Emergence and Influence of Expertise in Group Decision Making: A Judgmental Task

by

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

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Abstract

This thesis investigates the emergence and influence of expertise in group decision making while performing a judgmental task. Previous studies focused on intellective tasks or compared the group performance with the performance of the best individual in the group. In this study, performance feedbacks are provided to groups to help group members compare the individual performances and identify the expert.

Laboratory experiments were conducted in which the task was to select a proverb that Canadians would like the most from the list of four proverbs from countries other than Canada. The four proverbs for each question were guaranteed to have equal selection probability based on the pretest survey. 18 four-person cooperative groups were asked to perform the task for eight iterations each. One member in each group was selected randomly to be the expert. Groups received performance feedbacks that reinforced the expert at the end of each iteration. The amount of information conveyed to each group regarding the expertise level of each group member was measured with a novel application of information analysis that captures the expert's gradual emergence. Experiment results supported the hypotheses of this study that (1) group members recognize the expert when working on a judgmental task with performance feedback and (2) while performing a judgmental task, the expert has more influence on the group decision making compared to others.

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Dedicated To Iman:

In appreciation of all his support throughout this journey: a unique support

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Chapter 1

Introduction

From the early times to present, most people have lived in groups. They have preferred to perform their activities such as working, learning, worshiping, and playing in a group rather than isolated from others (Forsyth, 2006). Moreover, groups, in recent days, are essential management tools that organizations use to make a novel combination of individuals to work on novel tasks (Gersick, 1988). Therefore, research in this area would have a great influence on organizations. One of the important tasks that groups perform is making different types of decisions. In most cases groups outperform individuals in judging, estimating, choosing, and problem solving (Stasser and Dietz-Uhler, 2001).

When a group makes a decision, individuals have their own choices in most cases. The group discusses these individual choices and reaches the group choice. This is one of the interesting and important dynamics of a group that has attracted many researchers in previous decades. Many studies have addressed how the group choice is made from the individual choices.

A group should be able to recognize and utilize all its resources in order to enhance its performance. One of the major resources in a group is the expertise of its members(McGrath, 1984). Therefore, recognizing and utilizing experts has a great effect on the group's per-

formance. Experts emerge gradually in groups based on the individual and group performances and the feedback that a group receives during the group work. The first focus of this study is the emergence of the expert in group decision making and the group's ability to recognize the expert.

Expert recognition is the first toward utilizing expertise in group decision making. Therefore, the second focus of the current study is the influence of the expert in group decision making. This part would address the difference between the expert's influence and other group members' influence on the group decision.

In designing the experiment to investigate these questions, the main concern was to make a case that was a good representative of real life cases. Since in the realistic setting the tasks are often judgmental with feedbacks, the task chosen for the experiment was also a judgmental task followed by the performance feedback.

In summary, this thesis investigates the emergence, recognition, and influence of expertise in group decision making while the group works on a judgmental task and receives a performance feedback. The remainder of the thesis is ordered as follows. Chapter 2 begins with defining "expert"and "judgmental task"and proceeds to reviewing previous studies in the literature. The chapter concludes by identifying the existing gap in the literature and defining the hypotheses of this study. Chapter 3 discusses the methodology and provides a detailed description of the experiment. Chapter 4 analyzes the results of the experiment. Finally, Chapter 5 outlines the conclusions, areas for future research, and limitations of the study.

Chapter 2

Literature Review and Hypotheses

2.1 Literature

There is a rich literature on various aspects of group decision making and problem solving. This chapter provides an overview of the literature addressing similar issues to the one studied in this research: the emergence of experts and their influence on the decision making process of groups performing judgmental tasks. The first two sections provide definitions of the two major elements of the study: expert and the judgmental task. The last two sections discuss expert recognition and influence.

2.1.1 Expert

In the literature of group decision making there are two major definitions for expert, each corresponding to its own stream of research. The first definition builds on Wegner (1986) theory of transactive memory which views experts as individuals who have access to more information (than other group members) in a specific domain (Stewart and Stasser, 1995). With this definition, expertise does not necessarily imply possession of higher skills or abilities.

