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The Role of Salience in Tacit Coordination: an eye-tracking study

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Abstract

In this study, we have employed eye-tracking technology to investigate the role of salience in tacit coordination. It is found that people can develop coordination without information exchange by finding a focal point. We intended to verify the existence of focal points and reveal the cognitive process of making decisions during tacit coordination. We conducted a between-subject lab experiment that 100 Dutch students were randomly assigned to two conditions (coordination vs. individual) to complete the same set of pure coordination games. Participants in the coordination condition were asked to select an option that another participant may also choose. While in the individual condition, there was no such requirements of the task. The results showed that there were focal points that people would choose in tacit coordination. Participants in the coordination condition selected an option more based on its position than those in the individual condition. We conducted t-tests and found that there was no difference of decision time or eye fixation duration on options between two conditions. Furthermore, ANOVA analysis showed that some options had received longer eye fixation duration in both conditions. The interaction effect between condition and options revealed that people even paid less attention to certain options in the coordination condition. We concluded that the cognitive performance of coordination was about the same as it in individual decisions in terms of eye fixation duration and decision time. People may use intuitive thinking or heuristics in tacit coordination as well.

Keywords: tacit coordination, salience, focal point, eye-tracking

The Role of Salience in Tacit Coordination: an eye-tracking study

Imagine that you are asked to meet a stranger in Amsterdam, but no location or time is decided. The stranger and you do not have any ways of contacting each other to plan the meeting. Under this circumstance, where and when would you meet this person? To our surprise, more than half of the participants would choose Central Station and the time of 12 noon in a similar question from Thomas Schelling's study (1960). He found that people could coordinate with each other without any communication, and there is always a certain solution to a certain problem that leads to successful coordination. Schelling created the concept "focal point" to describe this special solution in such tacit coordination. He himself began the analysis of focal points by using pure coordination games in a less scientific environment and informally. However, with the introduction of focal points, both economists and psychologists have embraced this idea and conducted formal research in the field of decision making (Bacharach & Bernasconi, 1997; Colman, 1997; Cooper, DeJong, Forsythe & Ross, 1990; Mehta, Starmer & Sugden, 1994; Sugden, 1995; Van Huyck, Battalio & Beil, 1990). In these experiments, researcher designed a number of simple pure coordination games by which they uncovered the existence and characteristics of focal points in tacit coordination. Thus, pure coordination games are promising to reflect the underlying mechanism of tacit coordination that happens in daily life. In this study, we also employ this type of strategic games to investigate the focal point and the decision process.

In pure coordination games, there is no competition between the players; all players that make decisions are aware that the only way to earn the optimal payoff is to coordinate. However, players do not interact with other players or get access to their information. The lack of communications between players reduces the possibility of coordinating with each other, which means people cannot make logical moves based on others' behaviors since they are unknown and unpredictable.

From a classical game-theoretic perspective, the rational move in these games is to behave randomly because there are no rules for any movements to be distinct from the others, considering optimizing payoffs. In other words, every response is as good as any other to produce coordination and get the best payoff.

It is argued that human beings have the tendency toward self-interest (Smith, 2005). In order to get the optimal payoff, people have to develop successful coordination. However, since every strategy has the possibility to be the one succeeding in tacit coordination, the payoff of each strategy values the same. In this case, people will make decisions based on their own preferences to maximize their profits. For example, people can get the optimal payoff if they write down the same past year with others' answers. Since there are infinite options of past year, there is no way to speculate others' choices and most of them may choose their preferred years in which they were born. Although some answers would be the same because these people were born in the same year, it is not possible to develop successful coordination based on such coincidence. In other words, if people make decisions depending on own preferences in coordination games, coordination can hardly be made because of the divergence of individuals. However, it is found that decision makers will use some selection principle to identify a specific solution, which is defined as "focal point" that is prominent for everyone or at least the majority of people (Van Huyck, et al., 1990).

Crawford and Haller claimed that this focal-point strategy emerged from the basis of how people interpret the game and the shared common knowledge by the players in the situation where they are not aware of each other's decision (1990). Lewis (2002) also defined this strategy that people apply in tacit coordination games by using the term "salience". He described it as the property of an outcome that "stands out from the rest by its uniqueness in some conspicuous respect" and, second, as being "unique in some way that the subjects will notice, expect each other to notice, and so on" (p. 35). Back to the question about writing down same past year, people may spontaneously choose the year of 2000 because of its uniqueness of being a millennium.

To detect the "focal point" or the "salient option", we use one-shot pure coordination games where the focal point is most clearly defined (Mehta, et al., 1994). One-shot pure coordination games, which are played only once, can prevent people from using inductive selection principles or learning based on repeated interaction to coordinate (Van Huyck, et al., 1990). Instead, they have to find the salience that is evident enough for everyone to understand it as a focal point. In these games, successful coordination is defined as people giving same answers to the the problem. People have the complete information about the payoff and the payoff is the highest when they succeed in coordination. As a result, since players have the identical goal of optimizing payoffs, they have the most motivation to coordinate. In this way, we can detect the salience in the tacit coordination and reveal the process of people making decisions when they coordinate.

Among past studies, researchers infer the existence of focal points in tacit coordination games from the fact that there is always a popular answer chosen by people. However, none of them has uncovered what happens in the process of people making the decision. This is because the decisions that have been made are the only what is observable, while any information acquisition or internal computation is hidden inside during such cognitive tasks (Russo, 1978). In early process tracing research, verbal protocols were always used to reveal what people are thinking and doing during or after making their decisions. Nevertheless, no matter concurrent or retrospective verbal protocols could not ensure accuracy (Glaholt & Reingold, 2011). Meanwhile, cognitive and behavioral psychologists have found eye fixations useful in revealing what and how information is being processed. Eye tracking data are more detailed on what information the participant is searching and processing on the screen while making decisions, with recordings of natural gaze behavior which are objective and unobtrusive measure on what is processed at a specific moment (Russo & Rosen, 1975; Just & Carpenter, 1976), for how long and how often. Moreover, since the rapidity of eye fixations matches the rapidity of the cognitive processor (Just, & Carpenter, 1976), information of the position and the duration of eye fixations infers cognitive activity such as attention and processing speed in real time (Loftus, Mathews, Bell & Poltrock, 1975). As such, using eye-tracking in our research will help explore the decision process in tacit coordination. Fiedler, Glöckner, Nicklisch and Dickert (2013) have applied the eye-tracking technology into social cooperation studies, and they found out that differences of social value orientation are reflected in different information search patterns and preferences by analyzing eye-tracking data. Therefore, we intend to discover the characteristics of information search during coordination by eye fixation activities.

