Abstract

I investigate the hypothesis that time pressure matters for the strength of focal points. Using a simple asymmetric-payoff coordination game, I collect data under two different time limits. I find that whilst the effects are not statistically significant, there is a shift towards the selection of the focal strategy when time pressure increases. Consequentially, the expected coordination rate increases, and is significantly different from the mixed-strategy prediction.

1. Introduction

Schelling (1960) first conceptualised the notion of focal points, which is a fundamental concept in coordination problems. Schelling (1960, pp. 57) argued that in coordination problems there generally exists some “focal point for each person’s expectation of what the other expects him to expect to be expected to do”. That is, in the presence of multiple equilibria there may be some strategies that are more salient by nature, than others, on which individuals’ expectations converge. Experimental findings on focal points have found that individuals are relatively successful at coordinating over symmetric payoffs. However, when there is payoff-asymmetry, the tension between maximising self-earnings and successfully matching strategies leads to substantial declines in the level of coordination. Schelling (1960, pp. 283) suggests that focal points may be very sensitive to coordination contexts, stating that some “rule must be used must be used if success is to exceed coincidence, and that rule, whatever its rationalisation, is consequentially a rational rule”.

Here I test the hypothesis that time pressure matters for the power of focal points, by imposing different time constraints on participants in a simple asymmetric coordination game. The intuition for this is that, given that focal points are sensitive to context, factors that influence the environment in which such coordination decisions are made might impact the rules used to select strategies. I hypothesise, that under time pressure focal points will
become more powerful. When individuals have less time to coordinate, they might increasingly select focal strategies, given that they ‘stand out’ amongst the set of strategies. I find that whilst not statistically significant, selection of the label-based focal strategy increases under time pressure, and consequentially, expected coordination rates are higher, rising above the mixed-strategy Nash equilibrium prediction.

2. Motivation
This is an exploratory investigation into the effects of time pressure of focality, which aims to increase our understanding of focal points and their role in coordination problems. On a theoretical level, I believe that this research contributes to our understanding of the nature of focal points, and the factors which might affect them. On a more practical level, coordination problems, and therefore focal points, are economically important. For example, firms and consumers might want to coordinate their purchases of technologies and other goods that exploit network effects. On an organisational level, managers and departments must coordinate their actions to operate efficiently. Moreover, when such organisations are spread out geographically coordination may become more difficult. Coordination of this kind may be subject to time pressure and deadlines, or by the same logic, these decisions may need to be made quickly. As such, if strategy selection in such problems is affected by time pressure, then we may see changes in the ability to coordinate and the selection of strategies, in turn affecting the efficiency of organisational operation. Under such time constraints, if strategies that one would expect others to do becomes more salient, then it might be that such organisational entities might be more likely to engage in some form of team-reasoning (Sugden, 1993). Another issue could arise in financial markets. For example, different divisions of an investment firm might need to quickly coordinate their strategies in response to financial shocks. Therefore, it seems economically important, on both a theoretical and practical level that time pressure might matter for coordination and strategy selection, particularly with respect to intra-organisational coordination.

3. Theory
Coordination games refer to games in which payoffs are maximised when players coordinate their strategies. These games reflect the beneficial nature of coordinating strategies and the sub-optimal outcomes that arise when agents fail to coordinate. Coordination problems can arise in different contexts, and as such the payoffs structures may be different across games to reflect these different contexts. For example, payoffs for achieving coordination may be symmetric or asymmetric across agents, whilst payoffs from not achieving coordination may be positive, or zero. In this paper, I focus on a simple 2x2 coordination game with asymmetric payoffs (more commonly known as the battle of the sexes game). Here, each player makes their decision simultaneously and independently from one another, with no possibility of communication. Figure 1 displays the normal form representation of this game.