As such, the stream of research using this definition has largely focused on the information sharing effect of experts during the group decision making process. For example, Stewart and Stasser (1995) examined how the expert facilitates mentioning and validation of unshared information in collective recall and decision making groups. The facilitation occurs through increasing member's awareness of who holds what type of information. The study found that assigned expertise significantly increased the proportion of unshared information revealed in the group during both collective recall and decision making tasks.

The second definition sees experts as "the group member who had the highest performance on the task during previous tasks" (Bonner et al., 2002; Henry et al., 1996). This definition leads to the studies such as the recognition and influence of expert in group decision making process (For example: Littlepage et al., 1997; Bonner et al., 2002; Bonner, 2004) and comparing the group performance with the that of the expert (For example: Libby et al., 1987; Laughlin et al., 2003, 2006). Since these are also the focus of this research, the second definition is adopted. The following sections provide a more detailed overview of the studies in this latter stream of research, especially with regards to the tasks defined, and expert recognition and influence on the expert and group decision making process.

2.1.2 Task

The variety of tasks used in the literature fall along a spectrum of pure judgmental to pure intellective ones (Laughlin, 1980; Laughlin et al., 1991). Intellective tasks, such as mathematical problems, possess objectively correct answers, provable to others with the same conceptual system. In contrast, judgmental tasks involve evaluative, behavioral, or aesthetic judgment and it is impossible to demonstrate the correct answer to them (Laughlin et al., 2003; Bonner, 2000) .

As such, the main factor that differentiates between intellective and judgmental task

is demonstrability of the correct answer. Laughlin and Ellis (1986) suggested four requirements for demonstrability of correct responses: (a) group consensus on a conceptual system; (b) sufficient information regarding the task; (c) recognizability of the correct answer, if proposed, by incorrect members; (d) possession of sufficient ability, motivation, and time by the correct members to demonstrate the correct answer to the incorrect group member.

Some of the most commonly used intellective tasks in studying group decision making are: deductive rule-learning problem, Master mind game (Laughlin et al., 1999; Bonner et al., 2002), Letters to number task (Laughlin and Bonner, 1999; Laughlin et al., 2003; Bonner, 2004; Laughlin et al., 2006).

The Desert Survival Situation (Littlepage and Mueller, 1997), estimating unknown quantities (Henry, 1993; Henry et al., 1996), and choosing the title for the partly revealed picture (Bonner, 2000) are examples of the judgmental tasks found in the literature.

2.1.3 Expert and Group Decision Making

The majority of studies on the expert and group decision making compare the group performance with the performance of the best group member: the expert.

Literature suggests that groups perform better than independent individuals on a wide range of problems. In one study, the highly intellective task, Letters to Numbers, was used in five different ways. The result showed that the three-person groups performed better than the best of an equivalent number of individuals on letters to numbers problems (Laughlin et al., 2003). In another Letters-to-Numbers task study, Laughlin et al. (2006) examined the effect of the group size on the group performance and suggested that three-person groups are necessary and sufficient to perform better than the best individual on highly intellective problems. Moreover, Henry (1995) proposed two ways by which the groups can perform as well as their best members even in tasks without demonstrable solution (judgmental tasks): (a) asking a group to share task-relevant information or (b)

asking a group to try to determine the most accurate member.

In group decision making, information is contributed by members and then socially processed to reach the group agreement. In literature, the social process where information contributed by members is known as the social combination process, and the scheme the group used to reach the group decision is known as social decision scheme.(Davis, 1969; Restle and Davis, 1962). Lorge and Slomon (1955) developed the model for the group problem solving showing how group combine the individual answers to reach the group solution. Later, Davis (1973) applied their proposed model for the group decision making process. To apply the model, it was assumed that the group decision task is to select a response from a set of mutually exclusive and exhaustive alternatives. A group does that by mapping the individual preferences distribution to a collective group decision. This mapping process is tested against the model drawn from the theoretical expectations which implies what would happen (Bonner et al., 2002).