We set up an individual condition and a coordination condition respectively to investigate on the salience in coordination games as a precedent study did (Mehta, et al., 1994). The individual condition, as the control group, is used to observe how people make decisions when they are not motivated to coordinate. As reasoned above, when there is no external added value to one specific response, the player just gives any response she likes, recognizes or what happens to come to mind at that time. However, if the player searches the same answers with others to pursue the highest benefit in the coordination condition, she will choose the answer that she believes most likely to be salient to both of them (Mehta, et al., 1994) or seems natural to people “who are looking for ways of solving coordination problem” (Schelling, 1960 p.94). From the view of rational models of decision making, people attend to the full and relevant information prior to a decision (March, 1978; Simon, 1955). If we simply divide the process of decision making into two phases –everyone has been fully informed before a decision being made, and the second phase is how people in the individual (non-coordination) condition and the coordination condition operate. For people in both conditions, all of them will find their own preferred options. However, people who need to coordinate for optimal payoffs will trade off between options to find the salient one. Thus, we assume that people who are in the coordination condition will spend more time in making a decision. Besides, balancing options means that players seek for a thorough understanding of possible options in order not to miss the salient one, while an individual player may stop searching after she has found the option that satisfies her preference. Hence we assume that people in the coordination condition will spend more time on available options than those in the individual condition. In order to find out if there is any difference of cognitive activities between two conditions, we trace players eye movements that can directly reflect what information is in processing. The employment of eye-tracking will reduce human influence such as biased memory in retrospective verbal protocols and increase accuracy and precision.

Moreover, not merely the existence of "focal point" but also the feature of it is worth a study. What makes a choice salient in the game? Thus, the selection criteria in tacit coordination games need to be investigated as well. Therefore, besides the eye tracking experiment, we have designed a questionnaire containing eight questions in order to find out what principle the participants follow when making the decision. Based on Mehta's study (1994), we intend to investigate to what extent participants make choices to coordinate on the basis of their personal preference, the position of the option, the color of the option, their familiarity to the option, the possibility of justifying the decision and the conjecture of others' choices.

With the experiment, we aim to (a) verify the previous findings that there is a salient solution in tacit coordination games, compared to individual choices; (b) use eye-tracking to find the difference of information processing between two conditions before participants making their decisions, including the decision time and duration of eye fixations on available options. We hypothesize that (1) people in the coordination condition spend more time on decisions, compared to those in the individual condition; (2) options in the coordination condition receive longer duration of eye fixations.

Method

Participants and design. One hundred Dutch (mainly students from Leiden University; average age 22.9 years old; 75.5% female; volunteers recruited via Leiden University Research participation Sona systems and social media) took part in the study. Six participants' data were removed because of missing value.

It is a between-subject lab experiment design. The independent variable is the condition where the participants complete the task (individual vs. coordination). The dependent variables are participants' chosen solutions to each game, the duration of eye fixations on options in each game, decision time and their rating scores from the questionnaire. Fifty subjects were allocated in each condition randomly, and each participant in the coordination condition was paired with one partner within the group randomly. Participants in the control group played games individually, while participants in the experimental group were informed that they were playing the games with another person and only if they both choose the same option for each game, would they gain more money in total. The eye-tracker Tobii records eye fixation data and mouse click behaviors. The processor was attached on a screen with a resolution of 1280 x 1024 pixels to capture and record participants' eye movements. Participants did not need to wear any equipment that may make them feel uncomfortable and affect their decisions during the experiment. The experiment was programmed in Tobii Eye Tracker's supporting software - Tobii Studio. In each game, we defined equal area of interest (AOI) for each option. Eye-tracking and mouse click data were only recorded if participants fixated in these specific areas. If a participant's attention stayed at one AOI more than 60 milliseconds, then one eye fixation was counted (Salojärvi, Puolamäki & Kaski, 2005; Komogortsev, Gobert, Jayarathna, Koh & Gowda, 2010).

The participants earned money according to their actual performance in the experiment. Participants in the individual condition received 3.50 euro as compensation right after finishing the experiment. Participants in the coordination condition immediately received 3.50 euro as a base payoff after the experiment while they had chances to earn extra 2.50 euro if more than five of their chosen options were the same with their partners'. The extra compensation was transferred by bank to participants when the entire study finished and the collected data were analyzed.

Material and procedure. First, the participant was debriefed about the procedure of the experiment and signed the consent form. One participant completed the task at one time in the lab where the arrangement was kept the same until the entire study finished.

Before playing the games, in order to capture accurate eye movements, participants needed to conduct a 5-point calibration. The experimenter assisted the participant with the preparation which took around 3 minutes. After the calibration, participants in each condition were instructed at the very beginning of the experiment in Dutch that they would play games individually or coordinately. Before each trial, a statement which instructed participants to wait for the next trial was presented for 10 seconds on the center of the screen to have participants concentrated. All the games were presented in pictures, with a certain number of options. The participants needed to choose one option by clicking within the areas that were red outlined. Participants finished all the 10 games one by one and nonstop (see Appendix a), which last around 10 minutes. The ten games included both concrete objects like cities, books, dates, cars and abstract geometric shapes. With these two types of coordination games, we aim to delve the characteristics of focal points with respect to positions, color and common social knowledge.

After finishing the games, participants were asked to fill out an online questionnaire to report their demographic information including gender, age, education background and questions relevant to the games. These questions were statements about if participants themselves make decisions based on certain criteria. They answered each question by using a 7-point Likert scale from 1 (*slightly*) to 7 (*to a large extent*) (see Appendix b).

Results

We utilized *coordination index, c* as Mehta and her colleagues did in their research (1994) to measure the extent of coordination in each condition.

$$c = \sum_{i=1}^{k} (m_i \,/\, N)\, [(m_i - 1)/(N - 1)]$$

In the formula, N is the number of participants in a condition; k is the number of distinct responses given by those participants to a question; $m_1, \ldots, m_k$ are the numbers of participants giving each of the responses 1,..,k. The value of c ranges from 0 (each member of a group gives a different response) to 1 (all the members give the same response). Thus, the bigger c is, the more successful coordination between group members is.

For each coordination game, we calculated *coordination index* for both individual and coordination conditions (Table 1). In six games (squares and circles 1, cars, castles, European cities, rectangle, World cities), the coordination condition had a higher *coordination index* than the individual condition, which means that more participants in the coordination condition gave the same response to the question. In other words, people have achieved more coordination in these games. Hence, we decided to focus on these six games and find out the attribute of a salient option.

Table 1

Coordination index of two conditions for each game.

Games	Coordination index	
	Coordination condition	Individual condition
squares and circles 1	0.27	0.19
squares and circles 2	0.28	0.28
cake	0.21	0.23
date of December	0.24	0.30
cars	0.49	0.32
castles	0.29	0.27
European cities	0.29	0.27
Harry Potter	0.18	0.24
rectangle	0.74	0.32
World cities	0.33	0.30

The frequency of each option being chosen in six games is summarized in the form of percentage in Table 2. The full result for each game is in Appendix c.

Table 2

The percentage of each option being chosen in six games.