Figure 1: Battle of the Sexes Game

<table>
<thead>
<tr>
<th></th>
<th>Person 2</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Person 1</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>a₁, a₂</td>
<td>0, 0</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0, 0</td>
<td>b₁, b₂</td>
<td></td>
</tr>
</tbody>
</table>

The payoff structure is such that a₁= b₂ > a₂= b₂ > 0, where the number indexes the Player. Clearly, Person 1’s preferred strategy is A, whilst Person 2’s preferred strategy is B. However, both players prefer coordinating to not coordinating. In this case there are two pure strategy Nash equilibria, which is a feature present in 2x2 one-shot coordination games. The prediction of which equilibria will arise is particularly problematic for game theoretic analysis. The relevant solution concept for these types of game is mixed strategy Nash equilibrium (MSNE). A mixed strategy defines a probability distribution over the pure strategies that maximises expected payoffs. However, whilst this solution concept is theoretically sound, it does not seem entirely appropriate for predicting coordination behaviour. Camerer (2003, pp. 337) argues that it is “unlikely that a purely mathematical theory of ration play will ever fully identify which of many equilibria are likely to emerge”, since factors such as cultural significance and the way in which the problems are presented influence the selection process.
One selection tool for such coordination games, first conceptualised by Schelling (1960), is *focal points*. The intuition behind focal points is that, given that there is no unique dominant strategy, players are unable to work out which course of action to take, given that it is implausible that they will compute the MSNE. Schelling (1980, pp. 57) argues that in “most situations – perhaps every situation for people who are practiced at this kind of game – provide some clue for coordinating behaviour, some focal point for each person’s expectation of what the other expects him to expect to be expected to do”. Therefore, if there is such a strategy that has some salience amongst others, then player’s expectations might converge on this strategy, forming a focal point for coordination. Schelling referred to asymmetric coordination problems as *tacit bargaining* problems with divergent interests. Schelling posits that in tacit bargaining problems, individuals will again coordinate on the focal strategy, with the player who is in a disadvantageous position – whose preferred strategy is not focal – will compromise and settle for a lower, positive amount on the focal strategy to ensure coordination.

### 4. Related Literature

To my knowledge, no experimental research has been carried out on the effects of time pressure on focal points. However, there are important findings from focal point literature that are relevant to this experiment. Cooper *et al.* (1990) investigate selection criteria in coordination games with multiple Nash equilibria. Their research suggests that the selected strategy will be from the set of Nash equilibria, but that no selection rule provides a clear answer as to which Nash equilibria it will be. Mehta *et al.* (1994.a) conducted the first formal test of focal points, so as to investigate Schelling’s informal findings (1960). This paper focuses on focal points in symmetric payoff settings, specifically in two-player pure coordination games. The authors find that within pure coordination settings players “are more successful at coordination than they would have been had they ignored all labelling and thus chosen strategies at random”. Hence, individuals appear to use focal points as a selection rule, increasing achieved levels of coordination.

Mehta *et al.* (1994.b) further investigate the role of focal points in coordination settings. This evidence further suggests that in symmetric coordination problems focal points do in fact
appear to matter for coordination. Sugden (1995) builds on this research, presenting an outline for a theoretical framework of focal points. As an explanation for how these focal points lead to coordination, team reasoning (Sugden, 1993; Bacharach 1999, 2006) suggests that players if they reason as a team identity, rather than if they used a different rule. Focal points act as a strategy on which the team can converge it's expectations.

There is mixed evidence over whether or not Schelling’s insights with respect to focal points are valid in asymmetric coordination problems. Crawford et al. (2008) investigate the role of focal points in both symmetric and asymmetric games. They utilise simple label-based focal points in a battle of the sexes game. In the symmetric game treatment, they find that the selection of the focal strategy X is significantly greater than Y, closely replicating the findings of Schelling (1960), Mehta et al. (1994) and a pilot experiment ran by the authors. In the presence of even minute payoff asymmetries however, “salient labels may lose much of their effectiveness and coordination may be very low”. This evidence suggests that focal points may act as a coordination device in symmetric payoffs games, but lose traction with diverging interests.