A noteworthy theory in the literature of group decision making is the social decision scheme theory. The social decision scheme theory includes four basic elements: individual preferences, group composition (preference distribution among members), group influence (social combination rule), and collective decision (Stasser, 1999). Stasser (1999) demonstrated these four elements in a simple schematic depicted in figure 2.1.

There are many different forms of social decision schemes in the literature such as: majority in which the group selects the choice advocated by the majority of the group members, proportionality in which the probability of a group choosing a certain choice is the proportion of members advocating that choice, equiprobability in which each advocated choice is equally probable to be chosen as a group choice (Davis, 1973). Social decision schemes may be the combination of two or three. For example: majority otherwise proportionality which means that the group will select the choice advocated by majority but, if no majority exists, the group will weigh each options in proportion on number of members chosen that option. These decision schemes are referred as standard decision

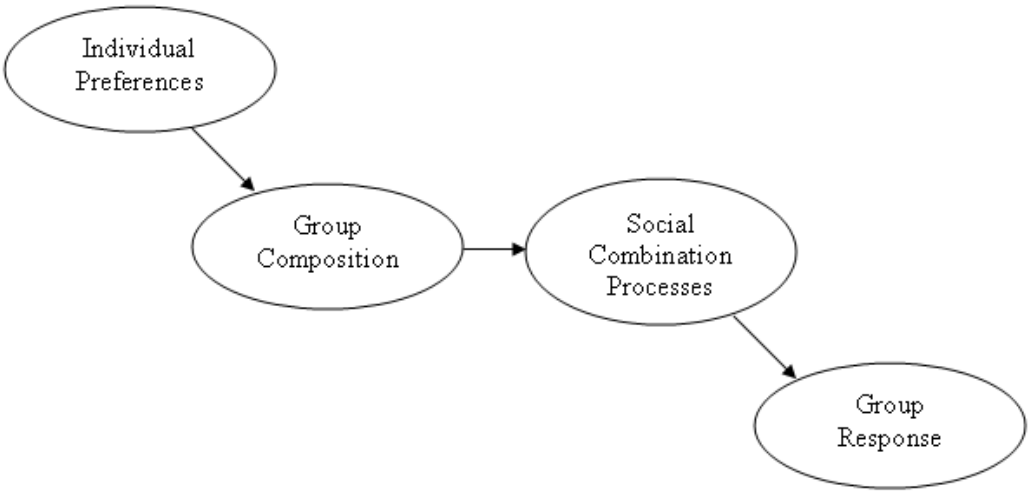


Figure 2.1: Schematic of the basic components of SDS theory (adopted from Stasser, 1999)

scheme (Bonner et al., 2002).

The standard decision scheme treats all the group members as being indistinguishable and interchangeable. Therefore, it is not suitable for the cases that there is a difference between the group members. For this purpose, Bonner (2000) introduced the social permutation which includes a new set of models that identify a certain group member and treat that individual as a consistent entity across the trials. These models are discussed in more detail in section 4.

2.1.4 Expert Recognition

In group decision making, one of the major resources available to the group is the expertise of the group members (Laughlin, 1980; McGrath, 1984). Therefore, the group performance depends on both the level of expertise in the group and the group's ability to recognize the expert(Bottger, 1984; Libby et al., 1987). A review of literature recommends that, for the purpose of expert recognition and utilization of the expertise, the task should possess two primary characteristics. First, diagnostic information on performance should be available

to group members. Second, the task should have a medium level of difficulty (Bonner et al., 2002). Diagnostic information on the relative competencies, knowledge, or performance of the group members should be available to all group members so that they can assess the relative expertise of group members. Explicit performance feedback leads a group member to carry out a social comparison process with other group members(O'Leary-Kelly, 1998). Moreover, the task should possess a level of difficulty that allows for substantial variation in member performance which helps members to recognize the differences in the expertise levels among group embers(Libby et al., 1987).