Question 1: squares and circles 1		
Option	Coordination	Individual
Left square	20.0	14.8
Left top corner circle	15.6	14.3
Left bottom circle	2.2	8.2
Right top circle	13.3	18.4
Right bottom circle	2.2	10.2
Right square	46.7	30.6
Question 5: cars		
Option	Coordination	Individual
Middle black car	33.3	38.8
Right black car	4.4	28.6
Left red car	62.2	32.7

Question 6: castles		
Option	Coordination	Individual
Castle A	44.4	38.8
Castle B	17.8	16.3
Castle C	20.0	28.6
Castle D	15.6	16.3
Question 7: European cities		
Option	Coordination	Individual
Amsterdam	75.6	44.9
Madrid	6.7	8.2
Moscow	11.1	16.3
Rome	4.4	28.6
Question 9: rectangle		
Option [row, column]	Coordination	Individual
[1,1]	4.4	2.0
[1,2]	0.0	6.1
[1,3]	4.4	8.2
[2,1]	2.2	4.1
[2,2]	86.7	55.1
[2,3]	2.2	16.3
[3,1]	0.0	2.0
[3,2]	0.0	2.0
[3,3]	0.0	4.1
Question 10: World cities		
Option	Coordination	Individual
Beijing	6.7	28.6
Cape Town	33.3	36.7
Panama	15.6	30.6
Tripoli	44.4	4.1

Question 1: squares and circles 1. Percentages of each option being chosen are close in the individual condition while almost half (46.7%) of participants who need coordination chose the second square. A Chi-square test of independence was calculated comparing the frequency of being chosen in the options. A significant interaction was found ($X^2(5) = 82.5$, $p < .001$).

Also, 45.4% participants in the individual condition selected the two squares as their solutions. A Chi-square test showed that there is an association between options and the percentage of being chosen ($X^2(5) = 20.9, p = .001$).

Question 5: cars. Each option had similar percentages of being chosen in the individual condition ($X^2(2) = 1.5, p = .471$). However, participants in the coordination condition mostly chose the red car (62.2%) instead of the other two black cars, and the second popular choice was the middle one ($X^2(2) = 51.0, p < .001$).

Question 6: castles. Comparing two conditions, the frequency of each option being chosen was nearly equivalent. In both conditions most participants chose Castle A as their answer (Coordination: $X^2(3) = 21.0, p < .001$, Individual:$X^2(3) = 15.0, p = .002$), while more participants in the coordination condition than those in the individual condition chose Castle A (44.4% vs. 38.8%).

Question 7: European cities. There were 75.6% participants with coordination need that opted for Amsterdam as the solution, but 44.5% participants also chose it in non-coordination condition. Chi-square test showed that the percentage of being chosen was dependent on the option in both conditions (Coordination: $X^2(3) = 145.3, p < .001$, Individual: $X^2(3) = 32.0, p < .001$).

Question 9: rectangle. Few participants chose other options instead of the most popular rectangle (86.7%) that located in the center in the coordination condition. Even for participants who played the game without coordination purpose, more than half of them chose the center rectangle (Coordination: $X^2(8) = 285.3, p < .001$, Individual: $X^2(8) = 212.4, p < .001$).

Question 10: World cities. While only 4.1% participants in the individual condition chose Tripoli, 44.4% participants who sought coordination selected this option which was in the center of the screen (Coordination: $X^2(3) = 33.2, p < .001$, Individual: $X^2(3) = 25.2, p = .001$).

According to the result of these six questions, we can see that there was often a particular response to a particular question that most people would make for successful coordination even when they could not exchange information. Thus, we have verified that there is a salient option or focal point people will choose in tacit coordination, compared to the decision made individually. Additionally, the choices people have made reveal that the salience they tend to use possesses the uniqueness in terms of an attribute, such as the color (red), the relative position to others (center), the social meaning (Amsterdam, the capital of Holland).

Eye-tracking results. To record participants' eye movements on the screen and their mouse click behaviors, we used Tobii eye tracker and its supporting software. We hypothesized that participants in a coordination mindset need more time to make decisions since they have to consider the performance of their partners besides their own preferences. We added up average duration of fixation on all areas of interest of one participant in all coordination games and looked at the average time to make a decision in all games, and found that the average eye fixation duration in the coordination condition is higher ($M_{coordination}$ = 31.4 seconds vs. $M_{individual}$ = 29.9 seconds); participants spent longer in making a decision in the coordination condition ($M_{coordination}$ = 64.3 seconds vs. $M_{individual}$ = 60.4 seconds). However, there was no significant difference between two conditions in the two aspects (eye fixation duration: t (92) = 0.43, p = .666; decision time: t (92) = 0.51, p = .544). Further, Cohen's effect size value (both d < .10) suggested low practical significance regardless of the sample size.

Since each game was independent and distinct, we decided to analyze them separately. As reasoned above, we also selected the six games that had a higher coordination index in the coordination condition. For each game, we intend to examine if participants spend more time in making decisions with cooperation mindset than those with individual mindset; if they have longer eye fixation duration when coordinating. We conducted a repeated measures ANOVA for the six games to investigate if participants in two conditions have different eye fixation duration on each option and decision time. For each game, the between-subjects factor was the condition (coordination vs. individual), and the within-subjects factor was the provided options.

Question 1: squares and circles 1. An analysis of variance of eye fixation duration revealed that there was a main effect of options (squares and circles), $F(4.325, 300.031) = 3.48$, $p < .001$, $\eta^2 = 0.06$, which means that different options received different duration of eye fixations. The first square and the second square, which were the two most chosen options in the coordination condition, received longer eye fixation duration than the circles regardless of conditions.

There is no significant difference between two conditions in terms of eye fixation duration or decision time ($F(1, 92) = 0.75$, $p = .388$, $\eta^2 = 0.01$; $F(1, 92) = 0.11$, $p = .742$, $\eta^2 < 0.01$). People succeeded in coordinating, but it did not take them longer eye fixation duration or decision time.

Question 5: cars. There is a main effect of options with regard to eye fixation duration, $F(1.826, 168.029) = 42.79$, $p < .001$, $\eta^2 = 0.31$. The red car received the shortest 1.00 second average eye fixation duration, (marginally) significantly different to the middle car ($M = 2.17$ seconds, $p < .001$) and the right car ($M = 1.27$ seconds, $p = .058$).

There is no significant difference of eye fixation duration between two conditions ($F(1, 92) = 1.90$, $p = .171$, $\eta^2 = 0.02$). However, we looked more closely at the average eye fixation duration on each option in the two conditions. There is a significant interaction effect between options and conditions, $F(1.826, 168.029) = 5.01$, $p = .010$, $\eta^2 = 0.04$, which means one or two options received different eye fixation duration in the two conditions.

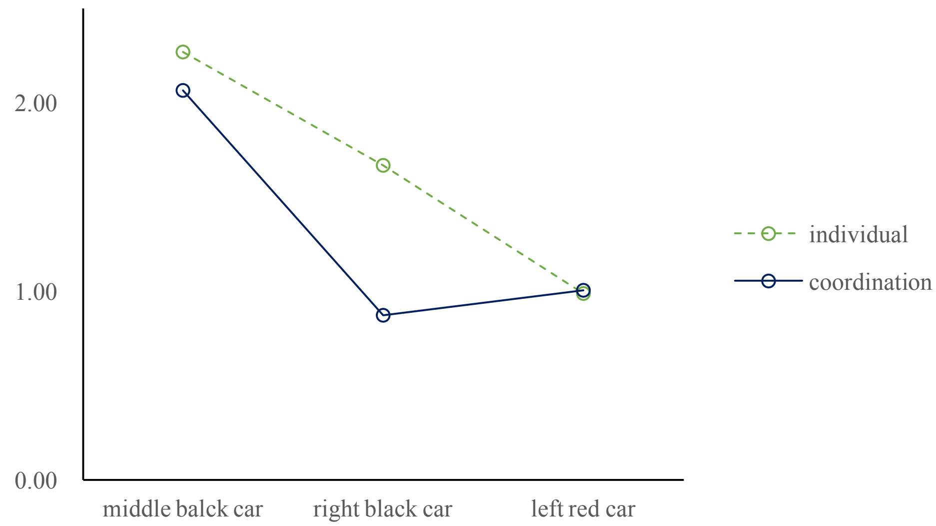

Figure 1. Average eye fixation duration on each option in two conditions in the game of Cars.

