Group Behaviour in Tacit Coordination Games with Focal Points - An Experimental Investigation

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Abstract

This paper reports an experimental investigation of Schelling's theory of focal points that compares group and individual behaviour. We find that, when players' interests are perfectly aligned, groups more often choose the salient option and achieve higher coordination success than individuals. However, in games with conflicts of interest, groups do not always perform better than individuals, especially when the degree of conflict is substantial. We also find that groups outperform individuals when identifying the solution to the coordination problem requires some level of cognitive sophistication. Finally, players that successfully identify the solution to this game also achieve greater coordination rates than other players in games with a low degree of conflict. This result raises the question of whether finding the focal point is more a matter of logic rather than imagination as Schelling argued.

Keywords: Groups; Coordination; Payoff-irrelevant cues; Cognition

JEL Codes: C72; C78; C91; C92

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1 Introduction

In his seminal paper, Schelling (1960) shows that in games with multiple Nash equilibria, where one equilibrium stands out (the *focal point* of the game), individuals can converge their expectations and successfully coordinate more often than what game theory predicts. This finding has been corroborated using a variety of games by many experimental studies (e.g. Mehta et al., 1994; Crawford et al., 2008; Isoni et al., 2013; Parravano and Poulsen, 2015). While Schelling's informal experiments and subsequent experiments have been conducted with individuals, his theory of focal points applies to war committees' negotiations as well as to drivers in a traffic jam. It applies to groups as well as individuals. Abundant experimental evidence however shows that groups and individuals do behave differently (e.g. Kugler et al., 2012), so it does matter whether decisions are taken by a board of directors or by a husband trying to meet his wife in New York.

The purpose of this paper is to experimentally investigate to what extent Schelling's theory of focal points applies to groups. We do not claim that our experiment will unveil how war committees agree on limiting wars, or how firms agree on the limits of competition, but we do hope to move a little closer. What we will show is that, starting with Schelling's interpretation of coordination games as games that have a solution (e.g. problem-solving tasks), groups have the potential to coordinate more successfully than individuals in tacit coordination games with and without conflicts of interest, provided the degree of conflict is small.

Schelling's theory of focal points is supported by many informal experiments involving two-player coordination games. In these games, two players are presented with the same set of n strategies. If they choose the same strategy, they earn some positive payoffs, if they do not, they earn nothing. Tacit coordination games can be distinguished into two subsets: games with no conflicts of interest and games with conflicts of interest.

Games with no conflicts of interest, where payoffs are identical in all equilibria and are the same for both players, are pure coordination games. From a game theoretical perspective, the equilibria in these games are indistinguishable to players who play rationally by uniformly randomising across strategies. Schelling reported that, in reality, people take advantage of some features of the game and manage to coordinate on a particular equilibrium more successfully than if their choices were random. These features that, following Isoni et al. (2019), we will call *payoff-irrelevant cues*, can be words, colour, spatial layout, symbols, or any other attribute used to attach labels to strategies. To explain equilibrium selection in games with focal points, some authors (Mehta et al., 1994; Bardsley et al., 2010; Casajus, 2012) have made explicit assumptions about the labels. Labels are tied to strategies, such that there is a distinct label for each strategy[1]. Choosing a label corresponds to choosing a strategy. Coordination is achieved if players choose the same label. Some labels might be more salient than others (they stand out) and can act as a coordination device. Players who choose the salient label coordinate on the focal point of the game.

A distinctive feature of Schelling's theory of focal points lies in the interpretation of coordination games as problems that have a solution. The solution is characterised by being unique and conspicuous (see Lewis, 1969). We can therefore think of these games as problem-solving tasks (e.g. Lorge et al., 1958). These are tasks with a correct solution. In terms of group productivity (Steiner, 1972), tasks can be classified into four types (i.e. conjunctive, additive, discretionary, and disjunctive), depending on how individual contributions combine to determine the group's productivity[2]. Problem-solving tasks are *disjunctive tasks* in that the performance of the group is determined by the performance of just one group member. In this type of task, groups are often found to perform better than individuals (e.g. Laughlin et al., 2006).

Laughlin (1980) distinguishes group tasks into intellective and judgemental tasks. Intellective tasks are tasks for which a correct and demonstrable solution exists. For a task to be

[1]Some authors, (Bardsley et al., 2010; Mehta et al., 1994) assume that labels are players' common knowledge, while some others assume they are player's private descriptions (Sugden, 1995).

[2]*Conjunctive tasks* are those where the group productivity is that of the least productive member (e.g. a group climbing a mountain). *Additive tasks* are those where the contributions of the members are added up or averaged to form the group's contribution (e.g. relay race); in *discretionary tasks* group members may combine their efforts in any way they like (e.g. musical band).

demonstrable four conditions should be satisfied (Laughlin and Ellis, 1986): the consensus of the group on a conceptual system of definitions, rules, operations and so on (e.g. mathematical system, logical system, verbal system, etc.); there should be enough information for the solution within the system; group members must be able to recognise the correct solution once a member proposes it; the member that proposes the solution should have enough motivation, ability and time to demonstrate the correct solution to the other members. Group success is achieved by finding the correct answer. Highly demonstrable tasks are intellective tasks with a solution that, once is found, is immediately recognised by group members as the correct one and adopted as a group response (e.g. mathematical problems). In contrast, judgemental tasks do not have a demonstrable correct solution (e.g. aesthetic judgements). In highly demonstrable tasks, the 'truth-wins' criterion, first proposed by Lorge and Solomon (1955), is often used to compare group and individual performance (Davis, 1992). The criterion assumes that group members will independently try to solve the problem and that the group will select the correct response if at least one of its members has found it. Empirical evidence (Davis, 1992) suggests that, while groups are more successful than individuals in these problem-solving tasks, their performance rarely meets the theoretical baseline defined by the truth-wins criterion. It is, therefore, reasonable to conjecture that, in pure coordination games, groups of two individuals, as the ones we employ in our experiment, have the potential to perform better than individuals.

While interpreting pure coordination games as problem-solving tasks seems uncontroversial, doing so for games with conflicts of interest requires more words of explanation. Games with conflicts of interest are coordination games in which players have conflicting preferences among equlibria. A typical example of such games is the Battle of the Sexes. Schelling argues that, when interests diverge, parties should simply choose following payoff-irrelevant cues and reconcile their interests:

> "Beggars cannot be choosers about the source of their signal or about its attractiveness compared with others that they can only wish were as conspicuous. [...] The conflict gets reconciled - or perhaps we should say ignored - as a by-product of the dominant need for coordination."

(Schelling, 1957, pp. 22, 27).

From this quote, it is clear that the dominant need for coordination is more important than the conflict of interest. If 'beggars' want to coordinate, they should just ignore the conflict and follow the 'signal'. This signal then provides a way to solve the coordination problem and to reconcile the conflict. So, these games, as pure coordination games, are seen by Schelling as games that have a solution.

Contrary to Schelling's expectations, and possibly his interpretation, recent experimental evidence (e.g. Crawford et al., 2008; Isoni et al., 2013; Parravano and Poulsen, 2015) has shown that when conflicts of interest are introduced, payoff-irrelevant cues lose much of their power as coordination devices. One possible explanation is that the need for coordination is dominated by the conflict of interest. However, we argue that, when the conflict is negligible, this evidence is not necessarily at odds with Schelling's analysis. In the experiments of Crawford et al. and Isoni et al., subjects frequently chose the option that would give them the lower payoff in the case of successful coordination (the so-called *after you effect*). We conjecture that subjects were distracted by the payoffs but still wanted to coordinate, even if this meant choosing the option with the lower payoff. We can think therefore of these games as *trade-off* games (Bacharach, 1993; Bacharach and Bernasconi, 1997). Trade-off games are pure coordination games characterised by the presence of two distinct families of attributes that players use to describe the game to themselves (Bacharach and Bernasconi, 1997). For each family there exists a set of labels with one label for each attribute[3]. One family is highly 'available' to players (it comes easily to mind) but contains more than one salient label. The other family is 'obscure' (it does not come easily to mind) but contains a unique label[4]. An example of a trade-off game is given by Bacharach (1993). Two players must make a secret mark on a wooden block out of a set of 20. If they both mark the same block they earn some

[3]Note that labels in these games are not common knowledge, but are players' private descriptions. In addition, Bacharach and Bernasconi do not use the term 'label' but 'attribute'.

[4]If a label is either prominent but not unique or unique but not prominent, according to the notion of salience in Lewis (1969), it fails to be salient. In fact, a label is defined as salient if it is both unique and prominent. Bacharach, however, argues that, if we interpret the concept of salience as one of degrees, then that label is salient.

amount of money. Otherwise they earn nothing. Two blocks are red and 18 are yellow. At closer inspection, the wood grain in one of the yellow blocks is wavy, while in all the others it is straight. The colour of the blocks is the obvious family with non-unique labels (two yellow labels and 18 red labels), and the wood grain is the obscure family with a unique label (wavy grain). A player should mark the wavy-grained block only if she believes that the probability, that the other player has noticed it, is high enough. Trade-off games can then be considered as problem-solving tasks with a non-obvious solution. With divergent interests, players' payoffs become more salient (we can think of them as the obvious family) than when the conflict of interest is absent, and their saliency has the effect of obfuscating that of the payoff-irrelevant cues (we can think of payoff-irrelevant cues as the obscure family). As for pure coordination games, we expect groups to be more successful than individuals at finding the solution not only in trade-off games, but also in coordination games with small conflicts of interest.