Parravano and Poulsen (2014) further investigate the role of focal points in both symmetric and asymmetric games. Specifically, they investigate whether stake size affects the power of focal points in such settings. In line with Crawford et al. (2008), it is found that coordination levels significantly deteriorate in the presence of asymmetric payoffs. Isoni et al. (2013) provide evidence of the importance of payoff irrelevant labels in tacit bargaining situations. Building on the design of Mehta et al. (1994a, b), using diagrammatic claiming of shapes a tacit bargaining situation is created between the two players, reflecting Schelling’s tacit bargaining situation. Evidence is found supporting Schelling’s hypothesis that focal points matter within such tacit bargaining situation, with effects on the efficiency and distribution of outcomes achieved.

5. Experimental Design
5.1 The Game

Subjects made decisions in a one-shot simultaneous move 2x2 coordination game\(^1\). Each subject participated in only one treatment and all subjects faced the same game. This experiment has a between-subject design. The game used was a simple coordination game with asymmetric payoffs. In this game, each strategy was labelled with a letter “A” and “B”, in which A is salient relative to B, since A is the first letter in the alphabet, and is therefore the focal strategy. This follows the same logic as Crawford et al. (2008) X-Y game and Parravano & Poulsen (2014) who use labels A and B in the same type of X-Y coordination game.

Figure 2. Asymmetric-Payoff Coordination Game

<table>
<thead>
<tr>
<th>Person 2</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Person 1</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>A</td>
<td>£5 , £3</td>
<td>£0 , £0</td>
</tr>
<tr>
<td>B</td>
<td>£0 , £0</td>
<td>£3 , £5</td>
</tr>
</tbody>
</table>

The payoffs in this game are contingent upon the two players coordinating strategies. That is, to earn a positive payoff, players must both choose A or both choose B ((AA); (BB)). If the players fail to coordinate ((AB); (BA)) then they both earn zero. Note, in contrast to pure coordination games with symmetric payoffs, coordination in this game leads to asymmetric payoffs between the two players. This structure creates a tension between the two players, since each has their payoff-salient preferred option, however failure to coordinate results in no earnings for either players. There is thus a trade-off between maximising ones earnings and successfully coordinating. The two pure strategy NE of the game are {AA} and {BB}. Hence, there is no unique pure strategy Nash equilibrium. However, game theory does predict a unique MSNE, which game theory predicts the players will select. The mixed strategy Nash equilibrium profile is given by \(\left[\left(\frac{5}{10}, \frac{3}{10}\right), \left(\frac{3}{10}, \frac{5}{10}\right)\right]\). Game theory predicts that players will play this mixed strategy yielding a coordination rate of 46.9%.

\(^1\) The task participants were not presented to subjects in matrix form. See Appendix 4 which contains the information subjects saw.
5.2. Treatments
Two treatments were used and will be referred to as “High-pressure” and “Low-pressure” (hereafter referred to as HP and LP respectively), and subjects participated in one treatment only to preserve the one-shot nature. In the HP treatments, subjects faced a limited time constraint of 15 seconds in which to make their decision. In the LP treatment, subjects faced a time constraint of 45 seconds. Importantly, game theory does not account for the time under which decision must be made, since agents are assumed to be perfectly rational. By keeping the game and payoffs constant across the treatment, any variation in coordination behaviour can be interpreted as a result of changes in time pressure. This allowed me to isolate the effects of time pressure on the subject’s ability to coordinate with one another. I carried out a pre-trial test on two economics student and a non-economics student to decide on the amount of time allocated in each treatment. They completed the task without any prior knowledge, under a hypothetical constraint of 10 seconds. After discussing the task and time pressure following the trial, I decided that a time constraint of 15 seconds was appropriate for the HP treatment and 45 seconds for the LP treatment.