As Figure 1 shows, eye fixation duration on right black car is significantly lower in the coordination condition than in the individual condition ($M_{coordination}$ = 0.87 vs. $M_{individual}$ = 1.67, p = .006). To the contrary, the right black car in the coordination condition received shorter eye fixation duration. In other words, people paid lower attention to it when they were searching for a focal point to coordinate.

There are no main effect of conditions in terms of decision time ($F(1, 92) = 1.10$, $p = .298$, $\eta^2 = 0.03$), but there is a significant interaction effect between the two factors which are options and conditions, $F(1.925, 177.122) = 3.60$, $p = .031$, $\eta^2 = 0.04$.

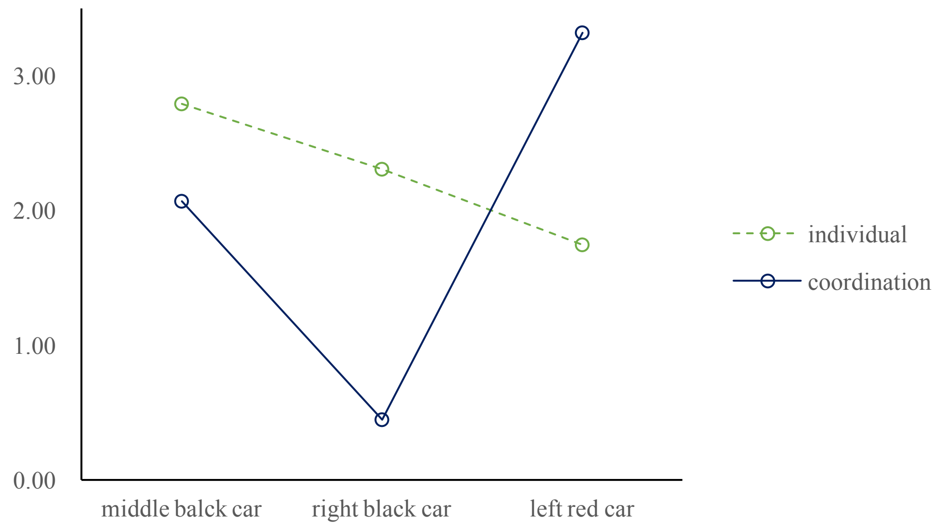

Figure 2. Average decision time of each option in two conditions in the game of Cars.

As shown in Figure 2, to make a right black car decision, it took coordinating participants much less time than participants play individually ($M_{coordination}$= 0.45 vs. $M_{individual}$ = 2.30, p = .013). This finding rejects our hypothesis that it takes longer for people to make a decision in the coordination condition. Oppositely, coordinating participants spent longer time deciding to choose left red car than those in the other condition ($M_{coordination}$ = 3.32 vs. $M_{individual}$ = 1.75, p = .023). So, when participants made the choice of the left red car, people spend more time in making a decision when they need to coordinate.

Question 6: castles. There is a main effect of options with regard to eye fixation duration, F(2.799, 19.396) = 8.47, p < .001, η^2 = 0.08. Castle A and Castle B received longer eye fixation duration than other two options.

No main effect of conditions in terms of eye fixation duration or decision time was found (F(1, 92) = 0.01, p = .926, η^2 < 0.01; F(1, 92) = 0.01, p = .933, η^2 < 0.01). In other words, participants in two conditions consumed the same length of time to fixate on options and to make decisions.

Question 7: European cities. As the fact that participants in both conditions mostly chose Amsterdam implies, there is a main effect of options, $F(2.014, 185.271) = 17.88$, $p < .001$, $\eta^2 = 0.16$. The option of Amsterdam was attended longer than all other three options (all $p <.001$). There is a main effect of options in terms of decision time as well, $F(2.440, 224.488) = 19.23$, $p < .001$, $\eta^2 = 0.17$. It took participants the longest time ($M = 2.69$) to make a decision when Amsterdam was chosen, compared to other three options (all $p < .001$).

There is no significant difference between coordination and individual condition on decision time ($F(1, 92) = 1.15$, $p = .285$, $\eta^2 = 0.01$), but there is an interaction effect, $F(2.440, 224.488) = 19.11$, $p = .050$, $\eta^2 = 0.02$. On the option of Rome, participants spent more time when playing individually than coordinating ($M_{individual} = 1.43$ vs. $M_{coordination} = 0.29$, $p = .014$).

Question 9: Rectangle. For eye fixation duration and decision time, both of them have a main effect of options ($F(3.772, 347.064) = 97.38$, $p < .001$, $\eta^2 = 0.51$; $F(1.959, 180.202) = 28.59$, $p <.001$, $\eta^2 = 0.24$). The rectangle in the center (second row, second column) received the longest eye fixations and took the longest time of making decisions, compared to all other ones (all $p < .01$).

There is no significant difference between two conditions in both aspects of eye fixation duration and decision time ($F(1, 92) = 1.57$, $p = .213$, $\eta^2 = 0.02$; $F(1, 92) = 1.03$, $p = .313$, $\eta^2 = 0.01$). That is, people did not spend more time in fixating options or making decisions when they were asked to coordinate.

Question 10: World cities. There are main effects of options in terms of eye fixation, $F(2.893, 266.114) = 8.02$, $p <.001$, $\eta^2 = 0.08$. The option of Panama and the option of Tripoli have longer average eye fixation duration than other two options (all $p < .050$). Neither eye fixation duration nor decision time has a main effect of conditions ($F(1, 92) = 1.06$, $p = .305$, $\eta^2 = 0.02$; $F(1, 92) =$

2.56, $p = .113$, $\eta^2 = 0.01$), but there is an interaction effect between options and conditions in terms of decision time, $F(2.763, 254.152) = 5.36$, $p = .002$, $\eta^2 = 0.05$.

