated games, because in a sequence of several games a certain game can be repeated. This will be discussed in the future work section on an empirical level. Yet another refinement is extending the theory to explain behaviour in more than two player games. What happens if individuals play a game within a group and after that only two individuals of that group play a game? Or vice versa, does the behaviour of two individuals differ after having played a game amongst themselves, and then later in a group? Yet another refinement can be by looking at more than just 2×2 games. What are the associations people can make between, for instance, a combination of a 2×2 game and a 3×3 game, and what are the consequences? All these questions remain unanswered in this study, but are definitely worth looking at.

6.4.2 Empirical

Before all the possible theoretical refinements should be considered, the associative approach itself should be tested in more experiments to see its applicability and its explanatory capacity. In the conclusion of chapter 5 some suggestions for different set–ups of experiments were already discussed and will thus only be shortly mentioned here again.

An experiment closely related to the experiment conducted in this study is one that would test how perceptions of fairness influence the behaviour of the participants. The participants get the opportunity to redistribute or destroy money after having played the distribution game. The difference between 'burning' amounts for the version where the distribution was done on association should then be compared with a version where the distribution is done by, for instance, the experimenter. If there are (major) differences in burning amounts this may mean that the associations players make between the games have an influence on the perception of the last game. This experiment could thus emphasise the explanatory value of the associative approach.

Another possible experiment, as mentioned before, is related to how different games in combination are played. Given all the possible 2×2 symmetric games (see Appendix A) there are many different combinations possible. To see what the robustness or explanatory power of the associative approach is many more tests of different 2×2 symmetric games should be conducted. Extending the amount of games in combination that participants play to more than two is yet another possibility to test the explanatory capacity of the associative approach, or extending it to more than two–player games. However, as mentioned in the former section, the associative approach is not yet capable of incorporating games of more than two players or more than two games in a combination.

Another experiment that can (should) be conducted is an experiment set–up in other countries, because, as has become apparent in the study, culture or conventions play an important role for the associations players make. Other countries, especially non–western countries, have different customs and different conventions compared to the Dutch culture. Hence, the associations players make in such an experiment will be different. To see whether the associative approach is also capable of explaining the behaviour where different conventions are rooted in society, experiments in other countries have to be conducted. As said in the former chapter, it is also interesting to see what would happen if two different groups of participants were to play against each other knowing and/or not knowing that the others are from completely different cultures.

Overall it is obvious that the associative approach is so far only verified in a small set of two games in combination in the Dutch culture, and that many more experiments should be conducted.

6.5 Overall conclusion

The associative approach developed in this thesis has proven its validity in explaining behaviour in interaction that is overlooked or unexplained by existing game theory. That is, the associative approach is able to explain the observed in the experiment conducted in this thesis. The approach is rooted in existing theories, but combines and extends them and is thus able to take a step further in explaining behaviour. Many more refinements in the theory and conducting of experiments are needed, but the associative approach looks like a promising start.

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APPENDIX A

2×2 (SYMMETRIC) GAMES

A.1 Introduction

According to Rapaport and Guyer (1966; p. 204) there are 78 different 2×2 games. However, many of them are not symmetric, and as such have not been studied and analysed frequently. For a general overview of all possible 2×2 games see Rapaport and Guyer (1966). In this appendix a general overview of 2×2 symmetric games will be given, which have been analysed and studied a lot through the years. So far no general overview of all the different 2×2 symmetric games has been given. In order to find a proper set−up for the associative approach experiment all different kinds of combinations between the 2×2 symmetric games have been checked. Many combinations look promising, even though the associative experiment opts for a different combination of games. An overview of all 2×2 symmetric games is useful, because many other combinations can be used to test the associative approach. If possible the original story and/or layout for a certain game will be maintained. The Nash equilibrium will be given to show the standard/traditional game−theoretic solution to these games:

> "The pair (s, t) is a Nash equilibrium if s is the optimal choice for a player I who knows that player II will choose t: simultaneously, t must be an optimal choice for a player II who knows that player I will choose s. In other words, each of the pure strategies in the pair (s, t) must be a best reply to the other." (Binmore, 1992; p.47).

A.2 Games with two players having dominant strategies

A.2.1 No−conflict games

The simplest 2×2 symmetric games (in the line of Rapaport and Guyer (1966)) are games in which both players have a dominant strategy, and in which there is no conflict. That is both players end up with the highest payoff (*d*, *d*), which they prefer most, if they both play their dominant strategy.

Table A−1 No−conflict games

		Column player	
		C_1	C_2
Row player	R_1	(d ; d)	(c ; b)
	R_2	(b ; c)	(a ; a)

The important preference orderings are:

- d > b
- d > c
- c > a

In this game both the column and row player have a dominant strategy to play C_1 and R_1, respectively, i.e., no matter what the other player does it is always a best response to play either C_1 for the column player or R_1 for the row player.

A.2.2 Games with strongly stable equilibria

The next simplest games are games in which both the column and the row player have a dominant strategy, but the outcome which is generated by both playing this strategy is the second best outcome, that is (*d*, *d*). However, there is no way out of this equilibrium: if either one player changes to a dominated strategy he will get less, while the other player gets the most preferred payoff, but there is no way that a player can force the other into diverting from his dominant strategy.

Table A−2 Games with strongly stable equilibria

		Column player	
		C_1	C_2
Row player	R_1	(d ; d)	(c ; b)
	R_2	(b ; c)	(a ; a)

The important preference orderings are:

- c > a
- c > d
- d > b

A.3 Coordination games

In the two−person coordination game each player has the same number of actions, which can be indexed so that it is a strict Nash equilibrium for the players to play the actions having the same index. In other words, the action of the players are indexed $j = 1, 2, \ldots m$, and let the payoff from playing the pair of actions with indices (j, k) be a_{jk} for the row player and b_{jk} for the column player. In the general coordination game, $a_{jj} > a_{kj}$ and $b_{jj} > b_{jk}$ for every distinct pair of indices j and k. Both a_{jk} and b_{jk} are larger than (or equal) to 0. Thus in the 2×2 game $a_{11} > a_{21}$ and $a_{22} > a_{12}$ for the row player, and $b_{11} > b_{12}$ and $b_{22} > b_{21}$ for the column player. (Young, 1998; p.40)

Table A–3 Coordination game

		Column player	
		C_1	C_2
Row player	R_1	(a_{11} ; b_{11})	(a_{12} ; b_{12})
	R_2	(a_{21} ; b_{21})	(a_{22} ; b_{22})

The important requirements are:

- $a_{11} > a_{21}$
- $a_{22} > a_{12}$
- $b_{11} > b_{12}$
- $b_{22} > b_{21}$

Both players in a coordination game do not know on which of the two strict Nash equilibria the other player is going to coordinate. Given the information available to both players they will both mix their strategies in order to try to coordinate on either of the two equilibria. Neither player has a good reason to prefer one of their strategies from the other since both are potential Nash equilibrium strategies.

> Mixed strategy behaviour may sound bizarre, but it is potentially an extremely useful additional type of behaviour because it both provides an alternative way of resolving situations where there is more than one plausible solution (e.g. multiple Nash equilibria) and it suggests a solution for games in which no actual (that is, pure) strategies correspond to a Nash equilibrium. (Hargreaves Heap and Varoufakis, 1995; p.70)

In the coordination game the mixed Nash equilibrium is for the row player (column player) to randomise between strategy R_1 and R_2 (C_1 and C_2) with probability p (q) in which both players are indifferent between the two possible strategies. The requirements are:

$$a_{11}q + a_{12}(1 - q) = a_{21}q + a_{22}(1 - q)$$
$$b_{11}p + b_{21}(1 - p) = b_{12}p + b_{22}(1 - p)$$

$$q = \frac{a_{22} - a_{12}}{a_{11} - a_{12} - a_{21} + a_{22}} \quad \text{and} \quad (1-q) = \frac{a_{11} - a_{21}}{a_{11} - a_{12} - a_{21} + a_{22}}$$

and $p = \dfrac{b_{22} - b_{21}}{b_{11} - b_{12} - b_{21} + b_{22}}$ and $(1 - p) = \dfrac{b_{11} - b_{12}}{b_{11} - b_{12} - b_{21} + b_{22}}$.

The expected payoff in this mixed equilibrium is:

$$\pi_{ex} = \frac{a_{11}a_{22} - a_{12}a_{21}}{a_{11} - a_{12} - a_{21} + a_{22}} \left(= \frac{b_{11}b_{22} - b_{12}b_{21}}{b_{11} - b_{12} - b_{21} + b_{22}} \right).$$

The pure coordination game is a special case of the general coordination game. The Nash equilibrium is the same; that is, if both players play the actions having the same index they play the strict Nash equilibrium. If they don't play the actions having the same index the outcome is zero. The same conditions for the general coordination game count here as well. The conditions are always fulfilled, however, because a_{jj} and b_{jj} are both larger than 0. For a nice and famous introduction into several coordination games, and the focal point approach of it, see Schelling's *The Strategy of Conflict* (1960).

Table A–4 Pure coordination game

		Column player	
		C_1	C_2
Row player	R_1	(a_{11} ; b_{11})	(0 ; 0)
	R_2	(0 ; 0)	(a_{22} ; b_{22})

The mixed equilibrium strategies are simplified because $a_{12} = a_{12} = b_{12} = b_{21} = 0$, i.e.,

$$q = \frac{a_{22}}{a_{11} + a_{22}} \text{ and } p = \frac{b_{22}}{b_{11} + b_{22}}.$$

The expected payoff in this mixed equilibrium is:

$$\pi_{ex} = \frac{a_{11}a_{22}}{a_{11} + a_{22}} \left(= \frac{b_{11}b_{22}}{b_{11} + b_{22}} \right).$$

A.4 Hawk–Dove games

V is a resource of value for which two animals are contesting. What is meant by value is the Darwinian fitness of an individual obtaining the resource would be increased by $V > 0$. The individual that does not obtain the resource need not have zero fitness. V is the gain in fitness to the winner, and the losers do not have zero fitness. There are two strategies: 1) *Hawk*, escalate and continue until injured or until opponent retreats; and 2) *Dove*, display; retreat at once if opponent escalates. An animal that displays does not injure its opponent; one that escalates may succeed in doing so. An animal that retreats abandons the resource to its opponent. Injury reduces fitness by a cost, $C > 0$. (Maynard Smith, 1982; pp.11–12)

Table A–5 Hawk–dove game

		Column player	
		Dove	Hawk
Row player	Dove	(V/2 ; V/2)	(0 ; V)
	Hawk	(V ; 0)	(½V–C ; ½V–C)

Requirements:

- $V > 0$
- $C \geq 0$

If $\frac{1}{2}V \geq C$ the dominant strategy for both players is to play *hawk*, because playing *hawk* always gives a higher payoff no matter what the other player plays. In other words, the Nash equilibrium for this game is (*hawk*, *hawk*) in which the expected payoff for both players is $\frac{1}{2}V - C$. This equilibrium is Pareto inefficient, because if both players would be able to coordinate on the (*dove*, *dove*) equilibrium, both of them would receive a higher payoff, that is $V/2$. The problem in this case is then that it improves the payoff of one player by changing his/her strategy to *hawk*. That is, in a one shot game the equilibrium of (*dove*, *dove*) is unsustainable[90].