Blume and Gneezy (2010) provide experimental evidence using a disc game with the characteristics of a trade-off game. In this game, players are presented with a two-sided five-sector disc with two black sectors and three white ones. The circular arrangement of the sectors is such that a white sector is always between the two black ones[5]. The two black sectors are prominent, in that there are only two of them compared to the three white ones while the white sector, in between the two black ones, is unique but not prominent (distinct sector henceforth). Results show that coordination success in this game is lowered by the difficulty of identification of the distinct sector, but it is higher than that implied by random choices.

Our interpretation of games with a low degree of conflict as trade-off games does not seem applicable when the conflict is large. Crawford et al. (2008) and Isoni et al. (2013) find that, in these instances subjects overwhelmingly chose the strategy where they could get, in the case of successful coordination, the higher payoff for themselves. This pattern

[5]Blume and Gneezy (2010) also employ in their experiment another disc game where the two black sectors are next to each other as are the three white sectors.

cannot be explained by claiming that it is just the saliency of the payoff-irrelevant cues that change. The need for coordination seems to be affected as well. This is not to say that subjects do not want to coordinate, they do want to, but on their preferred equilibrium. How groups are expected to perform in these games is not clear. Bornstein and Yaniv (1998) find that in ultimatum games, groups are more rational under the assumption of own profit maximisation than individuals, in that they propose and accept lower offers; similar conclusions are offered by Bornstein et al. (2004) who find that, in the centipede game, groups exit the game earlier than individuals. Cox and Hayne (2006) find instead the opposite result in common value auctions. Kocher and Sutter (2005) find that groups are not more rational than individuals in a beauty context game but learn faster. Cooper and Kagel (2005) compare group and individual behaviour in a signalling game. Groups outperform both individuals and the demanding truth-wins criterion, against which their performance is evaluated. Although evidence on group behaviour is mixed, Kugler et al. (2012) conclude that, in strategic settings, groups behave more in line with game theoretical predictions under the assumptions of rationality and selfishness than individuals.

In strategic interactions, groups are generally found to be more competitive (or non-cooperative) than individuals. This behaviour, termed the *discontinuity effect*, has been demonstrated in a series of studies involving the prisoner's dilemma game, where groups more often choose the non-cooperative strategy (for a review see Wildschut et al., 2003). Selfishness (*greed*) and fear of defection (Insko et al., 1990) are the leading explanations for this behaviour[6]. Competition can also have beneficial effects on group performance. Bornstein et al. (2002) show that group coordination in the weakest-link game (Van Huyck et al., 1990) increases when competition between groups is introduced. However, groups can

[6]Groups might choose the non-cooperative outcome that would result in a higher payoff for themselves if the other group chooses to cooperate (selfishness). However, they might also choose the non-cooperative outcome if they anticipate that the other group will choose it (fear of defection). Halevy et al. (2008, 2012), employ a modified inter-group prisoners dilemma game (Bornstein, 1992, 2003) to distinguish between situations in which competition is driven by a desire to hurt the out-group from those in which competition is motivated by the desire to help the in-group. They find that groups are not competitive per se but enter a competition in the attempt to maximise the group gains.

achieve higher coordination success, even without competition. Feri et al. (2010) compare group and individual behaviour in a range of coordination games. In games with Pareto-ranked equilibria, groups, contrary to individuals, select more often more efficient equilibria, earning on average higher profits. In games in which equilibria are not Pareto-ranked, they observe no difference between groups and individuals. Additionally, groups avoid miscoordination more successfully than individuals, but this only holds for large groups (i.e. five members) and when the number of strategies available to players is greater than two.

What emerges from this review is that groups are more competitive than individuals, and their behaviour is closer to rationality under the assumption of selfishness. In some cases, this can be beneficial for group performance (e.g. coordination games). However in others, it can be detrimental (e.g. prisoner's dilemma games). If we were to apply these conclusions to the games of concern, we should expect groups, when conflicts of interest are non-trivial, to coordinate less successfully on the focal point and to choose more often the strategy that, in case of successful coordination, guarantees the higher payoff for themselves.

In this paper, we explore group behaviour using three different games: the pie game (Crawford et al.); the bargaining table (Isoni et al.); and the disc game (Blume and Gneezy). The bargaining table and the pie game have been implemented with and without conflicts of interest, while the disc game, being a trade-off game, has only been implemented with no conflict of interest to avoid adding any further complexity to the already complex game.

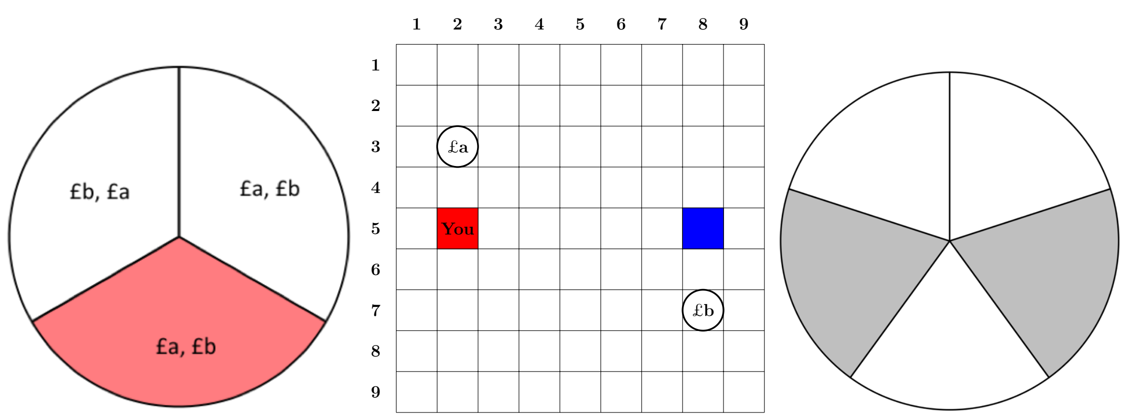
Our main findings are as follows. In pure coordination games, where conflict is absent, groups' choices agree more often with the choice suggested by the payoff-irrelevant cues. When conflicts of interest are introduced, groups do better than individuals only in the pie game when the size of the conflict is small. If we restrict our attention to groups and individuals that choose the distinct sector in the disc game, we find that they tend to coordinate more often on the focal point in both the pie game and the bargaining table, but only when the degree of conflict is small. This suggests that the ability to see the solution when interests are divergent is correlated with the cognitive sophistication needed to notice the inconspicuous but unique distinct sector.

Our paper is organised as follows. Section 2 presents the experimental design; section 3 is devoted to predictions; section 4 presents the results; and section 5 presents the conclusions.

2 Experimental Design

In our experiment, we employed three two-player coordination games: pie game (Crawford et al.), bargaining table (Isoni et al.), and disc game (Blume and Gneezy).

The pie game. In this game, players are presented with a pie (Figure 1a) with three slices of equal size: a red slice, that we will denote as R_{ab}, and two white slices that we will denote as W_{ab} and W_{ba}. The first subscript represents one player's payoff, and the second subscript represents the other player's payoff. Players have to choose one of the three slices simultaneously and without communication. If they choose the same slice, one earns the amount at the left of the comma while the other earns the amount on the right[7]. Colour is the payoff-irrelevant cue of the game and red is the salient label. To avoid creating other payoff-irrelevant cues, such as position, the rotation of the pie was randomised across players.



(a) Pie Game (b) Bargaining Table (c) Disc Game

Figure 1: Graphical representation of the games used in the experiment

[7]The payoffs shown on each slice were either ($£a$, $£b$) or ($£b$, $£a$). From each participant's perspective, the amount of money she could earn was always displayed on the left side of the comma, and the amount the other player could earn was always on the right. In other words, the order of $£a$ and $£b$ on the same slice was different between players.

We implemented five payoff pairs (Table 1) drawn from a value set $\{a, b\}$, in which $a \geq b$ (these payoffs represent monetary amounts in pounds). Payoffs $M1$ implement the pie game with no conflict of interest with $a = b$. Payoffs $M2 - M5$ introduce conflicts of interest where $a > b$. The payoffs on R_{ab} are always the same as the payoffs on the W_{ab} while the payoffs on the W_{ba} are always reversed.

Payoffs	a	b
M1	5	5
M2	5.1	5
M3	6	5
M4	8	3
M5	10	1

Table 1: Payoffs used in the pie game and the bargaining table

In determining the payoff pairs we followed the literature. Payoff pairs $M1$, $M2$ and $M3$ were used by Crawford et al. (2008) who showed that even a small difference in payoffs such as the one in $M2$ had a detrimental impact on coordination success. In addition to payoffs $M1$ and $M3$, Isoni et al. (2013) implemented $M4$ and $M5$ with the purpose of investigating whether increasing the difference in payoffs, while keeping the sum of payoffs constant with the exception of $M1$, would affect coordination.

The bargaining table. In the bargaining table, two players are presented with a 9×9 square grid with two coloured bases (red and blue) and two discs. Players are randomly assigned to one of the bases, and they select simultaneously and without communication only one of the two discs (we will say they claim a disc). If they claim the same disc, they earn nothing. If they claim different discs, they earn a positive payoff shown on the disc itself (see Figure 1b for a graphical representation of the bargaining table). The bases were always placed in row 5 and column 2 and 8, respectively (column and row numbers were not shown to subjects). The colour of the bases was randomised, so that the blue base was sometimes on the left of the table and sometimes on the right. The two discs were always placed in row 3, column 2 and in row 7, column 8, respectively, so that each disc was relatively close to one of the bases. In bargaining tables, closeness is the payoff-irrelevant cue, that has been shown to be a powerful coordination device (e.g. Isoni et al., 2013), and the close disc is the salient label. The payoffs we employed in this game are the same as the ones employed in the pie game.