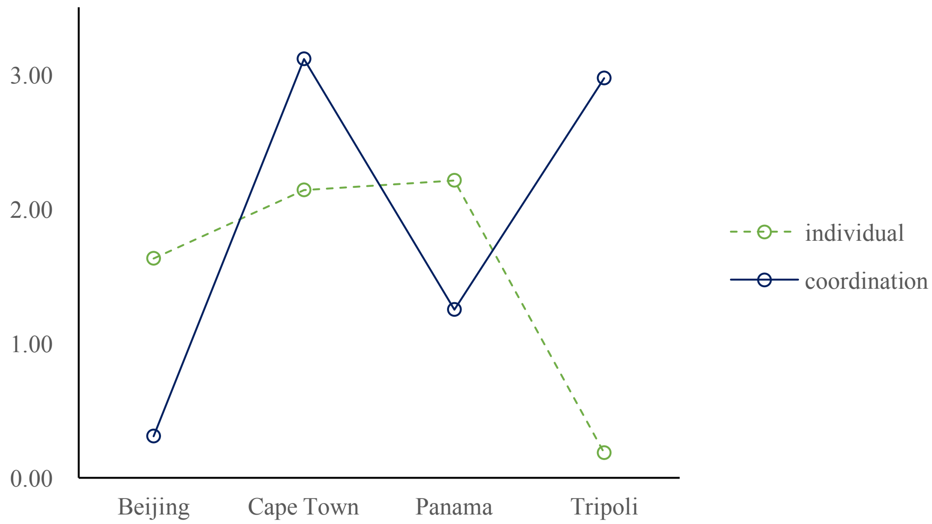

Figure 3. Average decision time of each option in two conditions in the game of World Cities.

Beijing took participants more time to make a decision in the individual condition than it in the coordination condition ($M_{coordination} = 0.31$ vs. $M_{individual} = 1.63$, $p = .018$). Participants who selected Tripoli in the coordination condition ($M = 2.97$) spent much more time on making a decision than in the individual condition ($M_{coordination} = 2.97$ vs. $M_{individual} = 0.19$, $p < .001$). Participants in the coordination condition did not necessarily spend more time in making decisions. It might take them less time to decide in some instances.

Questionnaire results. We asked eight relevant questions about how people made their decisions after the eye tracking experiment in a 7-point Likert scale questionnaire. We compared the answers for each question between two conditions by running *t*-tests. The result showed that in three questions participants in two conditions have different average scores, which means they had different motives underlying their decisions. In the question about making decisions based on own preference, there is a marginally significant difference between two groups. Participants in the individual condition scored higher than those in the coordination condition ($M_{individual}$ = 5.16 vs. $M_{coordination}$ = 4.60, p = .053), that it to say, participants playing individually made their choices more based on their own preferences. In the question about making decisions based on the rule of options' positions on the screen, coordinating participants followed this rule more than those in the individual condition ($M_{coordination}$ = 5.42 vs. $M_{individual}$ = 4.71, p = .029). In the question about the influence of presupposing what choice others will make, participants with coordination need indicated that the impact was quite powerful, while participants without coordination need did not see other's choice as a factor influencing their decisions ($M_{coordination}$ = 5.00 vs. $M_{individual}$ = 1.49, $p < .001$).

Discussion. In six out of ten games, people in the coordination condition gained higher *coordination indices* than those in the individual condition. People could succeed in coordination (choosing the same option) without any communication between each other. Thus, we have verified that people can successfully coordinate by finding focal points in tacit coordination games. However, some popular options chosen by people when coordinating were also mostly selected in the individual condition. In the analysis of eye fixation duration, there were main effects of options which means people put more attention to specific options regardless of coordination need. This result may explain why certain options became the most popular in both conditions.

In contrast to our hypothesis, we did not find differences between the two conditions in terms of eye tracking duration. People in the coordination condition spent about the same time looking at available options. Moreover, in Question 5 car, eye fixation duration on the right black car was even shorter in the coordination condition than it in the individual condition.

Concerning the time to make decisions, no main effect of conditions was found either. Participants in both conditions used about the same length of time to make decisions. However, there was an interaction effect between conditions and options in Question 5 and Question 10. Some certain options (left red car; Tripoli) took people more time to make a decision in the coordination condition than those in the individual condition. Also in these two games, to the opposite, people in the coordination condition spent less time when they chose another option (right black car; Beijing).

With the addition of questionnaire result, we can see that coordinating people indeed, to some extent, selected their strategy by speculating what others would choose instead of own preferences. Plus, they more relied on the rule of positions of options on the screen. For instance, they chose the center options in Question 9 and Question 10. In the following part, we will discuss what potential factors may make people reach such decisions.

General Discussion

Criteria of focal points. The use of focal points in tacit coordination has been shown in a number of experimental studies (e.g., Sugden, 1995; Colman, 1997; Bacharach & Bernasconi, 1997). This concept of focal point was firstly introduced by Thomas Schelling. Mehta and her colleagues have redefined the focal point as “Schelling salience”; that something becomes obvious when people are solving coordination problems. In this study, we verified the existence of focal points between people’s coordination by using pure coordination games. Through the choices that participants made, we can see that these options possess saliency in terms of position, cluster, color and social knowledge.

Position. The decision criteria that were self-reported by participants suggested that people in the coordination condition decided more based on the position of options. The results showed that people chose the option that had a salient position in the choice set. In Question 1, most people chose the second square as the focal point to make coordination. Regarding the position, some studies argued that people prefer to choose items on the right side where the second square was located (Nisbett & Wilson, 1977; Kruglanski, Chun, Sleeth‐Keppler & Friedman, 2005). Both in Question 9 and Question 10, people chose the center option of the choice set to coordinate. In Question 9, over 80% participants chose the center rectangle. In Question 10, almost half of the participants selected the center option (Tripoli) in the coordination condition while only few persons chose it in the individual condition. From these two questions, it is reflected that the position of center has higher saliency than other positions.

Cluster. Also, referring to similar coordination games used in Mehta's study (1994), people used the rule of closeness to assign these shapes into groups. In Question 1, the second square was more distant from other shapes, which means people were more likely to divide these shapes into "one square with four circles" and "one square". The isolation of the second square made it more unique to be the focal point. In the same vein, people chose the more isolated Castle A as the answer to the Question 6.

Color. In Question 5, although quite a few persons chose the middle car as answers, more people regarded the only red car as the focal point. The color is more salient than the position of center for this coordination game.

Social knowledge. From the coordination games analyzed above, people basically use a feature of an option to find the focal point. However, in Question 7, there was no obvious option that had a distinct position or color, but people succeeded in coordination still. Abele, Stasser, and Chartier (2014) claimed that common social knowledge is needed when the prominence of an object cannot provide a focal point. Most of them chose Amsterdam which is the capital of the Netherlands. Since the participants are all Dutch and the experiment location was in the Netherlands, it is more likely for the option of Amsterdam to be a salient social focal point.

Attention. What is more, we unfolded the decision process of coordination by using eye-tracking which was never involved in previous studies on tacit coordination. We hypothesized that people in the coordination condition would spend more time making decisions than those in the individual condition; eye fixation duration on options in the coordination condition would be higher than those in the individual condition. However, the results showed that there was no difference of decision time between the two conditions, and people in the two conditions had about the same eye fixation duration. In other words, people who needed to coordinate made decisions and processed information as quickly as people who decided based on the individual. Earlier in the article, we had assumed that it might take people more time to coordinate because they need to search for the focal point more thoroughly in the game and decide more cautiously. So, the time of information processing of the options will increase and the trade off between options may stall the decision time. However, it shows that people in the coordination condition paid about the same attention as people in the individual condition.

Salience. Although there is no difference of information processing between the coordination condition and the individual condition, we found the main effect of options that some options received longer eye fixation duration regardless of conditions. In other words, these options attracted more attention than others in both conditions. It is found that much of visual attention we pay to specific areas depends on bottom-up attention (Vazquez, Gevers, Lucassen, Van De Weijer & Baldrich, 2010). For instance, visual saliency, position and visual clutter will influence attention during decision making (Orquin & Loose, 2013).