A special case of the hawk–dove game is a game in which $\frac{1}{2}V < C$. The game known in this category is called the chicken game. The thought behind this game is that two cars are driving towards each other. The idea is to drive on straight and the other should swerve his car away from a collision. The opponent is trying to reach the same goal as you. If both do not try to avoid each other and continue to go straight ahead, a collision is unavoidable, and both will have injuries. If both behave as chickens, that is, turn the steering wheel to avoid a collision, they are embarrassed but they do not have an injury, which they prefer to a collision. They prefer most, however, that the other player is a chicken and

[90] The prisoner's dilemma game can also be seen as a Hawk–dove game. But given the small difference in the restriction on the payoffs and the fact that the prisoner's dilemma game leads a life of its own, without any reference to the Hawk–dove game, the prisoner's dilemma game will be dealt with in a separate section.

oneself is not. (For a illustration with numbered payoffs see Binmore (1994); pp.97–98).

The chicken game has two Nash equilibria in pure strategies: (*hawk*, *dove*) and (*dove*, *hawk*). In many games the amount of Nash equilibria are odd. This applies to the chicken game as well. There is also a Nash equilibrium in mixed strategies. The strategic advantage of mixing strategies is that of being unpredictable. When the other player knows exactly which strategy you are going to play, she will choose her best reply, which leaves you with a payoff of zero. When a player mixes his strategies, the best reply for the other player is to mix her strategies as well. To find the Nash equilibrium in mixed strategies in 'chicken', one needs to look at the probability, p (q), that makes the row player (column player) indifferent between *Hawk* or *Dove*. In the chicken game the requirements generate the following equations:

$$V/2(1-p) + 0p = V(1-p) + (\tfrac{1}{2}V - C)p,$$
$$V/2(1-q) + 0q = V(1-q) + (\tfrac{1}{2}V - C)q.$$

The solution for these equations is $p = q = \dfrac{V}{2C}$,

and the belonging expected payoffs for both players:

$$\pi_{ex} = \frac{V}{2} - \frac{V^2}{4C}.$$

A.5 Battle–of–the–sexes game

In the original game called battle–of–the–sexes (BOS) it is assumed there is a couple that is making a decision on how to spend an evening. The husband wants to attend a boxing match and the wife wants to go to the ballet. Going together to one of the two options is preferred by both compared to each going their separate ways. The game is a representation of many situations in which people try to coordinate their action, although they have conflicting preferences concerning which way to coordinate (see, for example, Kreps, 1990; p.40). After removing the labels for both boxing and ballet and husband and wife, the following general payoff matrix can be given, depicted in table a–6, where $x > y > 0$.

Table A–6 General payoff matrix for battle–of–the–sexes

	Column player	
	C_1	C_2

Row player	R_1	(0 ; 0)	(y ; x)
	R_2	(x ; y)	(0 ; 0)

Requirements:

- $x > 0$
- $y > 0$

In this game there are two Nash equilibria, (R1, C2) and (R2, C1), and there is a symmetric mixed strategy equilibrium with $p_1 = x/(x + y)$ and $p_2 = y/(x + y)$, where p_i denotes the probability of playing the ith strategy. In an existential game, in which we cannot discriminate between the players without referring to the index numbers given to players or strategies (see, Sugden, 1995a; pp.536–537), the game theoretical prediction of the average behaviour of a population is the mixed strategy. The expected payoff in this equilibrium is $xy/(x + y)$. Given that the expected payoff for the mixed strategy equilibrium is less than the minimum payoff in either pure strategy equilibria, players can improve their expected payoffs if they can coordinate on either one of the two pure–strategy equilibria.

The story is pretty old, that is why the story will now be considered sexist, but it does illustrate the point of the battle–of–the–sexes game as depicted in table a–6; that is, "one cannot identify either of the two Nash equilibria as the solution of the game given the circumstances of the story. Any argument in favour of one is equally an argument in favour of the other" (Binmore, 1994; p.141). Again Schelling (1960) has argued that the expected payoffs can be improved upon if there exists extra contextual information about the game.

A.6 Prisoner's dilemma

> When Albert Tucker first wrote about this most famous of all 'toy games', he could have had no idea of the immense literature he was initiating. Such toy games always come with a little story. For example, the story for Chicken is based on the James Dean movie in which teenage boys drive cars towards a cliff edge to see whose nerve will crack first. The story for the prisoner's dilemma is set in Chicago. The District Attorney knows that Adam and Eve are gangsters who are guilty of a major crime but is unable to convict them without a confession from one or the other. He orders their arrest and separately offers each the following deal: 'If you confess but your accomplice fails to confess, then you go free. If you fail to confess but your accomplice confesses, then you will be convicted and sentenced to the maximum term in jail. If you both confess, then you will both be convicted but the maximum sentence will not be imposed. If neither confesses, then you will be framed on a minor tax evasion charge for which a conviction is certain. (Binmore, 1994; pp.102–103)

The story should off course not be taken too seriously, but the point about the payoff structure, that follows from the story, should be clear: the requirement for the payoffs is that $\alpha > \beta > \delta > 0$. When the prisoners keep their mouths shut it means that they *cooperate*, while *defect* means that they confess to the police. These restrictions are almost the same as the hawk–dove game, with the exception that α only has to be larger than β, and not that $\beta = ½\alpha$.

Table A–7 Prisoner's dilemma

		Column player	
		Cooperate	Defect
Row player	Cooperate	(δ ; δ)	(α ; 0)
	Defect	(0 ; α)	(β ; β)

Requirements:

- $\alpha > \beta > \delta > 0$

The prisoner's dilemma could have been put in section A.2, because the two players both have dominant strategies. However, this game is the most (in)famous game of all, and thus needs to be treated in a separate section. The prisoners will try to minimise the penalty they can receive from the police. Because $\alpha > \beta$, and $\delta > 0$, the dominated strategy for both the row player and column player is the *cooperate* strategy. The unique Nash equilibrium in the prisoners' dilemma is thus (*defect*, *defect*), because to *defect* is always the best reply to any strategy used by the other.

The outcome (*defect*, *defect*), with an expected payoff for both players of δ, is not a Pareto efficient outcome of the prisoners' dilemma. The game has another outcome that both players prefer. The outcome (*cooperate*, *cooperate*) is a Pareto improvement on (*defect*, *defect*) because both players get a payoff of β with the former outcome and a payoff of only δ with the latter. Many authors have gone into detailed analyses about how cooperation can be created and/or maintained in a prisoners' dilemma. See, for instance, Axelrod (1984) who is one of the most well known forerunners of these projects in his book *The Evolution of Cooperation*.

A.7 Stag–hunt game

The stag–hunt game is a game–theoretic interpretation of a reading of Rousseau's parable of hunting a deer offered in his *Inequality of Man*. In the stag–hunt game the cooperative enterprise is to catch a deer. Unless both players play their part in the catching of the deer it will never be caught. If one of the two players abandons the cooperative plan to catch a deer, the player has the opportunity to catch a hare. This catching of a hare does not require the help from anyone. Even worse, if both try to catch a hare they are hindering each other. A deer is preferred to a hare, because it tastes better and is a lot larger than the hare, so both can eat from eat it (and maybe they can even eat from the deer for several days). Note that the same set–up for the stag–hunt game is used as for the prisoner's dilemma, however the preference ordering for the two games makes them different. The stag–hunt game is depicted in table a–8.

Table A–8 Stag–hunt game

		Column player	
		Cooperate	Defect
Row player	Cooperate	(β ; β)	(0 ; α)
	Defect	(α ; 0)	(δ ; δ)

Requirements:

- $\beta > \alpha > \delta > 0$

The stag–hunt game has two Nash equilibria in pure strategies. There is the equilibrium in which both players *cooperate* (with $\pi_{ex} = \beta$ for both) and the one in which both players *defect* (with $\pi_{ex} = \delta$). The equilibrium (*cooperate*, *cooperate*) is a Pareto improvement on the (*defect*, *defect*) equilibrium (the *cooperating* equilibrium is payoff dominant). Both players also prefer the equilibrium of (*cooperate*, *cooperate*) to the (*defect*, *defect*) equilibrium.

There is a danger in *cooperating*, however, because there is a chance that the player cooperating may end up with nothing. This is why the (*defect*, *defect*) equilibrium is sometimes called a precarious equilibrium, because if a player defects he will get a payoff of at least δ irrespective of what the opponent may do. Harsanyi and Selten (1988) capture this aspect of the situation with their notion of risk dominance (see also section 2.3.2). The (*defect*, *defect*) equilibrium risk dominates the (*cooperate*, *cooperate*) equilibrium. By an equal chance of the column player selecting to *cooperate* or to *defect*, the row player prefers to *defect*, and vice versa. This means that the adjustment processes are more likely to converge on (*defect*, *defect*) than (*cooperate*, *cooperate*).

However, the mixed strategy equilibrium should not be neglected (especially in a game that is only played once), and can be calculated in the same way as done before (see section A.3). The requirements are:

$$\beta(1 - q) + 0q = \alpha(1 - q) + \delta q$$
$$\beta(1 - p) + 0p = \alpha(1 - p) + \delta p$$

$$p = q = \frac{\alpha - \beta}{\alpha - \beta - \delta}, \text{ and } (1 - p) = (1 - q) = \frac{-\delta}{\alpha - \beta - \delta}.$$

The expected payoff in this mixed equilibrium is:

$$\pi_{ex} = \frac{-\beta\delta}{\alpha - \beta - \delta}.$$

A.8 Games of conflict[91]

In games of conflict, also called zero−sum games, one player's gain/loss is always the other player's loss/gain as the returns sum to zero. As in the coordination games, there are the games of conflict and the games of pure conflict. In the two−person game of pure conflict each player has the same number of actions. As in section A.2 the actions of the players are indexed $j = 1, 2, \ldots m$, and let the payoff from playing the pair of actions with indices (j, k) be a_{jk} for the row player and $-a_{jk}$ for the column player[92].