Bonner (2004) examined the recognition and influence of the expertise in three-person groups working on a letter-to-numbers task. First, all participants completed the task individually and were ranked from first (with the highest performance at the individual level) to third, within their prospective three-member group. Then the task was performed twice in the same three-person groups. Some groups were provided feedback on the ranking information of all group members; whereas, other groups did not receive any information regarding the individual performance of group members. The result showed that groups with explicit ranking information and group without ranking information both calibrated with respect to the expertise while working on an intellective problem-solving task.

In another study, Littlepage and Mueller (1997) investigated how personal characteristics and behavior of the expert relate to the group's recognition and utilization of expertise. The participants completed the desert survival situation problem in groups of four or five people. The study found that an expert who was more talkative and highly used the influence tactic reason was more likely to be recognized as an expert by other group members. Furthermore, an expert was more influential if one of the following conditions existed: (a) was male, (b) was talkative, (c) received support from a talkative colleague, (d) used reason to show that his/her response was correct.

Littlepage et al. (1997) examined the impact of group experience and task experience on the group performance. The participants completed the desert survival situation or

the price estimation tasks in groups of three to six people. The result showed that task experience led to better group performance. Moreover, group experience on a related task also increased the group performance by facilitating recognition and utilization of member expertise.

2.1.5 Expert Influence

Besides investigating the expert recognition, the important aspect studied in the literature was the influence of the expert in group decision making. Einhorn et al. (1997)) suggested that the group judgment is a weighted combination of the individual judgments and the crucial point is how the group allocated these weights to the opinions of different group members. They developed four base line models: (a) the random model, (b) the mean or composite model, (c) the best-member model, and (d) the proportional model. The third model is of interest in this research.

Yetton and Bottger (1982) also concluded that groups weighted individual inputs in proportion to an individual's expertise and this led to better group performance. In the study of expert's influence in group decision making, Bonner et al. (2002) asked three-person groups to solve either an easy or moderately difficult version of the deductive logic game Mastermind. The result demonstrated that groups gave more weight to the expert's input in their decision making in moderately difficult intellective problem, in which case the group decision making process was best approximated by expert-weighted social decision schemes. However, in the condition where the task was easy or the group lacked ranking information, groups were not more likely to adopt options advocated by the expert.

Later in another study, Bonner (2004) examined three-person groups working on letters to numbers, an intellective problem-solving task. Bonner believed that the greater complexity of the problem compared to Mastermind (The one used in Bonner et al., 2002) and the increased opportunities for group members to make decisions, provided a more

interaction-rich task environment. The study concluded that the group decisions were best approximated by expert-weighted decision schemes in which the expert has twice the influence of other group members.

2.2 Hypotheses

2.2.1 Expert Recognition

Reviewing the literature reveals gaps that can be addresses by future research. First, the emergence of expertise is not a one shot process. Instead, it is a dynamic continuous process that occurs throughout the group's life. Information regarding the expertise level of group members is generated gradually during the group work. This information accumulates and builds the group perception of each members' expertise in the given task. In real world settings, people often have estimates of other people's expertise level. These estimates are built based on the individual's performance compared to that of others. People do not recognize someone as an expert only because of one good performance. Neither do they change their mind about someone as a result of one poor performance. They accumulate all available information and change their perception regarding the individual's expertise level gradually. To capture this concept in the current study, first, the experiment is designed such that the group performs a task for eight iterations to allow enough time for building perceptions and, second, the amount of information generated at the end of each iteration regarding each group members' expertise is measured using information analysis discussed in details in Section 4.3.3.