6. Experimental Procedures
A total of 34 students were recruited from the University of East Anglia to participate in the experiment (average age = 21, 13 males, 21 females). For the LP treatment, 18 participants were recruited, comprising 9 pairs. For the HP treatment, 16 participants were recruited, comprising 8 pairs. The subject pool was relatively small due to time and logistical constraints. Participants were recruited via a participation email sent out to a number of different schools within the university: Economics, International Development, Business, Law and Psychology. I had a varied distribution of degree subjects and levels of study, including undergraduate, masters and doctorate students, in both treatments. The experiment was ran in a classroom setting and mediated via pen and paper. Participants were not permitted to communicate at any point and this was stressed throughout the experiment.

Prior to the experiment, desks were randomly allocated either a 1 or a 2. By randomly seating participants at desks, they were therefore randomly allocated the role “Person 1” or “Person 2” in the experiment. Person 1’s were randomly matched with person two’s, comprising a pair. Participants were made fully aware that the matching process between them and their
partners was totally random. Moreover, it was stressed that subjects were, and would remain, totally anonymous to one another.

Each participant received a copy of the instructions (see Appendix 3). The instructions were then read out, providing details of the experiment, protocol and task, and then any questions were answered. During the instructions participants were informed that they had all received the same set of instructions, which differed only by their role in the experiment. Moreover, Participants were made fully aware that they would be completing the task under a strict time constraint and what the constraint was. It was emphasised that if subjects had failed to make a decision in the allotted time frame, they would have failed to make a selection and would thus earn zero extra earnings. With respect to payoffs, the instructions clearly stated: "the only way for you and your partner to earn money is to pick the same option". Therefore, the subjects were aware that failure to match their strategies would earn them no additional money from the task. Subjects received a £1 show-up fee, regardless of their decisions in the experiment, so no participant left the room with no earnings. Finally, subjects were reminded that by breaking any of the specified rules they would be disqualified from the experiment and earn no money.

Participants then received a task sheet (see Appendix 4), on which to make their decision. On the front of this task sheet were important pieces of information from the instructions. Subjects were not permitted to turn over the task sheet until the timer had started. When ready, the experiment began and a timer displayed on the board counted down the allotted time period for that treatment. I counted down the final three seconds and then instructed participants to stop what they were doing. This informed the participants that they were running out of time, since under the time pressure it would have been difficult to complete the task and keep an eye on the clock. Task sheets were then collected and distributed feedback forms (see Appendix 5), which required them to fill out basic demographic details and a section to write down the factors that they felt were relevant to the decision they made.

Once the payoffs were calculated and the receipts were distributed. Participants simply took their feedback form and receipt to the payment desk on their way out and received their earnings. Subjects were informed that if their receipt did not contain any additional earnings,
then they had failed to coordinate as a pair and therefore, did not earn any additional money from the task. Participants were paid one-at-a-time upon exiting the room to preserve anonymity.

7. Results
In this section I provide the key findings from my experiment. I address the data in three sections. Firstly, I look at the overall sample strategy selection and expected coordination rates. Secondly, I look in particular at the strategy selection for each player role in isolation, given that payoffs are asymmetric. Finally, I will discuss some of the qualitative results from the feedback forms.

7.1. Overall Results
Table 1 summarises the results. The data is given for each individual treatment and in total across both treatments. The proportion of participants selecting strategy A and strategy B is reported. Moreover, the expected coordination rates for each treatment is given. Finally, I report the predicted MSNE predicted coordination rates.

Table 1: Overall Results

<table>
<thead>
<tr>
<th></th>
<th>Low Pressure</th>
<th>High Pressure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Constraint</td>
<td>45 Seconds</td>
<td>15 Seconds</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 P1’s</td>
<td>8 P1’s</td>
<td>17 P1’s</td>
<td></td>
</tr>
<tr>
<td>9 P2’s</td>
<td>8 P2’s</td>
<td>17 P2’s</td>
<td></td>
</tr>
<tr>
<td>Proportion Choosing A (%)</td>
<td>9/18 (50%)</td>
<td>12/16 (75%)</td>
<td>21/34 (62%)</td>
</tr>
<tr>
<td>Proportion Choosing B (%)</td>
<td>9/18 (50%)</td>
<td>4/16 (25%)</td>
<td>13/34 (38%)</td>
</tr>
<tr>
<td>Expected Coordination Rate$^2$</td>
<td>49.4%</td>
<td>59.4%</td>
<td></td>
</tr>
<tr>
<td>MSNE Coordination Rate$^3$</td>
<td>46.9%</td>
<td>46.9%</td>
<td></td>
</tr>
</tbody>
</table>