The disc game. The disc game is the only trade-off game in our experiment. In this game, a pair of players is presented with a two-sided disc with two black sectors and three white ones. The graphical representation of the disc is shown in Figure 1c. The side and the rotation of the disc are randomised across players. Players have to choose simultaneously and without communication one of the sectors. If they both choose the same sector, they earn a positive amount; otherwise, they earn nothing. With such a complex game, we decided to implement only payoffs $M1$ and not to display the monetary amounts on the sectors, as this was deemed not necessary. Given that subjects could be presented with either side of the disc and any rotation, the only sector that could be uniquely identified was the white sector between the two black ones (i.e. the distinct sector).

Our experiment involves two treatments, an individual treatment (Ind) and a group treatment (Group) implemented between subjects. The main difference between the two treatments is that in the Ind treatment players are individuals, while in the Group treatment players are groups of two individuals.

The Ind treatment. The Ind treatment is our baseline treatment. Each subject was randomly and anonymously paired with another subject in the room and played the 11 coordination games in random order. No communication was allowed during the experiment, and no feedback was given until the end.

The Group treatment. In the Group treatment players are groups of two individuals. At the beginning of each session, every participant was informed that she would be randomly paired with another participant in the room to form a group, and that this person would be the same for the duration of the experiment. It was common knowledge that players were groups of two individuals.

A group-decision was reached only when both members agreed on the same option. The process of reaching a group decision was the following. First, each group member privately suggested what the group should choose[8]. Once both members gave their suggestions, they could see the options they had suggested on their screen. At this stage, they were allowed to communicate via a chat box to concert their choices. Groups could chat for as long as they wished and there was no limit to the number of words that they could exchange. The only rule we implemented was that, even if both suggestions coincided, team-mates were asked to chat so to make sure that their choices were not the result of an unintended mistake made in the suggestion phase. Subjects were not explicitly told that this was the reason. Once a group agreed unanimously on which option to choose, each group member selected on their respective screen the option they had agreed on; a second screen would then show a message confirming that their choices coincided, and the group could then proceed to the next game. If, for any reason, after the chat stage, choices did not coincide, the group had the chance to chat again to revise their choices. This process could be repeated five times. If no agreement was reached by then, the computer would randomly choose on their behalf[9].

Groups, as well as individuals, were given no feedback until the end of the experiment, so until then they only knew what their choices were but not what other groups (or individuals) had chosen.

To keep monetary incentives the same between treatments, earnings per participant in the Group treatment were the same as the corresponding earnings in the Ind treatment. For example, if two groups coordinated successfully on a game with no conflict of interest, each group member would earn £5.

We ran the experiment at the University of East Anglia in February 2016. We recruited 148 subjects (48 subjects in the Ind treatment and 50 groups of two individuals each in the Group treatment) with the online recruiting system hRoot (Bock et al., 2014). Most subjects

[8]In the instructions, it was made clear that the rotation of both the disc and the pie was kept the same for members of the same group but was randomised across groups. In the Ind treatment, participants were told that the rotation of both the pie and the disc was randomised across participants.

[9]In the actual experiment, all groups reached a final decision. In fact, only few groups needed more than one chat session to reach a unanimous decision. In the few cases where two chat sessions were needed, it was because one of the group members changed her mind at the last minute.

were British (51.35%) and the second most frequent nationality was Chinese (14.86%). The average age was approximately 21, and 60.81% of the subjects were females. The experimental sessions in the Group treatment lasted on average 80 minutes while those in the Ind treatment lasted for 40 minutes. At the beginning of each experimental session, subjects were asked to read the instructions and to answer a brief questionnaire to make sure that instructions were correctly understood. Once all clarification questions were answered, the experiment started. At the end of the experiment, one of the games was randomly chosen, and subjects were paid the amount they had earned in that game. Average earnings were £3.08. Subject were given an additional participation fee of £5.

3 Predictions

In this section, we will derive some hypotheses that will be used as benchmarks to compare the behaviour of groups versus the behaviour of individuals.

To derive predictions in the Ind treatment, we will use the theory of team reasoning to draw hypotheses for the pie game and the bargaining table, and variable frame theory (VFT, Bacharach, 1993; Bacharach and Bernasconi, 1997) for the trade-off game (i.e. disc game). Both theories are consistent with Schelling's view of coordination games as problems with a solution, hence they seem to be the most natural choices. Although we could employ team reasoning to derive predictions in the disc game, VFT is the best-suited theory, as it has been developed by Bacharach to explain behaviour in tacit coordination games including those where cognition might play a role. Cognitive hierarchic theory (Camerer et al., 2004) and level-k models (e.g. Costa-Gomes and Crawford, 2006; Costa-Gomes et al., 2001) are also often used to explain behaviour in coordination games. These models assume that players differ in their level of cognitive sophistication. In order to apply level-k models to coordination games with payoff-irrelevant cues, Crawford et al. (2008) assume that level-0 players choose non-strategically, and higher levels best respond to players that are one level below theirs. Although these models can be used to derive predictions in the games we employ in this experiment, assumptions regarding the distribution of levels in the population, as well as how levels combine to form a group level, need to be introduced. The predictions so derived are, however, sensitive to these auxiliary assumptions, hence we will just employ team reasoning and VFT[10].

To derive predictions for the Group treatment, we first need to derive predictions for the behaviour of each individual group member. Then we need a decision rule for the group that will allow us to derive group behaviour from that of its members. Because group members do not interact when they first make a suggestion to the other member, we will use team reasoning and VFT as with Ind treatment. In fact, the same predictions apply to both individuals and group members. As a decision rule, given the interpretation of coordination games with focal points as problem-solving tasks, we will use the truth-wins criterion. The truth-wins criterion, used for highly demonstrable tasks (Davis, 1992), assumes that group members work independently on a problem and that the group will select the correct answer if at least one of its members proposes it.

3.1 Pie Game and Bargaining Table

Although some versions of team reasoning are different in respect of whether individuals aim to maximise team's utility (Bacharach, 2006; Sugden, 1993, 1995) or achieve mutual benefits (Sugden, 2018), their core is very similar. The theory of team reasoning posits that individuals will make choices based on team thinking, that is, instead of asking 'what should I do?' they ask 'what should we do?'. They first try to find a rule (*the best rule* - e.g. a strategy profile in a game), if such exists, that either maximises the team's utility or yields mutual benefits. Each individual then follows that rule in the expectation that others will do the same. In two-player pure coordination games, such a rule is for both players to choose the strategy suggested by the payoff-irrelevant cues. When conflicts of interest are

[10]See Appendix B for more details about the limitations of level-k predictions.

introduced, team-reasoning predictions do not change.

Team reasoning theories were developed as an attempt to formalise Schelling's theory of focal points, and in common with Schelling's theory, they do seem to consider coordination games as problems that have a correct solution (i.e. the best rule), that is, problem-solving tasks. Evidence in social psychology shows that groups do better than individuals in this type of task (Laughlin et al., 2006). Lorge and Solomon (1955) were the first ones to use as a theoretical benchmark, the so-called truth-wins criterion, to evaluate the superior performance of groups versus that of individuals. The criterion assumes that group interactions are neutral, so that the group should be able to correctly solve the problem if at least one member solves it. If the probability of an individual to solve the problem is equal to p then a group with n randomly selected members should be able to solve the same problem with a probability of $q = 1 - (1 - p)^n$. Given that in our experiment $n = 2$, the probability of a group finding the best rule is $q = 1 - (1 - p)^2 > p$.

H1: *When interests are aligned, in both pie game and bargaining table, groups will choose the red slice and the close disc more often than individuals.*

H2: *When interests are not aligned, in both pie game and bargaining table, groups will choose the red slice and the close disc more often than individuals.*

3.2 Disc game

A central concept of VFT is that of frame. In coordination games, players are usually required to choose one out of a set of n objects. These objects are characterised by some attributes. A frame is defined as a set of families of attributes which can be used to partition the objects or options into subsets. In the disc game, we can identify two families of attributes: the colour family (C) and the circular order of the sectors (O). There are therefore four possible frames associated with these families of attributes: the empty frame $\{\varnothing\}$, the colour frame

$\{C\}$, the circular order frame $\{O\}$, and the conjunction of the last two frames $\{C, O\}$. Only the last frame is complete while the others are subsets of this.

In VFT, frames determine which options players have available to choose from. If a player has only the colour frame $\{C\}$, her options are {choose a sector, choose a black sector, choose a white sector}. If a player has the complete frame $\{C, O\}$ she is able to notice, given the circular arrangement of sectors and their colour, that one of them is unique (the distinct white sector), her options are then {choose a sector, choose a black sector, choose a white sector, choose the distinct sector}.

Families of attributes can be distinguished depending on their availability. When families come easily to mind, they are said to be easily available. We define v as the probability that a player notices (is aware of) a family of attributes. In the disc game, colour is an easily available family, so it seems uncontroversial to assume that all players have the colour frame $\{C\}$, hence $v = 1$. The fact, that the circular order of the sectors in conjunction with the colour implies that the white sector in between the black ones is a unique one, is not easily available, hence $v < 1$. The probability v, in VFT, is independent across players. There will therefore be players that have a complete frame $\{C, O\}$ and players that only have a subset of it, that is, $\{C\}$. Players' beliefs about other players' frames are correct but limited by their own frame, that is, a player who only has the $\{C\}$ frame cannot have a belief that other players have the complete frame $\{C, O\}$, because she does not have that frame. Given a frame, players are assumed to choose the option whose attribute is rarer because this guarantees higher chances of successful coordination (i.e. rarity preference). In the disc game, if a player has the $\{C\}$ frame, she will pick one of the black sectors, as there are only two of them, while there are three white ones. If a player has a complete frame $\{C, O\}$ she will choose the distinct sector only if she believes that the probability v, that the other player has a complete frame, is greater than the probability of coordinating on the black sectors. Given that there are only two black sectors, a player with a complete frame will choose the distinct sector only if $v > 1/2$.