Second, most studies in the field of expert recognition and influence in group decision making have used an intellective task. As mentioned in Section 2.1.2, intellective tasks have a demonstrable solution that the expert can show and also provide a reason for in order to persuade other group members. In performing intellective tasks, the expert

recognition process is straight forward (Laughlin, 1980). In contrast, a judgmental task is one for which a demonstrable correct solution does not exist. The task chosen for the current study is a judgmental task for two reasons. First, to investigate whether the results of studies based on intellective tasks are also true for a judgmental task. Second, a judgmental task better represent real life decisions and better captures the effect of an expert compared to an intellective task. Most real life decisions do not have solutions that are demonstrable and provable. Different preferences, points of views, agendas, etc., create many feasible and desirable solutions for most real life decisions. In addition, expert followership in an intellective task is, arguably, following a certain line of logic and reasoning rather than following a certain individual (the expert). I believe that the expert's effect on group is better captured when the group follows the expert as an individual not as a provable mathematical problem. In judgmental tasks, group members are unable to present evidence for their correct answer in order to convince other group members (Henry et al., 1996). However, there should be a feedback system in the process in order to distinguish between individual performances and reinforce the expert. Therefore, the judgmental task should be designed such that to have a correct answer. The Task in the current study has designed in a way that can benefit from both characteristics of not having a demonstrable correct answer while having a correct answer which distinguished between group members' performances. This has been accomplished by choosing a qualitative judgmental task, which has a correct answer based on a survey conducted prior to the experiment. The details of the stimulus have been discussed in Section 3.1. Bonner (2004) showed that the group recognized the expert when working on an intellective problem-solving task, letters to numbers. This leads to questioning whether the group also recognizes the expert while performing a judgmental task. In the task chosen for this study there is a performance feedback which leads group members to carry out a social comparison process with other group members(O'Leary-Kelly, 1998).

As discussed in Section 2.1.4 Bonner et al. (2002) defined two characteristics for the

task in order for group members to recognize and utilize the expertise: (a) group access to the performance diagnostic information, (b) the task should possess a level of difficulty that allows for significant variation in performance in order for members to identify different levels of expertise. The task chosen for the current study satisfied both conditions. First, the group received performance feedback at the end of each iteration. Second, a pretest was conducted to choose questions such that all four choices had equal probability to be chosen by group members. These points lead to the first hypothesis:

H1: Group members recognize the expert when working on a judgmental task with performance feedback.

2.2.2 Expert Influence

Expert recognition is a first step in using this resource in group decision making. This leads to the more interesting question: does the expert have more influence in group decision making compared to other members? Literature suggests that in a group decision making process group members weight each individual's inputs in proportion to the individual's expertise level. Bonner et al. (2002); Bonner (2004) supported this idea using three-person groups working on two different intellective tasks: mastermind and letters to numbers. The most important characteristic of these two tasks is that both of them have correct demonstrable solutions. Therefore, it is easier for the expert to present evidence for the correct answer and persuade followership among other group members. But, how about a judgmental task in which it is not easy to prove the correct answer or there is no unique logic to find the answer? For example, in selecting the proverbs that Canadian would like, one might try to relate the proverbs to the Canadian culture, while others might look at the length or sound of the proverbs. There is no way to prove which one of these logics is correct if any. In addition, the result may not be the same even if two individuals apply

the same logics. So, what would the group members do when they have to choose between their own logic and the expert's answer while past experience shows that the expert's performance was better than any one else? I believe that group members often prefer the expert's choice over their own judgment. The example of this idea is pervasive in our day to day life when we ask experts for their recommendations and, furthermore, when we follow the experts' recommendations when we have experienced their good performance previously. Therefore, the second hypothesis was as follows:

H2: While performing a judgmental task, the expert has more influence on the group decision making compared to others.

Chapter 3

Methodology

3.1 Stimulus

To explore a specific behavior of the group during the decision making process, the group should have a task to perform. Each task, with its unique characteristics, would reveal different aspects of the group dynamics. Therefore, the first step in running the experiment is to select a task that is appropriate to test the hypotheses. Based on the hypotheses, the desired experiment should fulfill the following requirements:

1. To show the gradual emergence of expertise, the group should perform the task several times.

2. To create an expert, it should be possible to show that the expert's individual choices are correct in most cases without controlling the expert's choice in any way. Therefore, a task is needed that does not have a clear answer or a task for which any answer is believable and acceptable as the correct answer.