$^2$ See Appendix 2 for expected coordination rate calculations.
$^3$ See Appendix 2 for MSNE expected coordination rate calculation.
We can see that overall, 21 participants chose option strategy A compared to 13 participants who chose strategy B (62% and 38%) respectively. Strategy A is selected more than strategy, however this difference was not statistically significant, (binomial test, $p>0.1$). This result implies that in the presence of asymmetries, the label-based focal point A loses its power. However, whilst this is not statistically significant, selection of strategy A is large in terms of proportion relative to strategy B. One plausible explanation for this result is that the salience of the payoff-dominant strategy was generally too strong to overrule the label-based focal strategy.

The columns for Low Pressure and High Pressure represent the data across treatments. To address the issue of whether or not the power of the label-based focal strategy A is increased under time pressure, we need to look at the frequency in which it was selected across treatments. We can see that in the LP, the proportion of strategy selection is split evenly, with 50% of participants selecting strategy A and 50% selecting strategy B. In HP, there is a noticeable shift towards the focal strategy, with 75% of participants selecting strategy A and only 25% selecting strategy B. However, this difference is not statistically significant (chi2 test, $\chi^2_{(1)}=2.24$, $p=0.134>0.1$). Whilst this is not statistically significant, the sample size was relatively small. There does seem to be a strong transition of strategy towards the focal strategy A under higher time pressure. Thus whilst this result does not act as evidence for increased focal power under time pressure statistically, there does seem to be a suggestion that it does increase the focal strategy selection to some extent. Perhaps with a greater sample size, these proportions might have been more pronounced and yielded statistical significance.

The expected coordination rates were computed given the strategy selection choices of participants. The expected coordination rate$^4$ is given by the product of the proportions of Person 1’s and 2’s that choose strategy A plus the product of the proportions of Person 1’s and 2’s that choose strategy B, in each respective treatment. We can see that the expected coordination rate for LP is very close to the MSNE expected coordination rate. Approximating

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$^4$ The Expected Coordination Rate is given by $\sum_{k=1}^{N} \left( \frac{i_k}{N} \right) \left( \frac{j_k}{N} \right)$ where $i_k$ is the number of P1’s who choose $l_k$ and $j_k$ is the number of P2’s who choose $l_k$ (Parravano and Poulsen, 2014).
the expected coordination rate for LP as 49%, this is not statistically different from the MSNE predicted rate (binomial test, p>0.1). However, in HP, the expected coordination rate actually increases relatively significantly; it is almost 13% points higher than the MSNE expected coordination rate. This expected coordination rate is significantly higher than the MSNE predicted rate (binomial test, p>0.01). This implies that whilst the increase in selection A was not significantly higher in HP, the increase in selection of strategy A led to an expected coordination rate that is significantly different to the MSNE prediction.

Figure 3: *MSNE and expected coordination rates across treatments*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Proportion Choosing A</th>
<th>Proportion Choosing B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Pressure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person 1</td>
<td>5/9 (56%)</td>
<td>4/9 (44%)</td>
</tr>
<tr>
<td>Person 2</td>
<td>4/9 (44%)</td>
<td>5/9 (56%)</td>
</tr>
<tr>
<td><strong>High Pressure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person 1</td>
<td>7/8 (88%)</td>
<td>1/8 (13%)</td>
</tr>
<tr>
<td>Person 2</td>
<td>5/8 (63%)</td>
<td>3/8 (38%)</td>
</tr>
</tbody>
</table>

7.2. Results by Player Role

Table 2 below, displays the choices of participants across treatments, given by their role within the experiment (Person 1 and 2). Recall, option A was payoff-salient for Person 1 and option B was payoff-salient for Person 2.