Table A−9 Game of (pure) conflict

		Column player	
		C_1	C_2
Row player	R_1	$(a_{11} ; -a_{11})$	$(a_{12} ; -a_{12})$
	R_2	$(a_{21} ; -a_{21})$	$(a_{22} ; -a_{22})$

The difference between the general games of conflict and the games of pure conflict is the fact that in the general games of conflict some payoff a_{jk} can be 0, while in the pure conflict games a_{jk} is never 0. In games of conflict there is never a Nash equilibrium in pure strategies. There is a circular movement in actions for the players, because the best reply for one player always makes the payoff to the other player worse, who in turn by changing his action can raise his payoff, but by doing so worsens the payoff of the other player. The Nash equilibrium in this game is an equilibrium in mixed strategies. As in section A.3 to find the Nash equilibrium in mixed strategies, one needs to look at the probability, p (q), that makes the row player (column player) indifferent between either R_1 or R_2. In

[91] For a nice overview of several different zero−sum games see Shubik (1982; chapter 8).

[92] This does not mean that the payoff for the row player is always positive and for the column player always negative. For both players a_{jk} can be positive or negative (or zero). The only thing that counts is that the payoffs are opposites of each other.

the game of conflict of table a−9 the requirements generate the following equations:

$$a_{11}(1-p) + a_{12}p = a_{21}(1-p) + a_{22}p,$$

$$-a_{11}(1-q) + -a_{21}q = -a_{12}(1-q) + a_{22}q.$$

The solution (i.e., the Nash equilibrium in mixed strategies) of these equations is:

$$p = q = \frac{a_{11} + a_{21}}{a_{11} - a_{12} - a_{21} + a_{22}},$$

with an expected payoff for row and column player of:

$$\pi_{ex} = \frac{a_{11}a_{22} - a_{12}a_{21}}{a_{11} - a_{12} - a_{21} + a_{22}} \left(= \frac{-(a_{11}a_{22} - a_{12}a_{21})}{a_{11} - a_{12} - a_{21} + a_{22}} \right).$$

APPENDIX B

CALCULATIONS FROM CHAPTER 3

B.1 Cases for the hash−mark – BOS combination.

Case 2: *Claiming three as winner*

The maximum ($X = 3$) the winner of the hash−mark game can get when claiming three is:

$$\pi^{w}(3) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)3 + v_2(1 - v_1)0 + v_1 v_2 3$$

The minimum (X 0) the winner of the hash−mark game can get when claiming two is:

$$\pi^{w}(2) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)2 + v_1 v_2 0$$

To see for what values of v_1 and v_2 it is rational for the winner to claim two, the minimum of claiming two has to exceed or be equal to the maximum of claiming three. In formula: max $\pi^{w}(3) \leq$ min $\pi^{w}(2)$, which is satisfied if

$$v_2 \geq \frac{3v_1}{2 - 2v_1}.$$

Case 3: *Claiming two as loser*

The maximum ($X = 3$) the loser of the hash−mark game can get when claiming three is:

$$\pi^{l}(3) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)3 + v_1 v_2 3$$

The minimum ($X = 0$) the loser of the hash−mark game can get when claiming two is:

$$\pi^{l}(2) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)2 + v_2(1 - v_1)0 + v_1 v_2 0$$

To see for what values of v_1 and v_2 it is rational for the loser of the hash–mark game to claim two the minimum of claiming two has to exceed or be equal to the maximum of claiming three, which is satisfied if

$$v_2 \leq \frac{2v_1}{3 + 2v_1}$$

Case 4: *Claiming three as loser*
The minimum ($X = 0$) the loser of the hash–mark game can get when claiming three is:

$$\pi^l(3) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)0 + v_2(1 - v_1)3 + v_1 v_2 0$$

The maximum ($X = 2$) the loser of the hash–mark game can get when claiming two is:

$$\pi^l(2) = (1 - v_1)(1 - v_2)\tfrac{6}{5} + v_1(1 - v_2)2 + v_2(1 - v_1)0 + v_1 v_2 2$$

To see for what values of v_1 and v_2 it is rational for the loser of the hash–mark game to claim three the minimum of claiming three has to exceed or be equal to the maximum of claiming two. In formula, that is min $\pi^l(3) \geq$ max $\pi^l(2)$, which is satisfied if

$$v_2 \geq \frac{2v_1}{3 - 3v_1}$$

B.2 Cases for combination of "game with strongly stable equilibrium" and Coordination game.

Two associations

Case 1: $v_3 = 0$.
In this case the player does not have association on strategies available. To see for what values of v_1 and v_2 it is still rational for a player to play R_1, based on the conditional probabilities, one has to calculate the minimum of playing strategy R_1 and the maximum of playing the other strategy, which can be defined as:

$$\min \pi_i(R_1) = (1 - v_1)(1 - v_2)\tfrac{3}{2} + v_1(1 - v_2)2 + v_2(1 - v_1)1 + v_1 v_2 1$$

$$\max \pi_i(R_2) = (1 - v_1)(1 - v_2)\tfrac{3}{2} + v_2(1 - v_1)3 + v_1 v_2 3$$

The X in the first equation needs some explanation. If the player plays R_1 the minimum he will receive is one, that is when the other player will play R_2 (he will receive two if the other player also plays R_1), hence X is equal to 1. In formula: min π_i (R_1) ≥ max π_i (R_2) is satisfied if,

$$v_2 \leq \frac{v_1}{1+v_1}$$

To see for what values of the availabilities it is still rational to play strategy R_2 the minimum of playing R_2 must be equal to or exceed the maximum of playing R_1, where the minimum and maximum are,

$$\max \pi_i (R_1) = (1 - v_1)(1 - v_2)\tfrac{3}{2} + v_1(1 - v_2)2 + v_2(1 - v_1)1 + v_1 v_2 2$$

$$\min \pi i \ (R2) = (1 - v_1)(1 - v_2)\tfrac{3}{2} + v_2(1 - v_1)3$$

Where max π_i (R_1) ≤ min π_i (R_2) is satisfied if

$$v_2 \geq \frac{v_1}{1-v_1}$$

<u>Case 2</u>: $v_2 = 0$.

It can easily be seen that for every value of v_1 and v_3 the minimum of playing R_1 always exceeds the maximum of playing R_2. To see when it is rational to play strategy R_2 for the player, one has to calculate for what values of v_1 and v_3 the minimum of playing strategy R_2 is equal to or exceeds the maximum of playing the other strategy, that is; min π_i (R_2) ≥ max π_i (R_1). As can be seen this is never true. Because the minimum payoff of playing strategy R_2 always exceeds the maximum of playing strategy R_1 it is rational to play strategy R_1, or irrational to play strategy R_2. It is rational because both associations point in the same direction, and the opposing association is not in the frame of the player.

$$\min \pi_i (R_1) = (1 - v_1)(1 - v_3)\tfrac{3}{2} + v_1(1 - v_3)2 + v_3(1 - v_1)2 + v_1 v_3 2$$

$$\max \pi i \ (R2) = (1 - v_1)(1 - v_3)\tfrac{3}{2}$$

For now only the rationalisation of acting according to the association on structure will be given. Next it will be proven, however, that it is also rational to follow the other association when there is no association on payoffs available.

To see when it is rational to play strategy R_2 for the player, one has to calculate for what values of v_1 and v_2 the minimum of playing strategy R_2 is equal to or exceeds the maximum of playing the other strategy, that is, in formula; min π_I (R_2) ≥ max π_I (R_1).

$\max \pi_i \text{ (R1)} = (1 - v_1)(1 - v_3)\frac{3}{2} + v_1(1 - v_3)2 + v_3(1 - v_1)2 + v_1 v_3 \mathbf{2}$

$\min \pi i \text{ (R2)} = (1 - v_1)\ (1 - v_3)\frac{3}{2}$

This is exactly the same the above case for strategy R_1.

Case 3: $v_1 = 0$.
In this case, the association on structure is absent. One has to calculate when the minimum of playing R_1 is equal to or exceeds the maximum of playing R_2, which is the case if it is satisfied that:

$$v_2 \leq \frac{v_3}{1 + v_3}$$

Again the calculation to see for what values of v_2 and v_3 it is rational to play strategy R_2 the minimum of playing R_2 must be equal to or exceed the maximum of strategy R_1, which is the case if

$$v_2 \geq \frac{v_3}{1 - v_3}$$

All associations
In this case the player has all tree associations in his frame, he has beliefs about the other player having the same or a subset of his frame. In this case, the minimum of playing R_1 must be equal to or exceed the maximum of playing R_2 for it to be rational to play R_1 given the conditional probabilities of the associations being in the other player's frame. In this case, the minimum of playing R_1 must be equal to or exceed the maximum of playing R_2 for it to be rational to play R_1 given the availabilities of the opponent. In formula: $\pi_i\ (R_1) \geq \max\ \pi_i\ (R_2)$, where

$$\min \pi_i \text{ (R1)} = (1-v_1)(1-v_2)(1-v_3)\tfrac{3}{2} + v_1(1-v_2)(1-v_3)2 + v_2(1-v_1)(1-v_3)1 + v_3(1-v_1)(1-v_2)2 + v_1v_2(1-v_3)1 + v_1v_3(1-v_2)2 + v_2v_3(1-v_1)1 + v_1v_2v_3 1$$

$$\max \pi\text{i (R2)} = (1-v_1)(1-v_2)(1-v_3)\tfrac{3}{2} + v_2(1-v_1)(1-v_3)3 + v_1v_2(1-v3)3 + v_2v_3(1-v_1)3 + v_1v_2v_3 3$$

which is satisfied if

$$v_2 \leq \frac{v_1 + v_3 - v_1v_3}{1 + v_1 + v_3 - v_1v_3}.$$

To see for what conditional probabilities of v_1, v_2, and v_3 it is rational for the player to play R_2, the minimum expected payoff of playing R_2 must be equal to or exceed the maximum expected payoff of playing R_1, where the minimum and the maximum are defined as:

$$\max \pi_i (R_1) = (1-v_1)(1-v_2)(1-v_3)\tfrac{3}{2} + v_1(1-v_2)(1-v_3)2 + v_2(1-v_1)(1-v_3)1 + v_3(1-v_1)(1-v_2)2 + v_1v_2(1-v_3)2 + v_1v_3(1-v_2)2 + v_2v_3(1-v_1)2 + v_1v_2v_3 2$$

$$\min \pi_i (R_2) = (1-v_1)(1-v_2)(1-v_3)\tfrac{3}{2} + v_2(1-v_1)(1-v_3)3$$

In formula $\max \pi_i (R_1) \leq \min \pi_i (R_2)$, which is satisfied if:

$$v_2 \geq \frac{v_1 + v_3 - v_1v_3}{1 - v_1 - v_3 + v_1v_3}.$$

APPENDIX C

EXPERIMENT FORMS

C.1 Checklist for experimental session

Preparation + general

Put tables in proper position (U−form opening to door)/ put nameplates ready.
Put consent forms, instructions and pens ready on tables.
Start laptop.
Receive students.
Random drawing of lottery tickets (first ten).
Let the students enter classrooms and find their respective seats (monitors are in rooms)
Let students fill out consent form.
Depending on amount of students get the proper forms.
Explain that the students have to read the instructions carefully (just first page!!).
Ask if everything is clear.
Hand out understanding test and let the students fill it out.
Check understanding test (maybe exclude students from participation).
Let the students read page 2 and 3.
Ask if everything is clear.