3. To reinforce the position of one group member as the expert, group members should receive feedbacks on group and individual performances after each iteration.

4. To induce discussion and provide enough information regarding the difference between an expert and other group members, the answer to each question should have multiple choices that are chosen with the same probability. This concept is discussed in more details later in this section.

Based on the requirements above, the judgmental task selected for this study was to "choose a proverb that Canadians would like the most from a list of four proverbs from countries other than Canada".

One could use different arguments to find the best answer. Individuals select their choices based on their personal experiences and their perceptions of the proverbs and the Canadian taste and culture. Since group members have different perceptions and experiences, different answers are chosen. Hence, any answer for this question would be acceptable as the correct answer.

In order to fulfill the fourth requirement, the four choices of each question should have the same chance of being chosen by the group members at the individual level. For example, assume that a question has four choices: *a, b, c,* and *d*. If *a* has a higher chance of selection comparing to *b, c,* and *d*, it is likely that most or even all group members choose *a* as their individual choice. In such a case, by saying that *a* is the correct answer, little or no information on the expertise level of each group member is provided. The value of information would be more if individual choices are spread out on different choices. In contrast, consider the following scenario: one group member chooses *a*, while other members choose *b, c,* and *d*, respectively. Assuming *a* is announced as the correct answer, compared to the previous scenario, here the group members receive more information regarding the first member's expertise level. In the second scenario one person "sticks out"while no one does so in the first. In other words, the second scenario provides more information that distinguishes between the group members in terms of their expertise level.

To design the task that possesses the discussed characteristics, an on-line survey was run to select the desired questions from an original pool made earlier. The details of the survey are discussed in section 3.2.

To accomplish the first and second requirements, The group performed the task eight times and the chosen expert was reinforced to be correct in six out of eight iterations. The expert was decided to be correct six times instead of eight for the following reasons. First, this would be more realistic and, therefore, the result of the study would be more applicable to real situations. Second, the group members, including the expert, could get suspicious and alter their behavior accordingly if they were told that one individual is correct in all iterations.

3.2 Survey

The survey was aimed at finding eight questions in which all four choices have equal selection probability.

3.2.1 Task

The task is to choose one proverb that Canadian would like the most from the list of four proverbs from countries other than Canada. First, 120 proverbs from Germany, Italy, Russia, Japan, and France were chosen. All of these proverbs were translated into English. Then, a Canadian individual was asked to review them and eliminate those that were similar to an English proverb or those he had difficulty understanding.

As a result, the list of proverbs decreased to 97. Eighty proverbs were randomly chosen from this list and divided to groups of four, resulting in twenty four-choice questions. These questions are presented in Appendix A .

3.2.2 Participants

The participants in this survey were 111 students enrolled in the Organization Theory course at The University of Waterloo who received course credit for their participation. The participants were divided into four groups of 26, 29, 28 and 28 and each group was asked to answer an on-line survey containing five questions.

3.2.3 Procedure

Each set of five questions were uploaded in one web page and the corresponding group of participants were asked to visit the web page and answer the questions. The survey started with a set of instructions presented in Appendix B. After reading the instructions and entering their personal information (to receive the course credit), they were directed to the first question. Each question was uploaded on one page. They had to answer a question completely before advancing to the next one.

For each question, they were, first, asked to choose a proverb that they thought Canadians would like the most and, then, write down a brief description of their reason. The reasoning section was made a compulsory part of each question in order to move to the next question and earn credit. By doing so, the participants were forced to spend some time reading each question, thinking about the proverbs, and choosing one of them reasonably.

3.2.4 Result

The desired distribution for each question was a uniform distribution of $\left(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right)$. A goodness-of-fit test was performed for each question to test whether the question has the desired distribution. Eight questions that passed the goodness-of-fit test with $\alpha = 0.05$ and had the lowest test statistics were chosen for the group study.