We will now adapt this framework to obtain predictions for the Group treatment. The truth-wins criterion predicts that the probability of a group being aware of the distinct sector is $v' = 1 - (1 - v)^2 > v$. When players are randomly paired into groups, the probability that the distinct sector will be noticed increases, because only one individual in the group is needed for the group to notice it, and v is independent across players. Additionally, given that group formation is common knowledge, groups' beliefs, that are assumed to be correct albeit limited by their frame, about the probability that other groups will notice the distinct sector, will increase compared to individuals. Assuming for simplicity, that beliefs across treatments do not change, according to the truth-wins criterion, if the probability of an individual to choose the distinct sector is q, a group will choose the distinct sector with probability $q' = 1 - (1 - q)^2 > q$.

H3: *In the disc game, groups will choose the distinct sector more often than individuals.*

4 Results

4.1 Overview

Figure 2 and Table 2 report the proportion of times the *salient option* (the term salient option will be used to indicate the red slice for the pie game, the close disc for the bargaining table, and the distinct sector for the disc game) is chosen by treatment, game type and payoff type. In all games and for all payoffs, except $M5$ for the bargaining table (BT), groups choose the salient option more often than individuals. In both treatments, these proportions decrease as the difference in payoffs increases ($M1 - M5$). Similarly, the difference between treatments becomes less sharp.

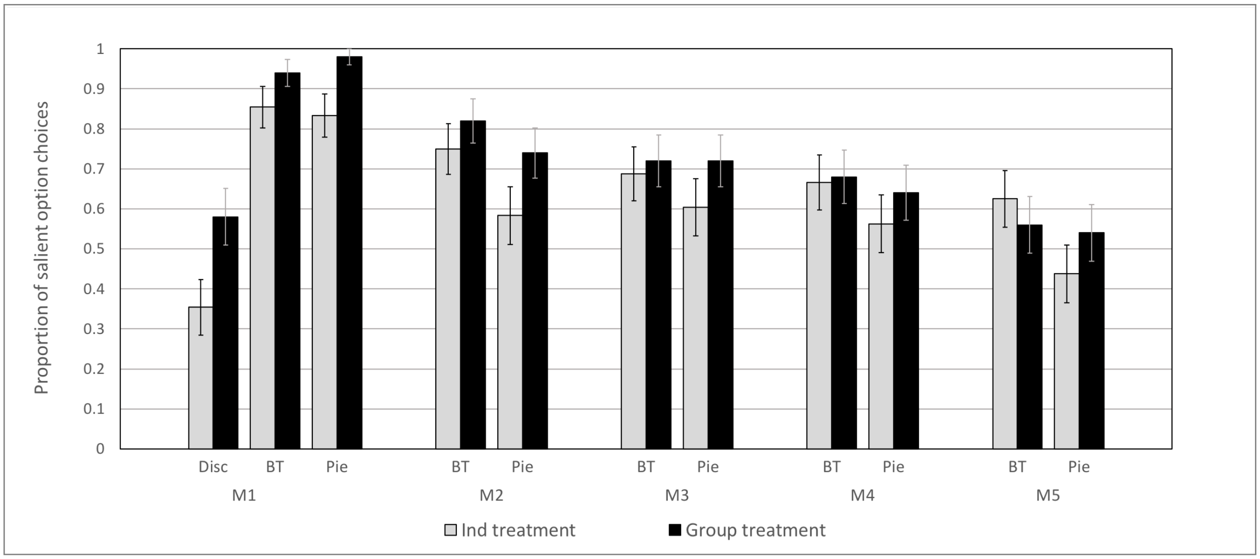


Figure 2: Proportion of salient option choices by treatment, game and payoff type with error bars.

Game	Salient Option	Treatment	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)
Disc Game	Distinct Sector (D)	**Ind**	0.35	-	-	-	-
		Group	0.58	-	-	-	-
Bargaining Table	Close Disc (C)	**Ind**	0.85	0.75	0.69	0.67	0.63
		Group	0.94	0.82	0.72	0.68	0.56
Pie Game	Red Slice (R_{ab})	**Ind**	0.83	0.58	0.60	0.56	0.44
		Group	0.98	0.74	0.72	0.64	0.54

Table 2: Frequency of salient option choices in all games by treatment and payoff type

Table 3 presents the same summary statistics as Figure 2 but with a greater level of detail. The table is split into three panels. **Panel a** reports summary results for the pie game, **Panel b** for the bargaining table and **Panel c** for the disc game. For each game, we report the distribution of choices over options (i.e. slices, discs, and sectors).

The slices in the pie game are R_{ab} (the red slice with payoffs (a, b)), W_{ba} (the white slice with payoffs (b, a)) and W_{ab} (the white slice with payoffs as (a, b), the same as R_{ab}). The sectors in the disc game are labelled D for the distinct sector, $B1$ and $B2$ for the two black sectors and $W1$ and $W2$ for the two white adjacent sectors. For the bargaining table we only report proportions of close disc choices, that is, the disc near a player's base.

For the pie game and the bargaining table, we report choices broken down by payoff type and also player type for games with conflicts of interest (payoffs $M2 - M5$). We define as Player 1 ($P1$) the player whose payoff is greater in the salient option and Player 2 ($P2$) the player whose payoff is instead lower. Finally, for each payoff pair we report the expected coordination rates (ECR), and the significance level of their difference between treatments.

Note that using the actual coordination rates obtained from our experimental data has no special significance. In our experiment, players (individuals or groups) were randomly paired at the beginning of the experiment[11]. This means that only one pairing out of many possible ones was actually implemented. However, because each player could, in principle, be matched with every other player that took part in the experiment, it is more meaningful to use the ECR that measures the probability that, in a game, two randomly matched players choose the same option.

In pure coordination games, the ECRs are obtained using the following formula (Mehta et al., 1994):

$$ECR = \sum_i ECR_i = \sum_i \frac{n_i\,(n_i - 1)}{N\,(N-1)}$$

where N is the number of players (individuals or groups, depending on the treatment), i is the slice, disc, or sector for which we are calculating the ECR, and n_i is the number of players that have chosen that slice, disc, or sector. The ECR_i are then added up to obtain total ECR for a particular game.

In coordination games with payoff pairs $M2 - M5$, the ECR_i is obtained in each game by multiplying the proportion of $P1$s that choose option i times the proportion of $P2$s that choose the same option. The ECR_i are then added up.

The ECR differs from the coordination success predicted by the mixed strategy Nash

[11]Note that this is not relevant for the subjects given they were only given feedback on a randomly selected game at the end of the experiment.

Panel a - Pie Game

Treatment	Slice	Player	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)
Ind	R_{ab}	P1	0.83	0.50	0.63	0.63	0.54
		P2		0.67	0.58	0.50	0.33
	W_{ba}	P1	0.06	0.46	0.33	0.29	0.21
		P2		0.04	0.21	0.33	0.67
	W_{ab}	P1	0.10	0.04	0.04	0.08	0.25
		P2		0.29	0.21	0.17	0.00
Group	R_{ab}	P1	0.98	0.72	0.80	0.84	0.80
		P2		0.76	0.64	0.44	0.28
	W_{ba}	P1	0.00	0.24	0.08	0.16	0.12
		P2		0.24	0.36	0.56	0.64
	W_{ab}	P1	0.02	0.04	0.12	0.00	0.08
		P2		0.00	0.00	0.00	0.08
			Expected Coordination Rates				
Ind			0.70	0.36	0.44	0.42	0.32
Group			0.96	0.60	0.54	0.46	0.31
S			***	***	*		

Panel b - Bargaining Table

Treatment	Player	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)
Ind	P1	0.85	0.75	0.58	0.58	0.79
	P2		0.75	0.79	0.75	0.46
Group	P1	0.94	0.72	0.72	0.76	0.88
	P2		0.92	0.72	0.60	0.24
		Expected Coordination Rates				
Ind		0.73	0.63	0.55	0.54	0.48
Group		0.88	0.68	0.60	0.55	0.30
S		**				***

Panel c - Disc Game

Treatment	D	B1	B2	W1	W2	*Total*
Ind	0.35	0.21	0.31	0.08	0.04	*1.00*
Group	0.58	0.22	0.16	0.02	0.02	*1.00*
	Expected Coordination Rates					
Ind	0.12	0.04	0.09	0.01	0.00	*0.26*
Group	0.33	0.04	0.02	0.00	0.00	*0.40*
S	***					***

Table 3: Frequency of choices in all games by treatment and payoff type.

Notes: In the bargaining table, we only report the frequency of choices for the close disc. Significance levels (S): * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

equilibrium. The former is derived from subjects' actual behaviour, whereas the latter is a theoretical benchmark. For example, in the disc game, the mixed strategy Nash equilibrium in which players uniformly randomise across strategies, predicts a coordination success of 1/5.

Given that each ECR consists of only one observation, to test whether there is a treatment effect, we use the bootstrap procedure employed by Bardsley et al. (2010). We repeatedly sample with replacement 10,000 times the distribution of choices for each payoff pair and game type in the Ind treatment. For each of these distributions, we calculate the corresponding ECR as explained above. We then use this distribution to obtain confidence intervals for the Group treatment.