Visual saliency. In previous studies, visually salient attributes were found to attract more attention than less salient attributes (Bialkova & van Trijp, 2011; Orquin, Scholderer & Jeppesen, 2012). For example, yellow color ads gained more attention than ads without color (Lohse, 1997).

Osberger and Rohaly (2001) suggested that the color of red attracts our attention more than other colors. However, in Question 5 of our study, the red car received the shortest eye fixation duration compared to the other two black cars, which means people paid less attention to the red car. It is suggested that red color will induce avoidance motivation in some cases (Mehta & Zhu, 2009; Tanaka, & Tokuno, 2011). The color of red can function as a stop signal in cognitive performance. Thus, people may keep attention away from the left red car. On the other side, it has been shown that attributes of an object can be encoded separately. For instance, people may process the information of color first and the shape in the next order. In Question 5, the left red car is more likely to be labelled as "red car" and the position is ignored because it was the only car in red. To the opposite, the color of black is not a unique attribute to label the other two cars. People need more time to process the information of position to label it as "middle black car" or "right black car". Therefore, the left red car received less attention than the other two.

Visual clutter. The finding of Visschers, Hess and Siegrist (2010) indicated that people pay more attention to less cluttered areas. In Question 6, Castle A was to some extent distant from other three castles which were more close together. As a result, Castle A has received more attention in the form of eye fixation duration than others.

Position. From our study, we also found that the longest fixation duration was mostly on the position of center. This may be caused by the instruction before each trial that participants were asked to focus in the center of the screen. However, it showed that the stimuli in the center attracts attention more than those in other positions (Chandon, Hutchinson, Bradlow & Young, 2009). Also, it is more likely for people to fixate on such salient stimuli which attention will be driven by. Besides, people prefer to gaze in the center of a choice set because the center is the optimal viewing position (OVP) (Orquin & Loose, 2013). It is efficient to use this strategy in decision making because fixations to OVP can minimize recognition time (Rayner, 2009).

Underlying mechanism. The hypotheses were made based on the assumption of people utilizing rationality models in coordination that they gather complete information to decide logically. However, some findings of dual-process model and bounded rationality model may suggest another explanation of the information processing in tacit coordination.

Automatic information processing. The dual-process model proposes that people have two types of thinking mode – System 1 and System 2. System 1, or intuitive thinking, is automatic, fast and low-effort required; System 2, or deliberative thinking, is stepwise, slower and more effortful. We have assumed that in the individual condition, people will pay little effort on the task because there were no performance requirements. To the contrary, we assumed that it requires more effort when people need to coordinate because they have to consider what decisions others will make. Thus, we regarded the individual choice more as intuitive decisions and assumed that people use deliberative thinking when making coordination decision. As deliberative thinking is slower and more effortful, we hypothesized that people pay more attention in terms of eye fixation duration and spend more time on decisions in the coordination condition. However, we found there is no difference of eye fixation duration or decision time between two conditions. Horstmann, Ahlgrimm, and Glöckner (2009) studied the difference of information processing between intuitive and deliberative decisions by using eye-tracking. Their findings suggest that intuitive and deliberative decisions share a similar basic process, and there was no difference of eye fixation duration between two decision modes. People also used an automatic process of information integration when they make deliberative decisions. Only when people were instructed to balance alternatives, there was additional processing of deliberative decisions that eye fixation amount increased. Therefore, in our study, people might perform about the same level of information processing in both the coordination condition and the individual condition. The available options were encoded all in a fast and automatic way.

Using heuristics. Moreover, from the view of bounded rationality models, there is the capacity limitation in cognitive activities. Hence, people will prioritize the information to which to attend when they construct the decision problem. In order to realize this prioritization, people select some effort-reducing strategies, such as heuristics to make decisions (Gigerenzer & Gaissmaier, 2011; Payne, Bettman & Johnson, 1992). Additionally, the recognition heuristic was found to be more used in deliberative judgments than it in intuitive judgments (Hilbig, Scholl & Pohl, 2010). For this reason, when people coordinate they employ some heuristics to find the focal point instead of logical reasoning. Based on the past experience of solving coordination problems, people may have mastered several principles of finding the focal point and they can recognize it automatically. According to the result that there was no extra eye fixation duration or decision time in the coordination condition, we can believe that people applied fast and effortless strategies as when they make individual choices. Moreover, there may be an alternatives selection process before encoding information. High relevant alternatives will be processed in depth while low relevant alternatives may be excluded from following processing (Beach, 1993; Russo & Leclerc, 1994; Senter & Wedell, 1999; Wedell & Senter, 1997). As in Question 5, the right black received low level of information processing in the coordination condition because it could be recognized as less salient option. Participants put more effort on other two options that were more likely to be the focal point.

In short, although people may have extra cognitive load that they have to consider what decisions others will make when they coordinate, it is likely that they use automatic information integration and heuristics that are learnt from their past experience to find the focal point and succeed in coordinating.

Limitations and Future Research

We have employed a new method of eye-tacking to study the decision process of tacit coordination. From eye-tracking data, cognitive activity can be revealed using eye tracking, such as eye fixation duration. However, there is also a limitation of using eye-tracking in our study. Glaholt and Reingold (2011) pointed out that it might require other sources of information to identify actual cognitive processing stages, besides what eye-tracking provides. A combination of eye-tacking and verbal protocols may be useful to reveal the decision process more in further research.

In this study, we focused on the eye fixation duration and decision time. We did not record other eye movements data, such as the sequence of fixations which may indicate if participants look back and forth between two options. In the future we can also probe into the path of eye movements to discover if there is any certain pattern of information processing in tacit coordination. In that way, we may find differences and similarities between coordination and individual choices.

Also, a questionnaire study was conducted after the eye-tracking experiment. However, the answers based on retrospection and about a collection of games may not be reliable enough. It would be better if participants are asked about these questions right after each trail. Besides the increased accuracy, a selection principle can be revealed for a specific coordination game as well.

In the pure coordination games that we used for the experiment, we provided choice sets with small number of options. Since we visually represented the options on the screen, people might focus on the position instead of other criteria to find focal points. Even in the non-geometric

Question 10, most people in the coordination condition chose the center option Tripoli which was barely selected in the individual condition. As Question 7, we also intended to inquire into social focal points that people use to coordinate based on common social knowledge. What option would a Dutch person choose to coordinate when the experiment is operating in Spain? Such extended questions will be interesting to ask in further research.

Conclusions

To summarize, we have conducted an eye-tracking experiment to study salience in tacit coordination and reveal the process of information encoding while decisions are being made. The results showed that people can find focal points to coordinate without exchanging information. It turned out that the participants in the coordination condition more relied on the assumption of others' choices to make decisions, and mainly chose the focal point based on its position in the choice set. Eye-tracking data demonstrated that people in the coordination condition spent about the same time in fixating options and making decisions. We infer that people utilize more intuitive thinking and heuristics when they are making decisions in coordination problems as they do in the individually independent choice situation. Overall, this study adds to the accumulating body of evidence that people use focal points in tacit coordination. Also, it was the first time to use eye-tracking technology to investigate the decision process of tacit coordination, which can be used for reference in future tacit coordination research.