→ Ask if it is really clear that they will play the two games in one stage against the same opponent. And that in each stage they will play a new opponent.

→ Tell subjects (again) to fill out the hash−mark game twice in exactly the same manner. That is, cross the same amount of lines on both sheets. And do not fill out anything in distribution game or forfeit your gains for the stage.

Hash−mark game / Distribution game

Hand out slips to starting players A.
Hand out slips to starting players B.
Get slips of players A.

Hand out/receive slips to/of players B.
Etc.

When there is a winner, separate two sheets and hand out the separate distribution sheets to the subjects, which they can then fill out.

Get slips after they're filled out and turn in for processing (make result slips).
Hand out result slips of distribution game to the players, together with the new hash−mark slips.

End
Tell students to read and fill out page 4.
Get all the instructions + the pens.
Some students will fill out post−questionnaire.
Call students one by one and pay them.

C.2 Recruitment announcements

To students

From: Peter Marks (Faculteit Wijsbegeerte, Visser 't Hooftgebouw, room 5−14, marks@fwb.eur.nl)

I shall conduct an (economic) experiment in October / November, 2000. The experiment will last around one hour and a half. During the experiment, you will be asked to play games in which you have to make strategic decisions. I shall give money for participating in the experiment and I will provide you with the instructions on how to play games. The amount of money you can earn will be determined by the rules of the games and you and your co−players' actions. The amount of money you can earn is quite considerable (expected average earnings range from 20 to 45 guilders). However, since the money you earn depends on your and others' actions, I cannot guarantee what amount you will earn. The money you earn will be paid to you in cash at the end of your participation in the experiment.

The experiment will take place in several rooms depending on the date. If you sign up for the experiment, you must come on *time* (otherwise everybody else has to wait for you, because the experiment can only start when everybody is there). If you are late, you may not be able to participate in the experiment (so that nobody has to wait).

C.3 Sign–up for participation

Example of the first session:

Name:
Student number:
E–mail address(ses):
Phone number:
Mobile phone number:

It is important that you come on time to receive a fl. 5.– on–time bonus. If you are late, you may not be able to participate in the experiment.

The participant of the experiment on Wednesday October 11 at 15.00 in rooms H6–05 and H6–06, hereby declares that (s)he understands the rules for participating in the experiment, and states that (s)he will be on time in the designated experiment room on the specified date.

Signature:

C.4 Subject consent form

I have volunteered to participate in this experiment.
I have the right to withdraw from the experiment at any time, forfeit any payments I may have earned from my participation.
I understand that the reports of this experiments will not identify me.
I understand that my participation in the experiment will not affect my academic standing at the University.
I understand that I can ask for a copy of this consent form and keep it.

Signed ______________________________ Date ___________________________

Name _______________________________ Phone _________________________

C.5 Actual experiment forms

There are two different versions of the experiment, only the first version is shown.

Sheet 1___________

Instructions

General

You are about to participate in an experiment in decision–making, more specifically in two–person interaction problems.
The purpose of the experiment is to gain insight into certain features of complex behavioural processes.
If you follow the instructions carefully, you might earn a considerable amount of money. The money amount depends on the decisions you make during the experiment. You will be paid in cash at the end of the experiment, when you turn in the papers.

Remain silent during the experiment, until the monitor breaks off the experiment. If not, you will have to stop, and you will forfeit your participation and you will forfeit all your gains.

Before starting the actual experiment you have to read the instructions and pass the Understanding Test. If you pass the understanding test you can continue with the experiment.
NOTE: The Understanding Test can be seen as a practice stage, and hence there is no money to be earned in this understanding test. In other words, the money one hypothetically could earn in the understanding test does not add up to your total amount of money earned in the experiment.

N.B.

Don't turn this page yet!
Wait until you receive the Understanding Test.
After the Understanding Test has been handed in to the monitor, please read page 2 and 3 very carefully.

If you have any questions, please ask the monitor now.

_______ Handout _______

A1

Understanding Test

This understanding test involves questions about the following, hypothetical game.

This game is played by two players, you and a fictitious co–player. The game will be played **only once**.

Hypothetical game

You and your co–player have to choose between right and left. If you choose the same direction as your co–player (that is, if you both choose Right or if you both choose Left), you will earn five guilders each.

If you and your co–player choose different directions, nobody will earn anything.

Circle *one* alternative!

Alternatives: Left Right

The following questions concern the above hypothetical game:
The minimum payoff I can make is ______
The maximum payoff I can make ______
The average payoff I expect from the game is ______
Which of the following do you prefer?

- fl. 3.– for sure.
- A fair coin toss which pays you fl. 0.– for heads and fl. 20.– for tails.

_______ Handout _______

Sheet 2___________

The experiment

The experiment is divided in **several** playing stages and a payment stage at the end. **In each stage you will play another player.** In other words, during one stage (two games) you play against a player that you will not meet (or have met) in another stage. The payment stage will follow the playing stages of the actual experiment.

Each stage of the experiment consists of **two games** that you play with **one and the same co–player** (sitting in the other room). The experiment requires decisions to be made by both players. The decisions will involve choosing alternatives. The alternatives chosen will correspond to an actual money amount (guilders).

In each stage the first game you have to play is the so–called hash–mark game. The second game in each stage is called a distribution game.

In short, each time you play the distribution game against the same opponent as in the hash–mark game, that is:

You against opponent *x*:	Hash–mark game
	Distribution game
You against opponent *y*:	Hash–mark game
	Distribution game
You against opponent *z*:	Hash–mark game
	Distribution game

Etc....

The money earned in one stage will be added to your total amount of money earned during the whole experiment. The total amount of money will be paid to you at the end of this experiment in private.

Your payoff depends partly on your own choices and partly on the choices of the other participant.

Note:

The handouts will consist of two almost identical sheets. Please fill out the hash–mark game **twice in exactly the same manner**, that is, copy onto the second page exactly what you did on the first page. This is done in order to speed up the process of the experiment.

Do not fill out the distribution game until you are told to. If you do fill out anything before granted permission you will forfeit your earning for that particular stage.

Sheet 3___________

Hash–mark game
Both participants A_i and B_i will play a so–called hash–mark game.
The hash–mark game has **no financial reward** for either player.

The rules of this game are as follows.

/ / / / / / / / / / / / / / / / /

Above here is a picture of 17 vertical hash–marks. Each player must, on each turn, cross out 1, 2, 3, *or* 4 hash–marks. After a player has crossed out 1, 2, 3, *or* 4 hash–marks, it is the other player's turn to cross out 1, 2, 3, *or* 4 hash–marks. The game continues until all hash–marks have been crossed out. The person who crosses out the **last** hash–mark **loses** the game. The starting players have been randomly selected.

Example. A_i goes first and crosses out 4 marks

~~/ / / /~~ / / / / / / / / / / / / /

Then B_i crosses out 4 marks

~~/ / / / / / / /~~ / / / / / / / / /

Then A_i crosses out 4 marks

~~/ / / / / / / / / / / /~~ / / / / /

Then B_i crosses out 4 marks

~~/ / / / / / / / / / / / / / / /~~ /

A_i must cross out the last mark on his turn, so A_i loses the game.

After you and your co–player finish the hash–mark game you will play the following distribution game:

Distribution game
You and your co–player have the possibility of sharing 10 guilders. In order to get the money, you and your co–player have to be in agreement over how to share the money.

The following alternatives will be on the handouts.

- ❑Alt 1. You get fl. 3.– and your co–player gets fl. 7.–.
- ❑Alt 2. You get fl. 7.– and your co–player gets fl. 3.–.

If both choose the same distribution, you will get the amount prescribed by your part of the distribution and your co−player will get his/her part of the distribution (This amount will then be added up to your total earnings for the experiment). That is:

You choose alt.1 and your co−player chooses alt. 2. You receive fl. 3.− and your co−player receives fl. 7.−
You choose alt.2 and your co−player chooses alt.1 You receive fl.7.− and your co−player receives fl. 3.−

If your choices lead to disagreement about how to share the money, both of you receive zero guilders (this means nothing will be added to your total earnings). That is:

Both of you choose alt. 1. Both receive zero guilders
Both of you choose alt. 2. Both receive zero guilders

_______ Handout example _______

A1 vs B1

Cross out the amount of lines you want to cross out. Then the experimenter will come and get the sheet after everybody is done, and will then give it to your co−player. This process will repeat itself till there is a winner and a loser.

/ / / / / / / / / / / / / / / / /

A1 player
Distribution game
Check *one* alternative below!

<u>Alternatives</u>:

- ❑ Alt 1. You get fl. 3.− and your co−player gets fl. 7.−.
- ❑ Alt 2. You get fl. 7.− and your co−player gets fl. 3.−.

_______ Handout _______

Sheet 4___________

Please take some time to fill in this last page, while waiting to be called for payment.

Name ________________________ Subject no. ______

Date _________________________

Please write down on this sheet any comments you may have about this experiment and your participation in it.

____

____

____

____

____

____

____

____

When you're done raise your hand and one of the experimenters will come and get the sheet. Wait till you are called so that you can receive your money in private.

C.6 Post questionnaire

In the following post–questionnaire the subjects had enough room to answer the questions on the sheet itself. However, in this appendix there is no reason to keep the spaces between the questions and are hence removed.

Post–questionnaire

Take your time to fill out this questionnaire. This questionnaire will serve me in understanding mental processes that people use and/or employ during both experiments and in strategic interactions (the games).

Remember while filling out the questionnaire, there is no good or bad, no right or wrong way to approach the games. That is, there is no best or worst way to play games.

There is also no such thing as a wrong or right, good or bad, stupid or smart answer.

So please fill out the questionnaire as truthfully and completely as possible. Please do not rationalise your answers afterwards, they will be useless then. This means try to think back to the moment you were playing the games and why you did what you did then.

Your answers will be treated anonymously.