4.2 The pie game and the bargaining table.

Games with no conflicts of interest. In games with no conflicts of interest (payoffs $M1$) groups choose the salient option more often than individuals. In the pie game, 98% of groups choose the red slice compared to 83% of individuals (test of proportions, $p < 0.01$); in the bargaining table, 94% of groups choose the close disc compared to 85% of individuals (test of proportions, $p < 0.09$). Binomial test results reveal that these proportions are significantly greater than those entailed by random choices ($p < 0.01$ in both cases). The ECRs are shown at the bottom of **Panel a** and **Panel b** in Table 3. They are extremely high in both treatments but exceptionally high in the Group treatment (96% in the pie game and 88% in the bargaining table). The difference in ECRs between treatments is significant (bootstrap procedure, $p < 0.001$ and $p < 0.05$ for the pie game and the bargaining table, respectively). This result is consistent with *H1*.

R1*: In the pie game and the bargaining table, groups coordinate more often than individuals on the focal point when there is no conflict of interest.*

Games with conflicts of interest. When conflicts of interest are introduced, the pattern in the data is more complex. In the pie game, see Table 2, we observe that the R_{ab} slice is chosen on average less frequently in both treatments as the payoff difference increases. The most notable difference between treatments is that groups (see Table 3) choose significantly less often than individuals the W_{ab} slice (Chi2 test, $p < 0.001$) and as a consequence, they concentrate their choices more on the two remaining slices R_{ab} and W_{ba}. This result seems to suggest that groups do indeed perceive focality more strongly than individuals, thus allowing them to exclude from their choices slice W_{ab} and to achieve greater ECRs than individuals for payoffs $M2$ and $M3$ (see Table 3). When the payoff difference increases, ECRs not surprisingly drop in both treatments.

In the bargaining table, both groups and individuals choose less often the salient option as the payoff difference increases. Groups tend to choose the close disc more often than individuals (except for payoffs $M5$) but the difference is small and not significant for any payoff pair we employ. ECRs decrease as payoff difference increases and, unlike in the pie game, there are no differences across treatments (the only exception is $M5$, where groups perform worse than individuals). Given that in this game there are only two options from which to choose (unlike in the pie game where there are three options), groups' stronger sensitivity to focality, observed in the pie game, is of no help. This result does not provide full support to $H2$.

R2: *Although groups seem to perceive saliency more strongly than individuals, this is not enough to fully support H2.*

4.3 Disc Game

The disc game is a trade-off game (Bacharach and Bernasconi, 1997) in that the identification of the unique distinct sector requires some level of cognitive sophistication. In line with $H3$, groups choose the distinct sector (58%) more often than individuals (35%). This difference is significant at a 5% level (test of proportions). Individuals (52%) choose the black sectors ($B1 + B2$) more often than groups (38%) while the two adjacent white sectors ($W1 + W2$) are chosen less frequently by both groups and individuals. In the bootstrapped results for the D sector, only eight observations out of 10,000 ($p < 0.001$) are greater than the observed ECR_D in the Group treatment. As a consequence, the difference in total ECR between groups and individuals is strongly significant as well (see Table 3, **Panel c**).

R3a: *In line with H3, groups choose significantly more often than individuals the distinct sector in the disc game, and this leads to a greater ECR in the Group treatment than that in the Ind treatment.*

To understand what is driving this result, we have looked at the decisions each group member made before having the chance to chat with their own partner. Before chatting, the proportion of group members that chose the distinct sector was 42%, a bit greater than that in the Ind treatment but not significantly different (test of proportion, $p = 0.85$). This shows that at the individual level, choices in the two treatments are similar. In only 14 cases, group members chose the same sector before chatting and, in 11 of these cases, they chose the distinct sector. All these groups confirmed their initial choices after chatting. Of the 36 groups whose members disagreed on their initial choices, 20 had one member who suggested the distinct sector before communication. In 17 of these cases, the group finally agreed on choosing the distinct sector, and only in three cases did the group opt for one of the black sectors. From the analysis of the chats we found evidence that 12 of these 17 groups chose the distinct sector because of its uniqueness. In the other five cases, the analysis of the chats is inconclusive. Finally, the groups that disagreed on sectors other than the distinct one reached a common decision because one of the members changed her suggestion to match the choice of the other member. In these cases, the chat analysis is inconclusive. But this is not surprising, as both black sectors and the two adjacent white ones are not unique, no argument can be provided for favouring one over the other. Just in a few cases, groups referred to the black sectors as being the right choice, or that coordination in that game was just random. This result provides support to the interpretation of coordination games as problems with a solution. If one of the members notices the uniqueness of the distinct sector, the other member is persuaded that choosing that sector is the *correct* choice. The chat analysis also shows that beliefs, about whether the other player has noticed the distinct sector do not seem to play a crucial role. Once one of the group members finds the solution the group will adopt it as such.

R3b*: If one of the group members is aware of the distinct sector, the group is more likely to choose the distinct sector.*

4.4 Group Performance and Truth-Wins Criterion

Figure 3 directly compares the proportion of salient option choices in the Group treatment with simulated truth-wins predictions. These predictions are indicated by the symbol '×', and error bars for the 90% confidence intervals are also reported. The truth-wins predictions are obtained using a procedure similar to the one employed by Cooper and Kagel (2005)[12].

In pure coordination games (payoffs $M1$), groups choose the salient option as often as the truth-wins criterion predicts. This is consistent with $H1$ and the results presented in the previous sections. In the pie game, for payoffs $M2 - M5$, the proportions of salient option choices are below the 90% confidence intervals for the truth-wins predictions. This distance is even more pronounced in the bargaining table.

R4*: In games with no conflicts of interest, groups choose the salient option at least as*

[12] Because we compare proportions of salient option choices, we need simulations to calculate error bars correctly. We have simulated 10,000 group datasets for each game and payoffs employed. Simulated groups are obtained from the individual treatment by repeatedly sampling with replacement a pair of distributions in the individual treatment. The two distributions are then combined to calculate the truth-wins predictions. A simulated group is considered as having chosen the salient option if either of its members choose the salient option. For payoffs $M2 - M5$, the pair of distributions are obtained separately for $P1$ and $P2$.

often as predicted by the truth-wins criterion, but they choose it less often in games with conflicts of interest.

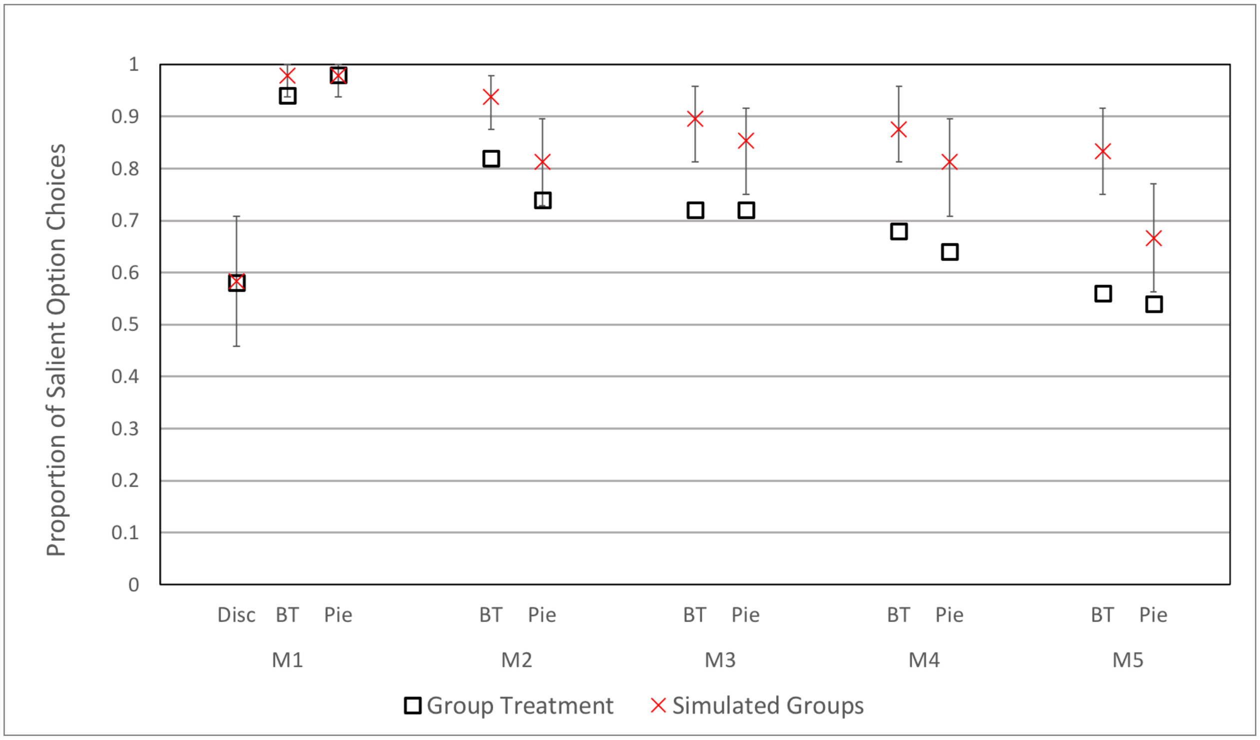


Figure 3: Comparing the performance of groups with the truth-wins predictions.

Notes: The vertical axis shows the proportion of times the salient option is chosen. The vertical bars give the 90% confidence interval for the truth-wins predictions. For the simulated groups, the large red '×' is the median value of the simulated 10,000 distributions.