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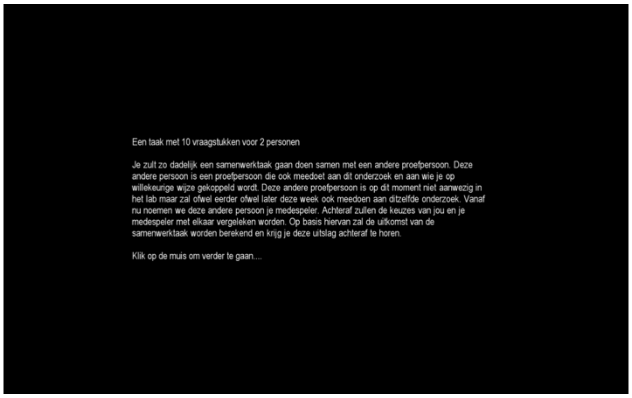
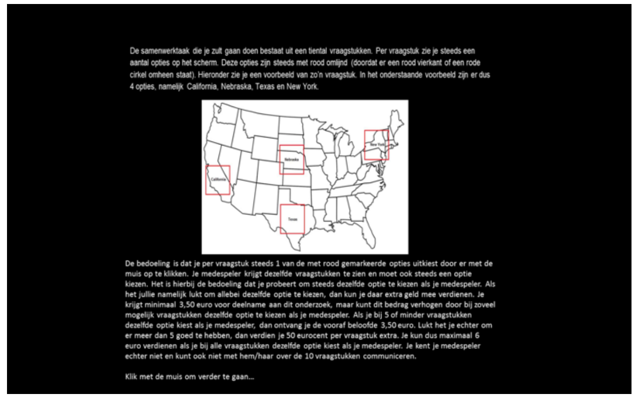
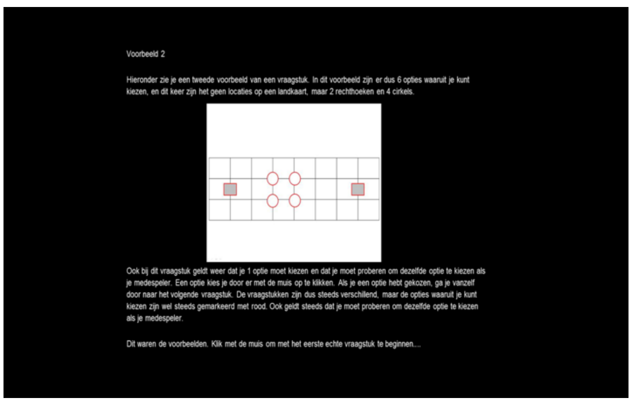
Appendix

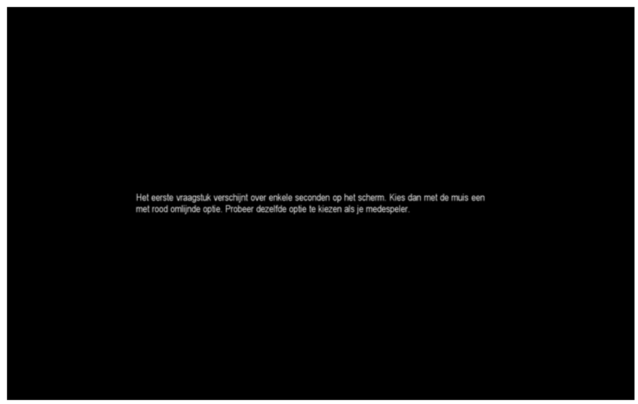
a

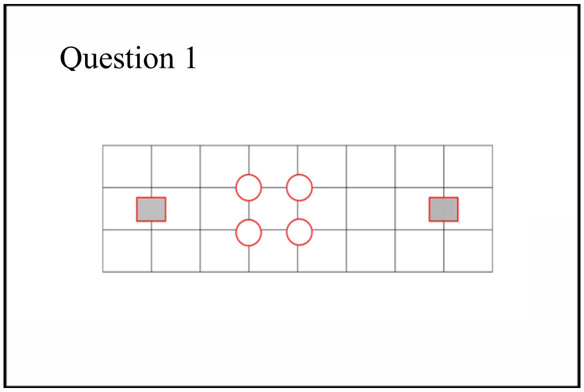
Instructions of the coordination condition and ten pure coordination games.







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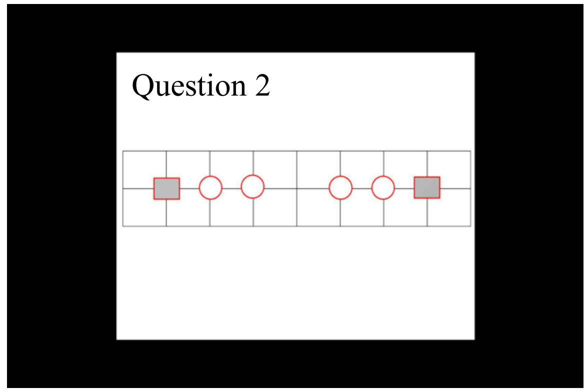
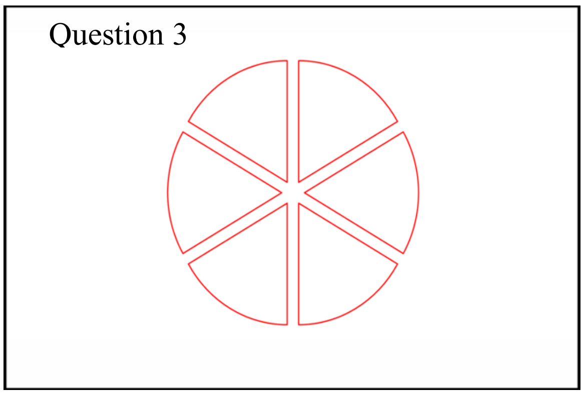
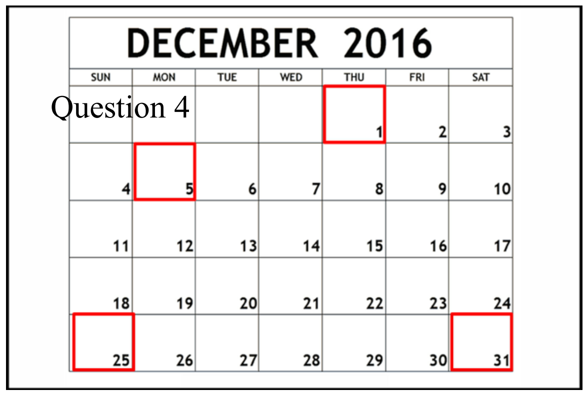
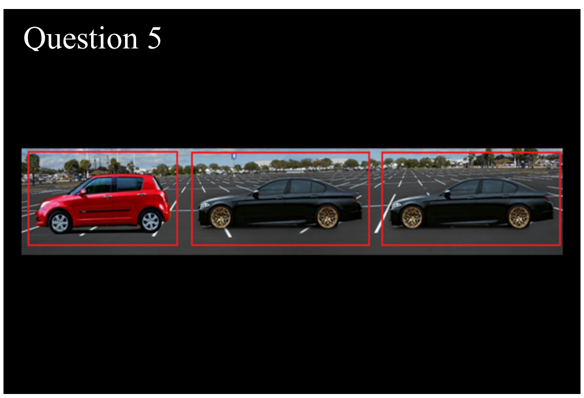