1. Hash–mark game:
   a) In the hash–mark game how did you choose how many hash–marks to cross?
   b) Did you change the way you played the hash–mark game in later stages?
   c) If yes, what did you change?
   d) If no, why not?
   e) Was there a difference in your approach when you started, compared to when the other player started?
2. Distribution game:
   a) In the distribution game how did you choose an alternative?
   b) Did you change the way you played the distribution game in later stages?
   c) If yes, what did you change and why?
   d) If no, why not?
3. General
   a) In hindsight, do you feel you should have done things differently?
   b) If yes, what and why
   c) If no, why not

C.7 Cash payment sheet

Received from ____________________________ fl. ________ in cash as payment for participation in research experiment.

Signed _____________________________ Date ___________________________

Name ______________________________ Subject no. ______________________

Address _____________________________ Phone _________________________

APPENDIX D

EXPERIMENT: DATA AND ANALYSES

D.1 Coding of variables

Start hash–mark game	1 =	Start
	2 =	Second
Result hash–mark game	0 =	Lose
	1 =	Win
Distribution alternative	1 =	Alternative 1
	2 =	Alternative 2
Distribution result	0 =	Non–matching offers
	1 =	Matching offers
Sex	0 =	Male
	1 =	Female
Cultural background	0 =	Dutch
	1 =	Non–native Dutch
Risk behaviour alternatives	0 =	fl. 3.– for sure
	1 =	Toss of coin 20 vs. 0
Faculty	1 =	Economics
	2 =	Business administration
	3 =	Law
	4 =	History & Arts
	5 =	Economics & Law
	6 =	Philosophy
Possible association version 1	0 =	Lost HM & chose alternative 2
		Won HM & chose alternative 1
	1 =	Lost HM & chose alternative 1
		Won HM & chose alternative 2

Possible association version 2	0 =	Lost HM & chose alternative 1 Won HM & chose alternative 2
	1 =	Lost HM & chose alternative 2 Won HM & chose alternative 1

D.2 Analyses version 1

D.2.1 Relations between independent variable

The following independent variables are tested by the use of the Pearson correlation, because they are all scale variables.

Table D–1 Correlations

		Risk behaviour	Cultural background	HM start
Sex	Pearson Correlation	−.122	.195	.000
	Sig. (2–tailed)	.408	.183	1.000
	N	48	48	278
Risk behaviour	Pearson Correlation		−.209	.018
	Sig. (2–tailed)	n.a.	.155	.769
	N		48	278
Cultural background	Pearson Correlation			−.026
	Sig. (2–tailed)	n.a.	n.a.	.669
	N			278

The one–way ANOVA test is used to analyse the relations between faculty and the other independent variables. The one student from the History & Arts faculty is left out in this analysis, because whatever the behaviour of this student might be, one cannot say whether this is because she is a History & Arts student, or because of other factors (e.g., personal characteristics). The one–way ANOVA test is used, because the *Faculty* variable is nominal, and the rest are scale variables.

Table D–2 One–way ANOVA test of Faculty

	F	Sig.	N
Sex	2.339	.087	46
Cultural background	1.769	.167	46
Risk behaviour	1.776	.166	46
HM start	1.059	.367	272

D.2.2 Calculations Learning HM−game

The Pearson correlation is used, because all variables are scale variables. The test is one tailed, because over the stages the subjects should be able to win more often.

Table D−3 Correlations

Controlling for unique player		HM result
Stage	Partial Correlation	−.000
	Sig. (1−tailed)	.499
	N	275

D.2.3 Testing distribution alternative

The Pearson correlation is used, because all variables are scale variables.

Table D−4 Correlations

		Distribution alternative
Cultural background	Pearson Correlation	−.045
	Sig. (1−tailed)	.229
	N	278
Risk behaviour	Pearson Correlation	.059
	Sig. (1−tailed)	.162
	N	278

Because *Faculty* is a nominal variable, a one−way ANOVA is used to test the relation between *Faculty* and *Distribution alternative*, see table d−5.

Table D−5 One−way ANOVA test of Faculty

	F	Sig.	N
Distribution alternative	2.096	.082	278

The result shows that there is no relation between *Faculty* and Distribution alternative given the 5% significance level. If, however, a 10% significance level is accepted there would be a relation between the two variables. The total amount of people in the subject pool per faculty is given in table 5−1 in section 5.3. There is only one person from the History & Arts faculty, which means that if that person would be incorporated into the analysis one would not know whether the relation and/or influence would be a person characteristic or a faculty trait. For a proper analysis this person is removed from the data when testing the relation between *Faculty* and *Distribution alternative*. The result is now shown in table d−66.

Table D−6 One−way ANOVA test of Faculty

	F	Sig.	N
Distribution alternative	1.189	.314	272

As is clear when removing the History & Arts student the relation between *Faculty* and *Distribution alternative* is totally not significant, and can thus be neglected.

D.2.4 Calculations null and alternative hypotheses

H_0: Traditional game−theoretic prediction: $p_{W0} = 0.7$.
H_1: Associative approach prediction: $p_{W1} >> 0.7$.

$P(p_{W,exp} > g \mid p_{W0} = 0.7) = 0.05\ (= 0.01)$[93]

$$P\left(\frac{p_s + p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} > \frac{g + p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} \mid p_0 = 0.7\right) = 0.05\ (= 0.01)$$

$$P\left(Z > \frac{g + 0.7}{\sqrt{\frac{0.7(1-0.7)}{139}}} \mid p_0 = 0.7\right) = 0.05\ (= 0.01)$$

$$\frac{g + 0.7}{\sqrt{\frac{0.7(1-0.7)}{139}}} = 1.645\ (= 2.326)$$

$$g = 0.7 + 1.645\sqrt{\frac{(0.7)(0.3)}{139}} \quad (= 0.7 + 2.326\sqrt{\frac{(0.7)(0.3)}{139}})$$

$$g \approx 0.764\ (\approx 0.790)$$

H_0: Traditional game−theoretic prediction: $p_{L0} = 0.7$.
H_1: Associative approach prediction: $p_{L1} << 0.7$.

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[93] The calculation is the same for each boundary that needs to be calculated. In the rest of the calculations only the results will be given, not the complete calculation.

$P(p_{L,exp} < g \mid p_{l0} = 0.7) = 0.05\ (= 0.01)$

$$g = 0.7 - 1.645\sqrt{\frac{(0.7)(0.3)}{139}} \quad (= 0.7 - 2.326\sqrt{\frac{(0.7)(0.3)}{139}})$$

$g \approx 0.636\ (\approx 0.610)$

D.2.5 Higher payoff?

H_0: Traditional game theory: $\pi = 2.1$; in other words, $p_0 = 0.42$.
H_1: Associative approach: $\pi >> 2.1$; in other words, $p_1 >> 0.42$.

$P(p_1 > g \mid p_0 = 0.42) = 0.05\ (= 0.01)$

$$g = 0.42 + 1.645\sqrt{\frac{(0.42)(0.58)}{278}} \quad (= 0.42 + 2.326\sqrt{\frac{(0.42)(0.58)}{278}})$$

$g \approx 0.4687\ (\approx 0.4889)$

Comparing particular cells (Lockean equilibrium)

H_0: Traditional game theory: $p_0 = 0.21$.
H_1: Associative approach: $p_1 >> 0.21$.

$P(p_1 > g \mid p_0 = 0.21) = 0.05\ (= 0.01)$

$$g = 0.21 + 1.645\sqrt{\frac{(0.21)(0.79)}{278}} \quad (= 0.21 + 2.326\sqrt{\frac{(0.21)(0.79)}{278}})$$

$g \approx 0.2502\ (\approx 0.2668)$

D.3 Analyses version 2

D.3.1 Independent variable tests

The following independent variables are tested by the use of the Pearson correlation, because they are all scale variables.

Table D–7 Correlations

		Cultural background	HM start
Sex	Pearson Correlation	.130	−.077
	Sig. (2–tailed)	.379	.199
	N	36	278
Cultural Background	Pearson Correlation		−.042
	Sig. (2–tailed)	n.a.	.489
	N		278

The one–way ANOVA test is used to analyse the possible relations between faculty and the other independent variables. The students of the Law & Economics, History & Arts faculty, and Philosophy are left out in this analysis, because these groups contain too little member. The one–way ANOVA test is used, because the *Faculty* variable is nominal, and the rest are scale variables.

Table D–8 One–way ANOVA test of Faculty

	F	Sig.	N
Sex	2.267	.141	35
Cultural background	0.110	.742	35
HM start	0.117	.733	208

D.3.2 Learning in HM game

The Pearson correlation is used, because all variables are scale variables. The test is one tailed, because over the stages the subjects should be able to win more often.

Table D–9 Correlations

Controlling for unique player		HM result
Stage	Partial Correlation	−.000
	Sig. (1–tailed)	.499
	N	275

D.3.3 Testing relation HM start & HM result

A Pearson correlation between the two variables shows whether there is a relation between the two variables.

Table D–10 Correlation HM start & HM result

		HM result	HM result (session 7)	HM result (no session 7)
HM start	Pearson Correlation	−.137	−.278	−.087
	Sig. (1–tailed)	.011	.009	.106
	N	278	72	206

The result in case of all sessions in version 2 is significant at 1.1%. The relation between the starting position and the result of the hash–mark game, however, is not strong. Only 13.7% of the starting players is able to win the hash–mark game more than the second players. If session 7 is excluded from the result the relation is not significant anymore. In other words, the influence of the participants in session 7 is quite large, see table d–10.

To test whether the starting players learn how to win the hash–mark game a one–sided Pearson correlation test is used. For the second players a two–sided test is needed, because they either learn to take advantage of "dumb" starting players, or lose because of "smart" starting players.

Table D–11 Learning in HM–game by starting players

Controlling for unique player		HM result	HM result (session 7)	HM result (no session 7)
Stage	Partial Correlation	.081	.245	.022
	Sig. (1–tailed)	.173	.078	.412
	N	136	33	100

Table D–12 Learning in HM–game by second players

Controlling for unique player		HM result	HM result (session 7)	HM result (no session 7)
Stage	Partial Correlation	−.081	−.223	.023
	Sig. (2–tailed)	.348	.184	.821
	N	136	33	100

As in version 1 the participants do not figure out in the process of play how to win the hash–mark game. This is true for both starting and second players. When a ten percent significance level would be accepted the relation would be significant for some starting players in session 7. However, it has to be kept in mind that some players in this session already knew beforehand the rules of the hash–mark game, and thus how to win it. These players won from the first round onwards, hence they did not learn.

D.3.4 Testing distribution alternative

For both the total subject pool and session 7 the following relation scheme needs to be checked for relations.