Our results, in games with conflicts of interest, are consistent with abundant evidence in social psychology (see Davis, 1992, for a review) that shows that, although groups are more successful than individuals at solving problems with a highly demonstrable solution, their performance is generally lower than that set by the truth-wins criterion. The lower performance of groups can be explained by some inefficiencies in the group decision process (e.g. reduced motivation of group members compared to individuals, inefficiencies in combining individual responses into a group one, etc.)[13].

[13]It is possible that the lower performance of groups relates to the size of incentives. The experimental sessions in the Group treatment were twice as long as those in the Ind treatment, but payments were the

Inefficiencies in the group decision process might relate to the demonstrability of the solution to a task. If a solution is not highly demonstrable[14], the group might not recognise it if one of the members suggests it, or members might disagree altogether on what the solution is. The length of the chats in our experiment could be used as an indication of how demonstrable a solution is in all the games and payoffs employed. Intuitively, if the solution to the coordination problem is highly demonstrable, the group should adopt it as an answer without the need for a lengthy discussion. If instead the solution is not highly demonstrable, the group might need to chat for longer in order to adopt it as a group response. The length of the chats can be measured not only in terms of time spent in the chat but also in terms of words exchanged. Both measures present advantages and disadvantages. For example, time does not only reflect the number of words typed but also how fast one can type. Similarly, the number of words used might correlate with written communication skills.

Panel a in Table 4 reports both the average number of words exchanged by groups and the time needed to exchange them, when members' initial suggestions differ. Because of the small number of observations (in particular for the pie game and the bargaining table in games with no conflict of interests) we have pooled observations across similar games: we report the disc game separately as its solution is not as obvious as it is in the other two games, we pool the observations for the pie game and the bargaining table in games with no conflicts of interest (payoffs $M1$), in games with small conflicts of interest (payoffs $M2$ and $M3$) and in games with large conflicts of interest (payoffs $M4$ and $M5$) rspectively. In the analysis, we have considered only the chats of those groups in which one member has selected the salient option that eventually the group chooses[15].

same. If groups perceived incentives as being too low, the observed difference in behaviour between groups and individuals might be underestimated. We needed payments to be consistent between treatments, but we do recognise that they were probably quite small. However, Parravano and Poulsen (2015) find that the size of payoffs does not affect coordination behaviour in games with focal points when interests diverge.

[14]To remind the reader, for a problem to be demonstrable, four conditions need to be satisfied: group agreement on the conceptual system used to solve the problem; sufficient information for a solution to exist; sufficient knowledge of the system that allows the group to recognise the solution once it is found; sufficient motivation, ability and time for the member that has found the solution to demonstrate the correct solution to the other group members.

[15]For this analysis, we have excluded the groups in which neither member suggested the salient option, as

Panel a - Length of chats					Panel b - Regression Analysis			
Game	Payoffs	Words	Time	N	Model 1		Model 2	
Disc	$M1$	45	120	17	-	-	-	-
Pie & BT	$M1$	28	89	9	-17.92^{*}	(9.74)	-30.36	(23.85)
Pie & BT	$M2$ & $M3$	44	108	27	-1.58	(8.66)	-12.00	(21.30)
Pie & BT	$M4$ & $M5$	54	138	31	8.85	(8.36)	17.97	(20.99)

Table 4: Panel a - Length of the chats in the Group treatment as a measure of demonstrability. Panel b - Regression analysis.

Notes: Panel a - The column 'Words ' reports the average number of words used in the chats by the groups in which there is an initial disagreement, and one of the members has selected the salient option. The column 'Time' reports the average time in seconds that groups spent in the chats. The column 'N' reports the number of observations, which corresponds to the number of groups. **Panel b** reports the results of two OLS regressions, clustering at the group level, with the average number of words (Model 1) and average time spent in the chat (Model 2) as dependent variables. Significance levels (S): * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

The average number of words exchanged in the disc game is almost twice as large as that in the pie game and the bargaining table with payoffs $M1$. Groups exchange as many words in the disc game as they do in the pie game and bargaining table with payoffs $M2$ and $M3$ but fewer when payoffs are $M4$ and $M5$. We observe a similar pattern for the time spent in the chat. To test whether differences across games are significant, we have run two OLS regression models with clustering at a group level (Table 4, **Panel b**). The independent variables, reported in the first column of **Panel a**, are four dummy variables: the disc game, the pie game and bargaining table with payoffs $M1$, payoffs $M2$ and $M3$, and payoffs $M4$ and $M5$ respectively. The dependent variables are the number of words exchange by groups (Model 1) and length of the chats in seconds (Model 2). The disc game dummy is the baseline case[16]. In Model 1, the results indicate that the number of words used in the disc

we are interested in groups in which one member has found the solution and tries to demonstrate it to the other member. The number of excluded groups is very small and the pattern in the data is not dissimilar from what is reported in Table 4, **Panel a**.

[16]Note that we can use neither a Mann-Whitney test for independent samples nor a Wilcoxon test for non-independent samples. We have selected the groups whose members' disagreed in their initial suggestion but one of the members chose the salient option. In our sample, some groups satisfy the selection criterion in more than one game (so, some observations are non-independent), and some others only in one game (so, some observations are independent). It would be possible to solve this problem by either considering only the independent observations or considering only the non-independent ones. This would however reduce even further the number of observations. Because of this, we have decided to opt for OLS regressions with

game is significantly greater than those exchanged in the pie game and bargaining table with no conflicts of interest ($M1$). In Model 2 no estimated coefficient is statistically significant.

If the number of words exchanged is a proxy for how demonstrable a solution is, these results suggest (although we need to be careful about drawing conclusions with such a small sample) that, demonstrability in the disc game is lower than that in the pie game and the bargaining table for payoffs $M1$ but does not significantly differ from that in the pie game and bargaining table for payoffs $M2$, $M3$, $M4$ and $M5$. At odds with this however, we have found that group performance in the disc game is as predicted by the truth-wins criterion, implying that the disc game has a highly demonstrable solution, unlike games with mild conflicts of interest (payoffs $M2$ and $M3$), where group performance is lower. A possible explanation for this contradicting results might lie in the fact that the non-obvious solution in the disc game, despite being highly demonstrable, is not easily explained and therefore, requires the group to exchange more words to see it.

4.5 Analysis by Type

In this section, we ask whether the cognitive sophistication needed for identifying the distinct sector in the disc game is correlated with salient option choices in the pie game and the bargaining table. The intuition is that groups and individuals that choose the distinct sector (D-type) appear to possess the necessary cognitive sophistication to solve coordination problems that might therefore be transferred to other contexts such as the pie game and the bargaining table. Cognitive sophistication can be thought of as a trait that individuals or groups possess and is observed in the disc game that acts as a measuring device.

It might be argued that the pie game and the bargaining table feature obvious solutions, hence cognition does not really play a role. However, we have contended in the introduction that, despite its saliency, the solution when there is conflict of interest, in particular when this is negligible (i.e. $M2$ and $M3$), is obfuscated by the payoff difference, hence relatively

clusters at the group level).

less salient. These games can therefore be interpreted as trade-off games such as the disc game. When the payoff difference is large ($M4$ and $M5$), both groups and individuals still want to coordinate but on their preferred outcome rather than the one suggested by the payoff-irrelevant cues. This seems to be supported by the fact (see Table 3) that an overwhelming proportion of both groups and individuals choose the option with the higher payoff for themselves. Hence these games cannot be interpreted as trade-off games.

We define as D-type those groups or individuals who have chosen the distinct sector (46 observations) and O-types those who have not (52 observations). Figure 4 and Table 5 present the frequency of salient options in the pie game and the bargaining table, broken down by treatment, payoff pair, and type. At the aggregate level, we found strong evidence that D-types choose the salient option more often than O-types (Mann-Whitney, $p < 0.02$).

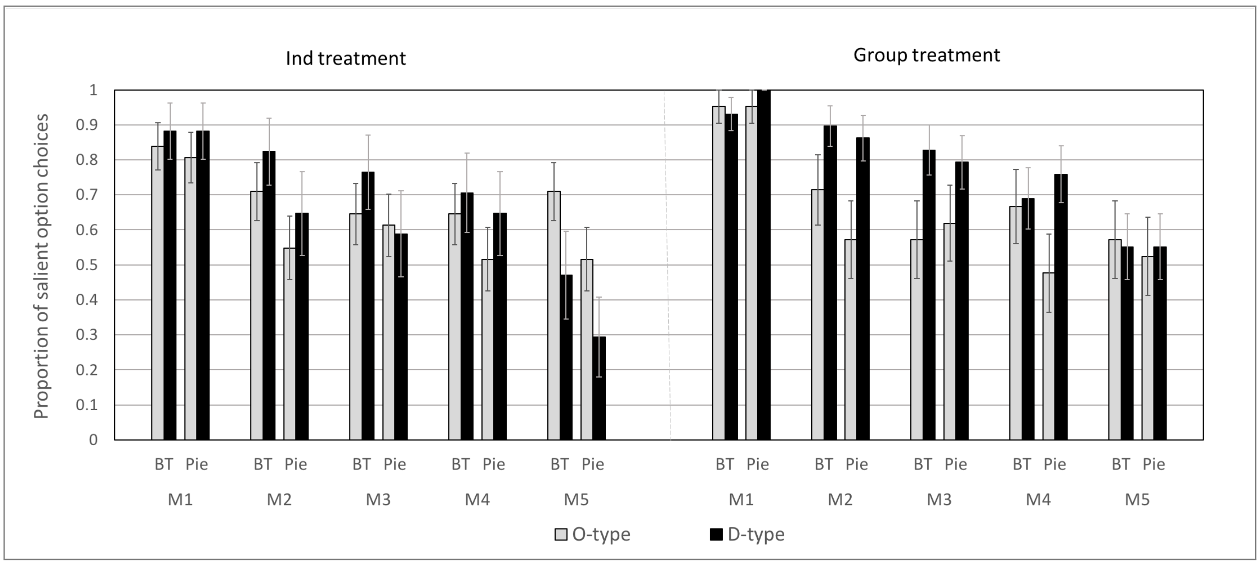


Figure 4: Proportion of salient option choices with error bars by type.