Question 2


Question 3


DECEMBER 2016
SUN MON TUE WED THU FRI SAT
Question 4
1 2 3
4 5 6 7 8 9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30 31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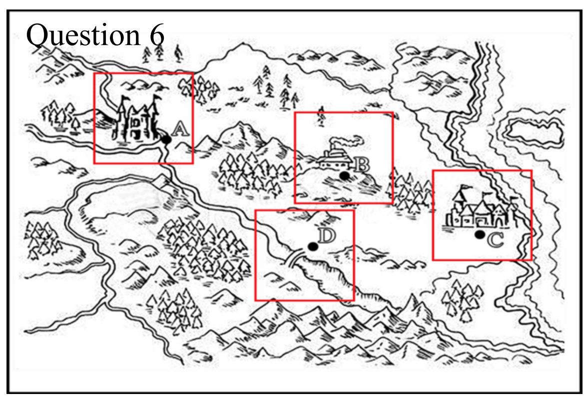
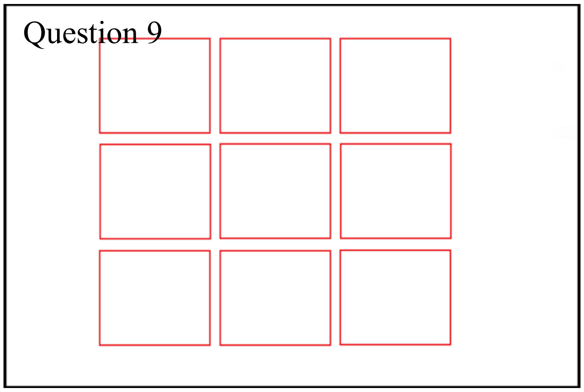

Question 6
A
B
C
D

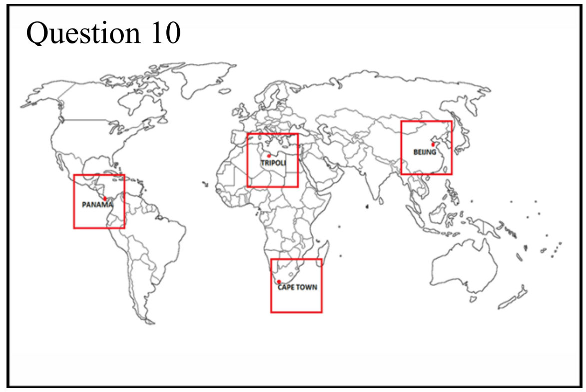

Question 7


Question 8

Question 9



Question 10



b

Questionnaire:

To what extent your choices to the task were influenced by your personal preferences for certain options? (1 = slightly, 7 = to a large extent)

To what extent you had to think deeply about your choices in the tasks?

(1 = slightly, 7 = to a large extent)

To what extent did you choose certain options because of their location / placement on the screen (eg upper left)? (1 = slightly, 7 = to a large extent)

To what extent your choices to the task were influenced by how familiar the options were for you?

(1 = slightly, 7 = to a large extent)

To what extent your choices to the task were influenced by the colors of the options?

(1 = slightly, 7 = to a large extent)

To what extent you felt that you have totally randomly made your selections in the task?

(1 = slightly, 7 = to a large extent)

To what extent do you feel that you might well explain your choices to the task, or explain to others? (1 = slightly, 7 = to a large extent)

To what extent your choices were influenced by what you thought others would choose?

(1 = slightly, 7 = to a large extent)

c

Result of chosen options proportion for each game.

Question 1: *squares and circles 1*

Response	Proportion	
	Coordination (N = 45, c = 0.27)	Individual (N = 49, c = 0.16)
Left square	20.0	14.8
Left top corner circle	15.6	14.3
Left bottom circle	2.2	8.2
Right top circle	13.3	18.4
Right bottom circle	2.2	10.2
Second square	46.7	30.6

Question 2: *squares and circles 2*

Response	Proportion	
	Coordination (N = 45, c = 0.28)	Individual (N = 49, c = 0.28)
Left square	26.7	16.3
First circle from left	4.4	0.0
Second circle from left	11.1	22.4
Third circle from left	11.1	16.3
Forth circle from left	0.0	2.0
Right square	46.7	30.6

Question 3: *cake*

Response	Proportion	
	Coordination (N = 45, c = 0.21)	Individual (N = 49, c = 0.23)
Top left	15.6	4.1
Middle left	24.4	12.2
Bottom left	2.2	10.2
Top right	28.9	32.7
Middle right	20.0	28.6
Bottom right	6.7	12.2

Question 4: *date of December*

Response	Proportion	
	Coordination	Individual
	(*N* = 45, *c* = 0.30)	(*N* = 49, *c* = 0.49)
1st December	28.9	10.2
25th December	20.0	46.9
31st December	22.2	24.5
5th December	28.9	18.4

Question 5: *cars*

Response	Proportion	
	Coordination	Individual
	(*N* = 45, *c* = 0.49)	(*N* = 49, *c* = 0.32)
Middle black car	33.3	38.8
Right black car	4.4	28.6
Left red car	62.2	32.7

Question 6: *castles*

Response	Proportion	
	Coordination	Individual
	(*N* = 45, *c* = 0.29)	(*N* = 49, *c* = 0.27)
A	44.4	38.8
B	17.8	16.3
C	20.0	28.6
D	15.6	16.3

Question 7: *European cities*

Response	Proportion	
	Coordination	Individual
	(*N* = 45, *c* = 0.29)	(*N* = 49, *c* = 0.27)
Amsterdam	75.6	44.9
Madrid	6.7	8.2
Moscow	11.1	16.3
Rome	4.4	28.6

Question 8: *Harry Potter*

Response	Proportion	
	Coordination	Individual
	(*N* = 45, *c* = 0.18)	(*N* = 49, *c* = 0.24)
Book 1	33.3	34.7
Book 2	2.2	2.0
Book 3	17.8	10.2
Book 4	8.9	0.0

Book 5	13.3	30.6
Book 6	11.1	14.3
Book 7	13.3	8.2

Question 9: *rectangle*

Response [row, column]	Proportion	
	Coordination ($N = 45$, $c = 0.74$)	Individual ($N = 49$, $c = 0.32$)
[1,1]	4.4	2.0
[1,2]	0.0	6.1
[1,3]	4.4	8.2
[2,1]	2.2	4.1
[2,2]	86.7	55.1
[2,3]	2.2	16.3
[3,1]	0.0	2.0
[3,2]	0.0	2.0
[3,3]	0.0	4.1

Question 10: *World cities*

Response	Proportion	
	Coordination ($N = 45$, $c = 0.33$)	Individual ($N = 49$, $c = 0.30$)
Beijing	6.7	28.6
Cape Town	33.3	36.7
Panama	15.6	30.6
Tripoli	44.4	4.1