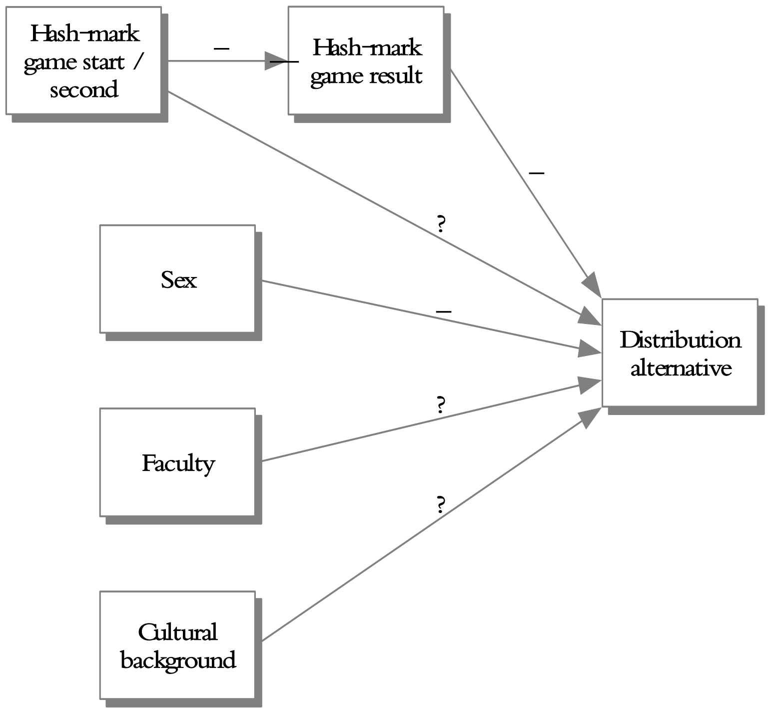

Figure D−1 Relations between variables and distribution alternative

Total subject pool

The Pearson correlation is used to test all the 'independent' variables for correlation with the distribution alternative chosen. All variables turn out not to have any significant relation with the distribution alternative chosen (see table d−13).

Table D–13 Correlations

		Distribution alternative
Sex	Pearson Correlation	−.055
	Sig. (1–tailed)	.181
	N	274
Cultural background	Pearson Correlation	−.050
	Sig. (1–tailed)	.205
	N	274
HM start	Pearson Correlation	−.022
	Sig. (1–tailed)	.359
	N	274

Because *Faculty* is a nominal variable, a one–way ANOVA is used to test the relation between *Faculty* and *Distribution alternative*, see table d–14.

Table D–14 One–way ANOVA test of Faculty

	F	Sig.	N
Distribution alternative	.077	.781	207

The result shows that there is no relation between *Faculty* and Distribution alternative given the 5% significance level. It turns out that *HM start* and all independent variables have no relation with the chosen *Distribution alternative*, and thus is the following correlation the only significant relation with the distribution alternative.

Table D–15 Correlation

		Distribution alternative
HM result	Pearson Correlation	−.154
	Sig. (1–tailed)	.005
	N	274

The only influential variable for the chosen alternative in the distribution game is the result of the hash–mark game. The result supports the associative approach. In table d–16 the amount and percentages are shown for the losers and the winners with their respective alternatives chosen in the distribution game.

Table D–16 Alternatives chosen based on losing/winning HM–game

			Distribution alternative		
			Alternative 1	Alternative 2	Total
HM result	Lose	Count	54	83	137
		% within HM result	39.4%	60.6%	100%
	Win	Count	75	62	137
		% within HM result	54.7%	45.3%	100%
Total		Count	129	145	278
		%within HM result	47.1%	52.9%	100%

To see whether the differences are significantly different the following hypotheses will be tested.

H_0: Traditional game–theoretic prediction: $p_{W0} = 4/7$ ($p_{l0} = 4/7$)
H_1: Associative approach prediction: $p_{W1} << 4/7$ ($p_{l1} >> 4/7$)

To see whether the observed outcome of the experiment is significantly different from the predicted outcome by traditional game theory, the boundaries of the null hypotheses have to be calculated (for the calculations see appendix D.3.5).

$P(p_{s,winners} < g \mid p_0 = 4/7) = 0.05 \wedge P(p_{s,losers} > g \mid p_0 = 4/7) = 0.05$

$g \approx 0.502$ $g \approx 0.641$

The winners of the hash–mark game chose alternative 2 only 45.3% compared to the boundary of 50.2%. In other words, the null hypothesis is rejected, and the alternative hypothesis accepted. The associative approach is able to explain the behaviour of the winners in the combination. The percentage of losers that chose alternative 2 is still within the boundary, which means that the null hypothesis is maintained.

Session 7 only

Again the Pearson correlation is used. All variables turn out not to have any significant relation with the distribution alternative chosen (see table d–17).

Table D–17 Correlations

		Distribution alternative
Sex	Pearson Correlation	.151
	Sig. (1–tailed)	.102
	N	72
HM start	Pearson Correlation	–.056
	Sig. (1–tailed)	.319
	N	72

The relation between *Faculty* and *Distribution alternative* could not be computed, because all the participants in that session were from one faculty, i.e., economics. The same line of reasoning applies to the relation between *Cultural background* and *Distribution alternative*, because all participants in session 7 have a Dutch cultural background.

Again there is no relation between *HM Start* and the other variables with *Distribution alternative*. As said in this session some participants did not read the instructions carefully and had discussed with their friends on what the experiment was about, and hence their behaviour was in line of the former version, while the group that did not know the experiment beforehand, played it differently, because they read the instructions. This might be the reason that there is no relation between *HM result* and *Distribution alternative*, as is obvious from the following table.

Table D–18 Correlation

		Distribution alternative
HM result	Pearson Correlation	000
	Sig. (1–tailed)	.500
	N	72

There is no correlation in this session between the result of the hash–mark game and the alternative chosen in the distribution game. In other words, the traditional game theoretic predictions apply to this session.

Subject pool without session 7

The Pearson correlation is used, because all variables are scale variables. All variables turn out not to have any significant relation with the distribution alternative chosen (see table d–19).

Table D–19 Correlations

		Distribution alternative
Cultural background	Pearson Correlation	−.035
	Sig. (1–tailed)	.311
	N	202
HM start	Pearson Correlation	−.050
	Sig. (1–tailed)	.242
	N	202

Because *Faculty* is a nominal variable, a one–way ANOVA is used to test the relation between *Faculty* and *Distribution alternative*, see table d–20.

Table D–20 One–way ANOVA test of Faculty

	F	Sig.	N
Distribution alternative	.029	.865	135

The result shows that there is no relation between *Faculty* and Distribution alternative given the 5% significance level.

D.3.5 Calculations null and alternative hypotheses

Total subject pool

H_0: Traditional game–theoretic prediction: $p_{W0} = 4/7$.
H_1: Associative approach prediction: $p_{W1} << 4/7$.

$$P(p_{W,exp} < g \mid p_{W0} = 4/7) = 0.05$$

$$g = \tfrac{4}{7} - 1.645\sqrt{\frac{(\tfrac{4}{7})(\tfrac{3}{7})}{137}}$$

$$g \approx 0.502$$

H_0: Traditional game–theoretic prediction: $p_{L0} = 4/7$.
H_1: Associative approach prediction: $p_{L1} >> 4/7$.

$P(p_{L,exp} > g \mid p_{l0} = 4/7) = 0.05$

$$g = \tfrac{4}{7} + 1.645\sqrt{\frac{(\frac{4}{7})(\frac{3}{7})}{137}}$$

$$g \approx 0.641$$

Subject pool without session 7

H_0: Traditional game–theoretic prediction: $p_{W0} = 4/7$.

H_1: Associative approach prediction: $p_{W1} << 4/7$.

$P(p_{W,exp} < g \mid p_{W0} = 4/7) = 0.05\ (= 0.01)$

$$g = \tfrac{4}{7} - 1.645\sqrt{\frac{(\frac{4}{7})(\frac{3}{7})}{101}} \quad (= \tfrac{4}{7} - 2.326\sqrt{\frac{(\frac{4}{7})(\frac{3}{7})}{101}})$$

$$g \approx 0.490\ (\approx 0.457)$$

H_0: Traditional game–theoretic prediction: $p_{L0} = 4/7$.

H_1: Associative approach prediction: $p_{L1} >> 4/7$.

$P(p_{L,exp} > g \mid p_{l0} = 4/7) = 0.05\ (= 0.01)$

$$g = \tfrac{4}{7} + 1.645\sqrt{\frac{(\frac{4}{7})(\frac{3}{7})}{101}} \quad (= \tfrac{4}{7} + 2.326\sqrt{\frac{(\frac{4}{7})(\frac{3}{7})}{101}})$$

$$g \approx 0.652\ (\approx 0.686)$$

D.3.6 Did they learn

The relation between *Stage* and *Possible association* controlling for *unique player* can be analysed by the use of a partial correlation test, because all the variables are either interval variables or scale variables.

Table D−21 Learning in HM−game by second players

Controlling for unique player		Possible association	Poss. ass. (session 7)	Poss. ass. (no session 7)
Stage	Partial Correlation	.018	−.098	−.000
	Sig. (1−tailed)	.386	.209	.498
	N	271	69	199

The results in the table show that in all three different analyses the subjects did not start using the possible association more than in other rounds. The null hypothesis is maintained.

D.3.7 Is association rewarding

Total subject pool

Table D−22 Frequencies of outcomes

		Winner Alt. 1	Winner Alt. 2
Loser	Alt. 1	0.190	0.204
	Alt. 2	0.358	0.248

The observed outcome for the total subject pool in version 2 is that in 56% of the cases the participants were able to match their offers, and in 44% they did not match their offers. The average earning for the participants in version 2 is 2.0 guilders, while the average traditional game theory predicts is 1.7 guilders. To check whether the outcome for the experiment is significantly different from the predicted outcome by traditional game theory, the following hypotheses need to be tested:

H_0: Traditional game theory: $\pi = 1.7$; in other words, $p_0 = 0.49$.
H_1: Associative approach: $\pi >> 1.7$; in other words, $p_1 >> 0.49$.

To check whether the 56% matching in the experiment is outside the boundary to be able to reject the null hypothesis, again a 5 percent significance level will be used.