Mann-Whitney test results also reveal that this proportion is significantly greater for D-groups than both D-individuals and O-type individuals and groups ($p < 0.09$, $p < 0.001$ and $p < 0.04$, respectively). Pairwise comparisons between D-individuals and O-types are not significantly different.

R5: *D-groups choose the salient option significantly more often than D-individuals, O-*

groups, and O-individuals.

Panel c of Table 5 reports the ECRs per treatment and payoff pair obtained by matching D-players with D-players and O-players with O-players. D-type's ECRs are, in most cases, greater than those of O-types. In the Ind treatment, the difference in ECRs between types is less pronounced than in the Group treatment but it is almost always significant. In the Group treatment, the difference in ECRs between types is significant except for payoffs $M4$ and $M5$. Interestingly, these ECRs do not significantly differ from the ECRs obtained in the Ind treatment for games with no conflicts of interest. This suggests that, for D-groups, small payoff differences are not an issue and do not lead to coordination failure.

The results in this section lend some support to the hypothesis that games with small payoff differences can be thought of as trade-off games. In these games, D-groups, and to a lesser extent D-individuals, are not distracted by small payoff differences and additionally have the necessary cognitive sophistication to identify the unique solution. Our hunch of why cognition might play a role lies in the fact that D-types might be particularly sensitive to symmetry. That is, to see the distinct sector, they should notice that there is an asymmetry and this lies in the distinct sector. In the pie game and the bargaining table, Player 1 and Player 2 are in exactly the same position but with opposite interests. A person sensitive to symmetry might be able to see, from a purely logical point of view, that whatever applies to Player 1 applies, but in the opposite direction, to Player 2. Hence the unique rule that can accommodate this difference is to choose that which is not based on payoffs and is the same for both players (i.e. symmetric). This rule is to choose the salient option.

D-groups are more successful in coordination than D-individuals. We postulate that a possible reason might relate to the way we measure cognition. Firstly, some participants might have chosen the distinct sector randomly (this might account only for a small number of choices). In the Group treatment, however, we have provided evidence that most groups choose the distinct sector because of its uniqueness rather than randomly. Secondly, VFT predicts that the belief that other players have noticed the distinct sector is smaller in the

Panel a: Frequency of salient option choices by type

			Bargaining Game					Pie Game				
Treatment	Player	Type	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)
Ind	P1&P2	*O*	0.84	0.71	0.65	0.65	0.71	0.81	0.55	0.61	0.52	0.52
		D	0.88	0.82	0.76	0.71	0.47	0.88	0.65	0.59	0.65	0.29
Group	P1&P2	*O*	0.95	0.71	0.57	0.67	0.57	0.95	0.57	0.62	0.48	0.52
		D	0.93	0.90	0.83	0.69	0.55	1.00	0.86	0.79	0.76	0.55

Panel b: Frequency of salient option choices by type and player type

			Bargaining Game					Pie Game				
Treatment	Player	Type	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)
Ind	P1	*O*	-	0.75	0.53	0.60	0.93	-	0.40	0.61	0.61	0.59
		D	-	0.75	0.67	0.56	0.56	-	0.67	0.67	0.67	0.43
	P2	*O*	-	0.67	0.75	0.69	0.50	-	0.69	0.62	0.38	0.43
		D	-	0.89	0.88	0.88	0.38	-	0.63	0.55	0.64	0.20
Group	P1	*O*	-	0.54	0.58	0.73	0.85	-	0.50	0.70	0.67	0.75
		D	-	0.92	0.85	0.80	0.92	-	0.87	0.87	0.94	0.85
	P2	*O*	-	1.00	0.56	0.50	0.13	-	0.64	0.55	0.33	0.22
		D	-	0.88	0.81	0.63	0.29	-	0.86	0.71	0.54	0.31

Panel c: *ECR*s by type

			Bargaining Game					Pie Game				
Treatment	Player	Type	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)	M1 (5,5)	M2 (5.1,5)	M3 (6,5)	M4 (8,3)	M5 (10,1)
Ind	-	*O*	0.73	0.58	0.52	0.54	0.50	0.69	0.28	0.44	0.35	0.32
		D	0.79	0.69	0.63	0.54	0.49	0.79	0.47	0.45	0.55	0.43
		S		*	*				**		***	*
Group	-	*O*	0.91	0.54	0.51	0.50	0.24	0.91	0.46	0.43	0.44	0.29
		D	0.87	0.82	0.72	0.58	0.33	1.00	0.76	0.64	0.53	0.32
		S		**	***				***	**	*	

Table 5: Frequency of salient option choices and ECRs by game, payoff and player type.

Notes: Significance levels (S): * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

Ind treatment than in the Group treatment. In the Group treatment, from chat analysis, evidence suggests that beliefs did not play a substantial role, however we do not have this evidence in the Ind treatment. Thus, it might be possible that the number of participants choosing a black sector, even if aware of the distinct one, is greater in the Ind treatment than in the Group treatment. Both these factors together make the D-type/O-type distinction in the Ind treatment less precise than in the Group treatment.

5 Conclusions

The purpose of this paper was to investigate how group behaviour compares to individual behaviour in coordination games with focal points. We have argued, consistently with Schelling's view, that these games can be thought of as games with a correct solution and this should lead groups to coordinate more successfully than individuals.

In line with our predictions, we find that groups outperform individuals when interests are aligned and when some level of cognitive sophistication is required to identify the solution to the problem of coordination.

When interests are not aligned, and consistent with previous findings (e.g. Crawford et al., 2008; Isoni et al., 2013), the expected coordination rates in both treatments drop. Our analysis though suggests that groups seem to be more sensitive to salience than individuals, as evidenced by the results in the pie game. This phenomenon is not detectable in the bargaining table where the choice is only between two strategies, close disc and far disc. Groups however, in these games, do not always perform better than individuals. So, on the one hand, groups seem more sensitive to salience but despite this, their coordination success is not higher than that of individuals, except in a few cases. Previous findings on group behaviour show that groups are generally more selfish and competitive than individuals, and even more so when the conflicts of interest are severe (Wildschut et al., 2003; Kugler et al., 2012). In our experiment, being more competitive could translate into groups choosing more often than individuals the option that favours themselves disregarding what payoff-irrelevant cues suggest. This could explain, compatibly with our results, why the behaviour of groups in our experiment, for this class of games, does not differ significantly from that of individuals, that we conjecture are both less sensitive to salience but also less competitive.

Finally, groups and individuals who choose the distinct sector more frequently choose the salient option in the other games more often than those who have chosen any other sector. We advanced a conjecture based on cognition. Cognition endows players with the ability to identify the perfectly anti-symmetrical position of their co-player compared to theirs and to find the rule that applies equally to both of them. This does not necessarily imply maximising the team's utility function but stems mainly from logical considerations arising from the structure of the game. For these groups and individuals, uniqueness might be so salient as to overshadow the saliency of the payoffs.

Schelling (1960) believed that finding the key to solve a coordination problem involved more imagination than logic, however we have shown that this is only part of the story. Groups and cognitively sophisticated players display a better ability to find the solution to the riddle of coordination. This implies that coordination success is not just a matter of wanting to coordinate but also being able to do so, and groups have shown a greater ability in this respect.

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Appendix A. - Experimental Instructions

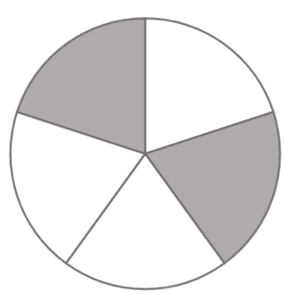
Note: The instructions for the Ind treatment and the Group are similar. When there are differences, the texts for the Ind treatment are enclosed in curly brackets ' {} *', and the texts for the Group treatment are enclosed in square brackets '* [] *'.*

Experimental Instructions

Welcome to this experiment in [team] decision making. [During the experiment, you will be part of a team made of two people - you and another participant.] In each round of the experiment {you} [your team] will be matched with another {person} [team (also made of two people)] in the room. Your earnings will depend both on your [team's] decision and the decision of the other {person} [team]. There are 11 rounds (displayed in a random order) and the decisions you have to make depend on the type of task in that round. There are three types of task in the experiment.

TASK A

In this type of task, {you} [your team] and the other {person} [team] will be asked to choose one of the five slices of a pie, like the one shown below, by clicking on your choice. The pie is two-sided. The computer will flip and spin the pie so that [although] the side and rotation you see [will be the same as what your team-mate sees, they] may not be the same as the ones the other {person} [team] sees.

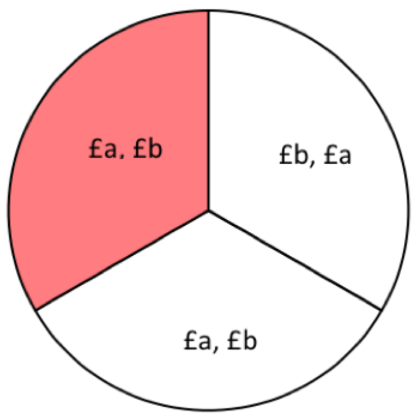


if you and the other {person} [team] choose the same slice each {of you} [player in the teams] will earn £5. If {you} [your team] and the other {person} [team] chooses a different slice, {both of you} [you all] will earn nothing.