Table 2: *Results by player role*
We can see that Person 1’s choose strategy A more frequently across both treatments, the distribution of which is statistically different from a binary random distribution (binomial test, \( p > 0.01 \)). That is, Person 1’s systematically select strategy A. Moreover, we can see that across treatments, Person 1’s select A more frequently in the HP treatment than in the LP treatment (88% compared to 56%). This difference statistically significant (Fisher’s exact test, Fisher’s exact=0.053, \( p > 0.5 \)). However, for Person 1, strategy A is both the focal point strategy and the payoff-salient strategy. Therefore, the causes of this increase in selection of strategy A in HP for could be due to two confounding factors. Firstly, given that strategy A is payoff-salient for person 1, the increase in the time pressure in HP could have led to more Person 1’s simply selecting their payoff-salient strategy. The second confounding factor is that strategy A was increasingly focal for Person 1’s under the time pressure in HP. These effects cannot be disentangled under this experimental design.

Person 2’s strategy selection between A and B was not statistically different from a binary distribution (binomial test, \( p > 0.1 \)). This result implies that even though strategy A was payoff-salient, it was not selected significantly differently from randomising between A and B. For Person 2’s, we are interested in their strategy selection across treatments. In LP, the majority Person 2’s selected their payoff-salient strategy, with 44% selecting strategy A. In HP however, there is a shift towards strategy A (63%), the proposed focal strategy, over the payoff-salient strategy. However, this difference is not statistically significant, (Fisher’s exact test, Fisher’s exact=0.399, \( p > 0.1 \)). This suggests that under the time pressure the selection of the focal strategy A increased for Person 2’s, but this increase was not statistically significant. Again, perhaps with a bigger sample the proportion selecting the focal strategy A might have become more pronounced and potentially yielded statistical significance.

Figure 4: *Strategy selection by player role*
7.3. Feedback Form Results

On the feedback form participants were asked to report information on how they made their decisions. In LP where participants had ample time to make their decision, many reported that they used some form of inductive reasoning. The general logic of this reported reasoning was (to some extent) in line with cognitive hierarchy theory and level-k reasoning (Stahl and Wilson, 1995; Camerer, Ho and Chong, 2004). Many reported that they believed that their partner would likely select their payoff-maximising option, so they should play their best response to this ($L_0$ and $L_1$ reasoning). Some participants even reasoned beyond this level, anticipating that others might be playing their best response to people selecting their maximum payoffs, selecting their strategy as a best response to this ($L_1$ and $L_2$ reasoning). This reasoning occurred frequently in the LP treatment where participants had more time to think the problem through.

In the HP treatment, peoples explanations of how they made their decisions becomes less clear. Some subject reported that they simply chose the strategy that would maximise their payoffs. Other subjects found the time constraint too short so simply picked an answer randomly. However, some participants did specifically mention that they believed others would pick strategy A, since it was more “obvious” out of the two. These participants reported that they expected their partners to select strategy A because of this reasoning, which is in line with team reasoning models (Sugden, 1993; Bacharach, 1999, 2006). It appears under time pressure, individual’s reasoning in this game become more diverse. Some participants

![A Selection Across Treatments](image-url)
focused purely on their payoffs, whilst others selected their strategy based on how they, as a pair, would expect each other to select strategies.

8. Conclusion

I collected data from payoff-asymmetric coordination games with a label-salient focal point under two time limits to test whether the power of focal points increases under time pressure. I find that, whilst not statistically significant, selection of the focal strategy increases under time pressure, leading to higher expected coordination rates. This research suggests that time pressure could matter for the strength of label-based focal points. This implications of this is that under time pressure, individuals might be relatively effective at coordination, maybe even more so than given time to think, in the presence of payoff asymmetries. This might stem from individual’s increasing propensity to select the focal strategies under time pressure. However, further research with a larger sample size, and a variety of label-based focal points and coordination settings would be required to obtain a clearer picture of the effects of time pressure on focal points.
References