$P(p_1 > g \mid p_0 = 0.49) = 0.05 \rightarrow g \approx 0.5399$ (see below appendix D.3.8)

The actual matching result of the experiment is 0.562. This is higher than the boundary, in other words, the null hypothesis can be rejected. The substantial amount of associating players in the subject pool helps the subject pool in total to create a higher payoff. The payoff is 30 cent more, which is 17.6% higher than what the players would earn according to traditional game theory.[94]

Session 7

Table D−23 Frequencies of outcomes

		Winner	
		Alt. 1	Alt. 2
Loser	Alt. 1	0.139	0.278
	Alt. 2	0.278	0.306

In 55% of the cases the participants were able to match their offers, and in 45% they did not match their offers. As said before, the players in this session behave according to traditional game theory, and hence there is no use testing for a higher reward when associating. Actually, the subjects in this session even did better than traditional game theory predicts (55% vs. 49%). However, because there are only 72 cases in this session the acceptance area is quite large ($g \approx 0.5869$), hence the six percent difference in outcome is not significantly deviating. The average payoff generated in this session is 1.9 guilders, which is still a 20 cents better than the average predicted by traditional game theory.

D.3.8 Higher payoff?

Total subject pool

H_0: Traditional game theory: $\pi = 1.7$; in other words, $p_0 = 0.49$.

H_1: Associative approach: $\pi >> 1.7$; in other words, $p_1 >> 0.49$.

$$P(p_1 > g \mid p_0 = 0.49) = 0.05$$

$$g = 0.49 + 1.645\sqrt{\frac{(0.49)(0.51)}{272}}$$

$$g \approx 0.5399$$

[94] The matching in the 'egalitarian' cell significantly higher than traditional game theory predicts. The boundaries for the result to be in the confidence areas of 5% or 1% are 0,2879 respectively 0,3057. In other words, traditional game theory is not able to explain the behaviour of the participants, while the associative approach is.

Comparing particular cells (Egalitarian equilibrium)

H_0: Traditional game theory: $p_0 = 0.245$.
H_1: Associative approach: $p_1 >> 0.245$.

$$P(p_1 > g \mid p_0 = 0.245) = 0.05 \ (= 0.01)$$

$$g = 0.245 + 1.645\sqrt{\frac{(0.245)(0.755)}{272}} \qquad (= 0.245 + 2.326\sqrt{\frac{(0.245)(0.755)}{272}})$$

$$g \approx 0.2879 \ (\approx 0.3057)$$

Subject pool without session 7

H_0: Traditional game theory: $\pi = 1.7$; in other words, $p_0 = 0.49$.
H_1: Associative approach: $\pi >> 1.7$; in other words, $p_1 >> 0.49$.

$$P(p_1 > g \mid p_0 = 0.49) = 0.05$$

$$g = 0.49 + 1.645\sqrt{\frac{(0.49)(0.51)}{202}}$$

$$g \approx 0.5478$$

Comparing particular cells (Egalitarian equilibrium)

H_0: Traditional game theory: $p_0 = 0.245$.
H_1: Associative approach: $p_1 >> 0.245$.

$$P(p_1 > g \mid p_0 = 0.245) = 0.05 \ (= 0.01)$$

$$g = 0.245 + 1.645\sqrt{\frac{(0.245)(0.755)}{202}} \qquad (= 0.245 + 2.326\sqrt{\frac{(0.245)(0.755)}{202}})$$

$$g \approx 0.2948 \ (\approx 0.3154)$$

SAMENVATTING

ASSOCIATIES TUSSEN SPELEN

(DUTCH SUMMARY OF ASSOCIATIONS BETWEEN GAMES)

In termen van speltheorie is een spel de strategische interactie tussen mensen. Speltheorie analyseert de abstracte modellering van strategische interacties tussen individuen. Met andere woorden, speltheorie is een handig instrument om een bepaald deel van het menselijk gedrag te kunnen verklaren en/of voorspellen.

Speltheoretische experimenten hebben de afgelopen decennia aan populariteit gewonnen. In veel van deze experimenten wordt door de deelnemers gedrag vertoond dat niet altijd adequaat te verklaren valt door bestaande traditionele speltheorie. Het blijkt bijvoorbeeld in het zogenaamde onderhandelingsspel (*bargaining game*) dat voor deelnemers bepaalde rechtvaardigheidsprincipes een rol spelen, welke traditionele speltheorie niet (h)erkent. Dit verschijnsel komt ook naar voren in een experiment uitgevoerd door Hoffman en Spitzer (1985), waarin verschillende opzetten voor het experiment zijn gebruikt. Eén van de opzetten is dat de deelnemers een 'hash–mark' spel spelen voordat ze in een onderhandelingsspel onderling geld mogen verdelen. Het resultaat is dat in het onderhandelingsspel bepaalde rechtvaardigheidsprincipes worden gebruikt die voortkomen uit het resultaat van het eerste spel.

Binnen de sociale wetenschappen is het idee dat geschiedenis een belangrijke rol speelt, gemeengoed. Speltheorie is hierin geen uitzondering. Speltheoretici hebben zich echter nog niet beziggehouden met het idee dat in een combinatie van spelen een eerste spel invloed kan hebben op de manier van spelen in een tweede, ander spel, oftewel met het idee dat ook als de spelen van elkaar verschillen geschiedenis tussen twee spelers opgebouwd kan worden. Een voorbeeld hiervan is de geschiedenis die een getrouwd stel samen opbouwt doordat ze in de loop van de tijd veel verschillende spelen (interacties) met elkaar spelen. In dit proefschrift wordt een benadering ontwikkeld die in staat is het gedrag van individuen die twee verschillende spelen in combinatie spelen, te modelleren en analyseren. De spelers leggen een verband tussen het eerste en het tweede spel op basis van associaties: de benadering heet dan ook de associatieve benadering.

Bij de ontwikkeling van de associatieve benadering is het van belang te weten of er andere benaderingen of theorieën zijn die zich hebben beziggehouden met analyse van gedrag van spelers in verschillende spelen in combinatie. Ofwel, welke theorieën kunnen helpen de associatieve benadering op te bouwen. De eerste relevante onderzoeksvraag die hiermee verbonden is luidt als volgt:

1. Hoe kunnen we de idee dat spelers verschillende spelen met elkaar spelen plaatsen binnen de bestaande literatuur?

De uitgangspositie voor de beantwoording van deze vraag is het geobserveerde gedrag van deelnemers in het experiment van Hoffman en Spitzer (1985). Verschillende speltheoretische benaderingen die hiervoor een verklaring zouden kunnen geven worden geanalyseerd, waarna ze toegepast worden op het geobserveerde gedrag van het experiment. In het experiment worden twee spelen na elkaar gespeeld: het eerste spel levert altijd een winnaar en een verliezer op, waarna in het tweede spel overeengekomen dient te worden hoe een bepaald bedrag onderling verdeeld moet worden. Nu blijkt dat een 'loon naar werken' principe optreedt in het gedrag van de deelnemers. Dit houdt in dat de winnaars van het eerste spel vinden dat zij recht hebben op een groter deel van het bedrag en de verliezers op een kleiner deel, en vice versa voor de verliezers van het eerste spel.

Zowel traditionele speltheorie als alternatieve theorieën zijn niet volledig in staat om een verklaring te geven voor het geobserveerde gedrag. Een aantal theorieën geeft wel indicaties om tot mogelijke verklaring te komen. De associatieve benadering wordt opgebouwd door het combineren van verschillende inzichten uit de diverse theorieën. De associatieve benadering veronderstelt dat mensen zoeken naar externe informatie om hen te helpen een probleem op te lossen. De externe informatie kan gehaald worden uit een ander spel dat kan verschillen van het spel dat ze aan het spelen zijn. Als spelers informatie halen uit een verschillend voorafgaand spel maken ze associaties tussen de spelen. Gegeven de als relevant voor de oplossing van het tweede spel gepercipieerde informatie uit het eerste spel, kunnen de spelers verschillende associaties maken tussen de twee spelen. Echter, doordat de spelers uit een zelfde achtergrond komen (bijvoorbeeld een zelfde cultuur) worden gemiddeld dezelfde associaties gemaakt[95] en zijn de spelers in staat de symmetrie in het tweede spel te doorbreken, waardoor de kans op coördinatie groter wordt. Met andere woorden, door de associatie die de spelers maken met het eerste spel percipiëren ze het tweede spel anders en zijn ze daardoor in staat het probleem beter op te lossen dan traditionele speltheorie voorspelt.

Om aan te tonen hoe de associatieve benadering werkt wordt het idee dat spelers associaties leggen tussen verschillende spelen om beter in staat te zijn het tweede spel op te lossen, toegepast op zowel een denkbeeldige situatie als op de combinatie van twee spelen in het Hoffman en Spitzer (1985) experiment.

Nadat het idee van de associatieve benadering duidelijk is geworden is het tijd voor formalisatie van de benadering. Hoe kan deze formalisering plaatsvinden en wat voor raamwerk moet er gebouwd worden om een consistente verklaring te kunnen geven voor gedrag van spelers in een combinatie van spelen? Van welke theorieën kan de associatieve benadering delen of inzichten van kan lenen voor de opbouw van dat formele raamwerk? De tweede onderzoeksvraag is daarom:

2. Wat voor soort benadering is vereist die in staat is het gedrag van individuen die verschillende spelen in combinatie spelen, te verklaren, en welke theorieën kunnen hierbij assisteren?

Volgens Schelling (1960) gebruiken individuen externe informatie om hun acties in een spel te kunnen coördineren. De externe informatie zorgt ervoor dat bepaalde strategieën of evenwichten in het spel er uitspringen, de zogenaamde focuspunten (*focal points*). Zowel Bacharach (1993) en Janssen (2001) tonen aan dat deze benadering van Schelling geïncorporeerd kan worden in een formeel raamwerk van rationele keuze. Hun idee is dat verschillende etikettering (*labelling*) van strategieën asymmetrie tussen strategieën in een spel oplevert die spelers rationeel gebruiken.

Als spelers associaties maken tussen twee spelen creëert dit asymmetrie in het tweede spel van de combinatie. Spelers kunnen een oneindig aantal associaties maken tussen de spelen. Echter, door een gedeelde achtergrond zullen een aantal associaties eerder in gedachten komen dan andere associaties. Dit principe kan geformaliseerd worden met het begrip beschikbaarheid (*availability*) dat geïntroduceerd is door Bacharach (1993). Het idee is dat individuen, wanneer ze geconfronteerd worden met een bepaald beslissingsprobleem, aan bepaalde facetten denken, terwijl andere individuen in dezelfde situatie niet aan die facetten denken; of dezelfde individuen denken in andere vergelijkbare situaties niet aan deze facetten. Met andere woorden, individuen hebben variërende

[95] Er worden gemiddeld genomen dezelfde associaties gemaakt door de spelers, omdat bepaalde associaties meer 'prominent' aanwezig zijn in de gedachten van de spelers dan ander associaties.

denkkaders (*belief–spaces*). Facetten of dimensies in een spelsituatie hangen samen: als een bepaald onderdeel in gedachten komt (bijv. de kleur rood) komen de samenhangende onderdelen van die dimensie ook naar boven (bijv. de kleur geel). De dimensie en de samenhangende onderdelen zijn dan beschikbaar (*available*). In een spelsituatie kunnen spelers naast hun eigen denkkader ook nog ideeën hebben over het denkkader van de andere speler. Janssen (2001) bouwt verder op de idee van Bacharach (1993). Hij introduceert daarbij verschillende concepten om tot een formalisatie over te gaan, waardoor de benadering op meer spelen toepasbaar is.