The experimenter has a pie made of paper. Raise your hand if you want to inspect it.

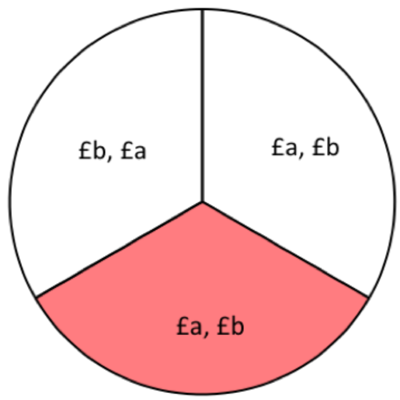
TASK B

In this type of task, {you} [your team] and the other {person} [team] will be presented with {a} [the same] pie with three slices, like the one shown below, and asked to choose one slice by clicking on your choice.



In each slice there are two amounts, represented by the letters 'a' and 'b' in the pie above. If {you} [your team] and the other {person} [team] **choose the same slice {you} each member of your team] will earn the amount on the left of the comma of the chosen slice** {and} [while each member of] the other {person} [team] will earn the amount on the right. If you and the other {person} [team] **choose a different slice you {both} [all] earn nothing in that task.** In the actual experiment the letters will be replaced by numbers.

The orientation of the pie is randomly decided by the computer separately for each {person} [team] in the room. This means that, although {you} [your team] and the other {person} [team] will see the same pie, its orientation will vary. For example, {you} [your team] may see the pie above while the other {person} [team] may see the pie below. There is therefore no way for you to know what orientation the pie of the other {person} [team] sees.

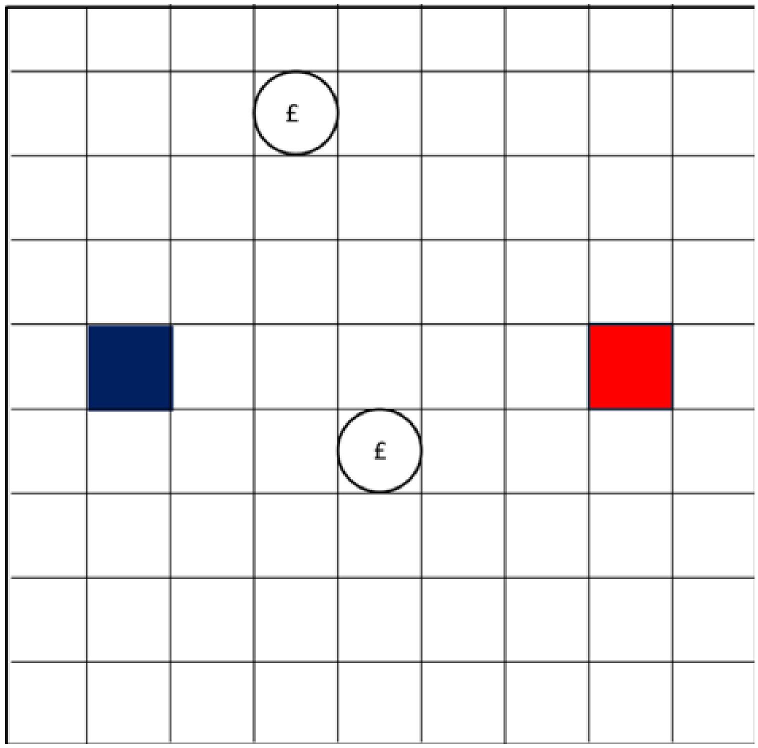


[NOTE. The amounts displayed are the earnings per player NOT per team!]

TASK C

In this type of tasks, you will be presented with a table similar to the one shown below. {You} [Your team] and the other {person} [team] will be assigned a colour. If {you are} [your team is] the Red {player} [team] then the other {person} [team] is the Blue {player} [team] and vice-versa. {You} [Your team] will be assigned a base, represented by a red square if {you are} [your team is] the Red {player} [team] or a blue square if {you are the} [your team is a] Blue {player} [team]. You will be told in each of these tasks whether {you are} [your team is] the Blue {player} [team] or the Red {player} [team].

There are two discs on the table. {You} [Your team] will be asked to choose one of these discs; you can do so by clicking on it. You earn the amount written inside the disc if the other {person} [team] has chosen the other disc. So, **you earn some money if {you and the other person} [both teams] choose a different disc. If {you} both [teams] choose the same disc you [all] earn nothing.**



[NOTE. The amounts displayed are the earnings per player NOT per team!]

[How to reach a team's decision

In every task, you will be asked to make a suggestion. Once you have made and submitted your suggestion you will be shown both what you have suggested and what your team-mate has suggested. These suggestions may either be the same or different. You will be asked to chat with your team-mate before you can proceed. A team's decision will be reached only if both you and your team-mate make the same suggestion and confirm it. You can revise your suggestions up to 5 times. If by then you and your team-mate have not reached the same suggestion, the computer will choose randomly for your team.]

Final earnings

At the end of the experiment the computer will randomly choose one of the 11 rounds. Your earnings will be determined (as explained in the previous pages) by {your choice} [the choice of your team], the choice of the other {person} [team] and the type of task played in the randomly chosen round. In addition to whatever you have earned in that round, you will be given a show up fee of £5.

Appendix B. - Level-k predictions

There are several models of level-k reasoning (Stahl and Wilson, 1995; Camerer et al., 2004; Costa-Gomes and Crawford, 2006). A common feature of these models is that players are assumed to maximise their own payoffs, and they are heterogeneous in terms of depth of reasoning. The lowest level, level-0 ($L0$ henceforth) players do not play strategically. In some models, they are assumed to choose at random; in other models, they are assumed to choose the option that favours themselves. Higher-level players form beliefs about what players who are one level below them would do and best respond to that behaviour.

In this appendix, we demonstrate that in coordination games involving conflicts of interest, group behaviour, as predicted by level-k theory, depends to a high degree on assumptions about the distribution of players' depth of reasoning (i.e. levels), the size of the conflict (i.e. difference in payoffs), and the assumption about $L0$ players' non-strategic behaviour. For simplicity, we first assume that $L0$ players will choose the option with the greater payoff for themselves with probability $p > 1/2$ (used in Crawford et al., 2008). This assumption helps us demonstrate how prediction changes with p, the size of the conflict, and the distribution of players' depth of reasoning. We will later discuss how different assumptions on $L0$ behaviour will affect the prediction.

Let us define Player 1 as the player favoured by the choice the payoff-irrelevant cue suggests (i.e. the player who has the higher material payoffs than their co-player in the focal point) and Player 2 as the player not favoured by it (i.e. the player who has the lower material payoffs than their partner in the focal point). Based on this assumption, an $L0$ Player 1 will choose the red slice (R_{ab}) in the pie game and the close disc (C) in the bargaining table with probability $p > 1/2$, while an $L0$ Player 2 will choose W_{ba} and the far disc (F) in the pie game and the bargaining game respectively with the same $p > 1/2$. An $L1$ Player 1's best response depends on both p and the difference in payoffs a and b (see Table 3). Other things being equal, if the difference is small or p is large, an $L1$ Player 1 will choose W_{ba} and an $L1$ Player 2 will choose R_{ab}. $L2$ behaviour is the same as an $L0$, and $L3$ behaviour is the same as an $L1$ and so and so forth. If the difference in payoffs is big or p is small, $L1$ players will switch their behaviour and choose R_{ab} if they are Player 1 and W_{ba} if they are Player 2. The same applies to higher levels. Therefore, level-k predictions depend critically on the size of the conflict and p. Notice that specifying these two parameters is still not enough to give clear predictions on group behaviour. When we move from individuals to groups, we assume that groups' depth of reasoning will be on the aggregate higher[17]. However, without specifying the distribution of levels, we are unable to know how the distribution of odd and even level players will change, and this is critical to derive meaningful predictions.

Even if we were able to specify the distributions of levels in the population, level-k predictions will still be sensitive to the assumptions on $L0$'s behaviour. Consider the level-k theory proposed by Crawford et al. (2008) as an example. The model assumes that $L0$ only exists in the mind of the players and that the frequency of players with a level higher than two is negligible. As shown above, $L0$ players are assumed to choose the option with the greater payoff for themselves with probability $p > 1/2$. For simplicity, let's assume $p = 1$, which means $L0$ always chooses the option that favours themselves. Under these assumptions, $L0$ Player 1 will choose the salient option (i.e. R_{ab} or close disc)[18], $L1$ Player 1 chooses the non-salient option that favours their partners (i.e. W_{ba} or far disc), and $L2$ Player 1 will choose the same as $L0$ Player 1. Accordingly, the model predicts that Player 1 in the Group treatment is more likely to choose the salient option than Player 1 in the Ind treatment. This is because the number of $L2$ players increases in the Group treatment. However, if $L0$'s behaviour is specified as choosing a random option, as some level-k models do, then $L0$ ($L2$) players in the new specification will behave the same as $L0$ ($L1$) in the old specification. Accordingly, the prediction of $L2$'s behaviour in the Group treatment will be different, depending on which assumption of $L0$'s behaviour is adopted.

[17]Penczynski (2016) shows that a when low-level reasoning individual is paired with an individual with a higher level of reasoning, the former tends to adopt a high level of reasoning persuaded by the sophistication of their partner's argument.

[18]To explain subjects' behaviour in pure coordination pie games, level-k (Crawford et al., 2008) assumes that the probability that $L0$ players choose the red slice is greater than a half. We also make this assumption so $L0$ Player 1 will choose R_{ab} rather than W_{ab}.