De associatieve benadering gebruikt een aantal essentiële onderdelen van het formele raamwerk van Janssen, namelijk het begrip beschikbaarheid (*availability*) en uitkomstgelijkheid (*payoff symmetry*). Op basis van informatie uit het eerste spel in de combinatie maken spelers associaties met het tweede spel. De verschillende associaties die gedefinieerd kunnen worden als zijnde relevant in de combinatie van twee spelen, zitten in het frame (denkkader) van de speler (het frame is gedefinieerd als F); m.a.w. de associaties zijn beschikbaar. Een speler kan nooit andere associaties maken dan die in zijn denkkader zitten; hij weet namelijk niet van het bestaan van eventuele andere associaties. Gegeven het denkkader van een speler kan deze speler een idee hebben over wat de associaties zijn in het denkkader van de andere speler. Het denkkader van de andere speler (gedefinieerd als G) vanuit het oogpunt van de ene speler, bevat dezelfde associaties als in zijn eigen denkkader of een deelverzameling hiervan ($G \subseteq F$). Met andere woorden, een speler kan verwachtingen hebben over de associaties in het denkkader van de andere speler (als jij van type F bent is de conditionele waarschijnlijkheid dat de ander van type G is gedefinieerd als $V(G|F)$). Gegeven de beschikbaarheid van de associaties (v_i is de beschikbaarheid van een associatie en $(1 - v_i)$ is het niet beschikbaar hebben van een associatie) en de conditionele beschikbaarheden die hierop gebaseerd zijn, kan het formele raamwerk van de associatieve benadering aantonen wat het optimale gedrag is voor spelers in een specifieke combinatie van spelen.

Het formele raamwerk van de associatieve benadering wordt daarna toegepast op de al eerder genoemde denkbeeldige situatie en op de combinatie van twee spelen in het Hoffman en Spitzer (1985) experiment. Bij deze toepassing wordt duidelijk hoe het formele raamwerk werkt en hoe gedrag aan de hand van de formele definities verklaard kan worden in de twee toepassingen.

De laatste vraag die beantwoord moet worden, is in hoeverre de ontwikkelde associatieve benadering ondersteund wordt door de empirie. Is de associatieve benadering werkelijk beter in staat bepaald menselijk gedrag te verklaren dan andere theorieën? Is de associatieve benadering überhaupt in staat menselijk gedrag te verklaren? Met andere woorden,

3. Is er enige empirische ondersteuning voor de associatieve benadering?

Om deze onderzoeksvraag te beantwoorden is een experiment opgezet. Om de associatieve benadering te testen is voor een experiment gekozen, omdat daar reële mensen geconfronteerd worden met strategische interacties in een gecontroleerde omgeving. Wederom is het experiment van Hoffman en Spitzer (1985) het vertrekpunt voor de opbouw van het experiment. In het associatieve benadering experiment worden dezelfde twee spelen in combinatie gespeeld: (1) het hash−mark spel, (2) een distributiespel. Er is gekozen voor twee verschillende varianten. De voor de hand liggende associaties die de deelnemers kunnen maken, zijn de 'loon naar werken' associatie (gedefinieerd als v_1) en de gelijkheidsassociatie (gedefinieerd als v_2).

In de eerste variant is er geen betaling voor het winnen van het hash−mark spel en dient er door de keuze van twee alternatieven tien gulden verdeeld te worden. De spelers moeten (zonder overleg) kiezen uit twee alternatieven:

Alt. (1): Ik krijg fl. 3.− en mijn medespeler krijgt fl. 7.−.
Alt. (2): Ik krijg fl. 7.− en mijn medespeler krijgt fl. 3.−.

Als de spelers twee verschillende alternatieven kiezen betekent dit dat ze overeenkomen hoe het geld verdeeld dient te worden en krijgen ze de respectieve uitkomsten. Als ze dezelfde alternatieven kiezen krijgen ze niets, vanwege het feit dat de alternatieven hoe het geld verdeeld dient te worden niet overeenstemmen.

Omdat het eerste spel altijd een winnaar en verliezer oplevert betekent dit, als de spelers deze informatie meenemen bij het ingaan van het tweede spel, dat dit spel anders gepercipieerd wordt. Het 'loon naar werken' principe gaat hier op: de verliezer van het eerste spel ziet zichzelf minder effectief om tot een oplossing van het spel te komen, en vindt daarom dat hij recht heeft op het kleinere deel van de tien gulden en dat de winnaar van het eerste spel aanspraak mag maken op het grotere deel, en vice versa voor de winnaar. Als de spelers deze associatie maken tussen de twee spelen, zijn ze in staat hun alternatiefkeuze vaker in overeenstemming te brengen dan verwacht mag worden volgens traditionele speltheorie.

In de tweede variant is er een betaling van vier gulden voor het winnen van het hash−mark spel, waarna een keuze tussen twee alternatieven gemaakt dient te worden om zeven gulden te verdelen.

Alt. (1): Ik krijg fl. 3.− en mijn medespeler krijgt fl. 4.−.
Alt. (2): Ik krijg fl. 4.− en mijn medespeler krijgt fl. 3.−.

De informatie uit het eerste spel is dezelfde als voor de vorige variant. Echter, de winnaar van het eerste spel is al beloond voor zijn moeite. De spelers kunnen wederom verschillende associaties maken, maar de gelijkheidsassociatie is de meer 'logische'. Deze houdt in dat men de winnaar al als beloond ziet en daarom vindt dat de inkomsten over de gehele combinatie meer gelijk verdeeld dienen te worden, met dien verstande dat de winnaar in totaal nog steeds recht heeft op meer. Met andere woorden, de verliezer zal in het tweede spel het grotere deel voor zichzelf opeisen en het kleinere deel aan de winnaar toekennen, en vice versa. Als de spelers deze associatie volgen, betekent dit dat de winnaar van het eerste spel in totaal zeven gulden en de verliezer vier gulden zou verdienen.

De data uit de twee versies is getest op verschillende relaties, waaronder de kernrelatie of het gedrag van winnaars en verliezers verschilt en dan met name of de deelnemers inderdaad associaties maken tussen de twee spelen. Nu blijkt dat in de eerste versie de data de associatieve benadering volledig ondersteunt. Het geobserveerde gedrag van de deelnemers kan verklaard worden vanuit de associatieve benadering en niet vanuit traditioneel speltheoretisch perspectief. Vanwege het feit dat de spelers op basis van informatie uit het eerste spel een asymmetrie creëren in het tweede spel, zijn ze in staat om hogere inkomsten te genereren dan verwacht wordt door traditionele speltheorie, wat ervoor zorgt dat de gehele groep hogere inkomsten genereert.

Het gedrag van de deelnemers in de tweede variant is enigszins moeilijker te verklaren. De winnaars en verliezers van het hash−mark spel gedragen zich duidelijk verschillend ten opzichte van elkaar: dit ondersteunt de associatieve benadering. Het gedrag van de verliezers is echter nog steeds in lijn met de traditioneel speltheoretische voorspelling. Het gedrag van de winnaars kan echter niet verklaard worden vanuit traditioneel oogpunt, maar wel vanuit de associatieve benadering. Een mogelijke verklaring is dat de winnaars zich terdege bewust zijn van de financiële beloning voor het winnen van het hash−mark spel, terwijl de verliezers dat minder bewust ervaren. Een andere verklaring zou kunnen kan zijn dat de gehele groep van verliezers op basis van twee conflicterende associaties handelt. Het zou kunnen dat het ene deel zich gedraagt volgens de gelijkheidsassociatie (v_1 is klein en v_2 is groot), terwijl de andere groep zich volgens de 'loon naar werken' associatie gedraagt (v_1 is groot en v_2 is klein). Het geaggregeerde resultaat kan hetzelfde zijn als wat traditionele speltheorie voorspelt. In zijn geheel is de deelnemerspopulatie wel in staat meer inkomsten te genereren door de associërende spelers in de populatie.

In het algemeen wordt door deelnemers uit beide versies aangegeven dat ze inderdaad associaties maken tussen de twee specifieke spelen in combinatie. De associatieve benadering wordt voor deze combinatie ondersteund door de empirie.

Om te zien of de benadering op meer en andere combinaties van toepassing is dient vervolgonderzoek gedaan te worden. Te denken valt aan zowel theoretische verfijning als experimenteel onderzoek, zoals bijvoorbeeld:

- Theoretisch:
  - Gelimiteerde cognitieve capaciteiten bij spelers. (zie bijv. Young (1993, 1996, 1998))
  - Antropologische studies om meer te weten over de verschillende grondslagen voor de associaties die spelers maken.
- Theoretisch en experimenteel:
  - Andere combinaties van twee spelen.
  - Combinaties van meer dan twee spelen
  - Combinaties met meer dan twee spelers
- Experimenteel:
  - Andere landen dan Nederland om te zien hoe cultuurverschillen hun opgeld doen, of spelers uit twee verschillende culturele achtergronden tegen elkaar laten spelen.

Er kunnen altijd bezwaren worden aangedragen tegen een nieuwe theorie, dus ook tegen de associatieve benadering. Maar zelfs als mensen niet overtuigd zijn van de associatieve benadering, zijn ze aan het denken gezet over geobserveerd gedrag wat tot op heden niet verklaard kan worden met bestaande theorieën. Stel dat de associatieve benadering uiteindelijk verworpen zou worden door de wetenschappelijke samenleving, dan heeft deze studie toch bijgedragen aan deze samenleving doordat ze mensen bewust heeft gemaakt van de beperkte verklarende capaciteit van de bestaande theorieën.

In zijn geheel kan geconcludeerd worden dat de associatieve benadering een verklaring kan geven voor geobserveerd gedrag wat tot op heden niet verklaarbaar is vanuit bestaande theorieën. De associatieve benadering is in staat het gedrag van spelers uit de Nederlandse cultuur te verklaren, die een hash−mark spel spelen gevolgd door een distributiespel. Veel moet nog gedaan worden om de associatieve benadering gestalte te geven, maar deze studie lijkt op een veelbelovende start.

CURRICULUM VITAE

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