3.3 The Experiment

3.3.1 The Task

Each group consisted of four members. A group of four was chosen because it seems that such a group can generate all the different scenarios such as:

- *Majority:*
  - Strong majority: four individuals choosing the same answer *e.g.,(a,a,a,a)*
  - Medium majority: three individuals choosing the same choice *e.g.,(a,a,a,b)*
  - Weak majority: two individuals selecting the same answer while the other two select answers that are different from majority and from each other *e.g.,(a,a,b,c)*
- *Even split:*

  The situation in which two members choose one answer while the other two select another choice *e.g.,(a,a,b,b)*.
- *Distributing over the choices*

  The condition in which each individual picks the choice different from others *e.g.,(a,b,c,d)*

The Task was to choose one proverbs that they think Canadians would like the most from four choices provided . They were asked to, first, answer the question individually and, then, have a group discussion and pick an answers as the group choice. Each group was asked to perform the same task eight times. These eight questions that had the desired characteristics discussed in Section 3.1 are presented in Appendix C.

3.3.2 Participants

The participants in this experiment were 79 undergraduate students enrolled in the Organization Theory course at The University of Waterloo who received course credit for their participation and 4 graduate students who participated in the pilot study. Participation in this experiment was voluntary and students received two bonus marks for participating in the experiment with the opportunity of receiving two additional bonus marks depending on their individual and group performance.

In order to participate in this experiment, the students were asked to register for their desired time slot by visiting a web page designed for registrations. The web page included a brief description of the study, instructions for registration, and the available time slots. These instructions are included in Appendix D.

Although four participants were required for each experiment, five individuals were allowed to register for each time slot. By doing so, the common situations that an experiment needed to be canceled due to the absence of one individuals was avoided. In the cases that all five participants showed up, the fifth person was assigned to an observer role.

3.3.3 Procedure

The experiment was set up in the Uncertainty Lab at the Management Sciences Department at The University of Waterloo. Four cameras were used to video record the experiments. Each camera focused on one of the participants. The participants were made aware of the video recording before the registration process and, once more, before the experiment.

The group members sat around a round table with dividers assigning a quarter of the table to each one of them. Each group member was assigned a color code written on a piece of paper on their table segment: blue, green, red, and yellow.

To maintain consistency among all groups, the experiment instructions were video recorded and projected for each group before they started the task. The instructions are

Table 3.1: Algorithm for choosing the expert

	Possible scenarios in the first iteration	**Expert**
1	$(a,\ a,\ a,\ a)$ [1]	One of four chosen randomly
2	$(a,\ a,\ a,\ b)$ [2]	Member 4 (The one with a different answer)
3	$(a,\ a,\ b,\ c)$ [3]	Member 3 or 4, chosen randomly
4	$(a,\ a,\ b,\ b)$ [4]	One of four chosen randomly
5	$(a,\ b,\ c,\ d)$ [5]	One of four chosen randomly

[a] All group members choose the same answer

[b] Three group members choose the same answer while the other member chooses a different answer

[c] Two group members choose the same answer while the other two choose answers different from each other and the first two

[d] Two group members choose the same answer while the other two choose another answer

[e] Each group members chooses one of the answers

presented in Appendix E.

After showing the instructions, each participant was provided with the first question written on paper. After reading the question and spending some time to decide, each member wrote their individual choice on a piece of paper, folded the paper, and gave it to the experimenter. As soon as all four members of the group gave their answer to the experimenter, the experimenter wrote down their individual choices in a table drawn on the white board. The details of the table is shown in Appendix F.

After answering the first question at the individual level one of the group members was chosen to be reinforced as the expert. The expert was chosen using the algorithm summarized in Table 3.1.

The following pattern is used to reinforce the chosen expert: $C\ C\ W\ C\ C\ C\ C\ W$ meaning that the expert is correct in iterations 1, 2, 4, 5, 6, and 7 and is wrong in iterations

3 and 8. So, the correct answer in 6 out of 8 iterations is the same as the expert's individual choice. In the two iterations that the expert is wrong the correct answer is chosen randomly.

Following the individual choice, the group had a discussion to pick the group choice. The time for discussion was not limited and there was no suggested process on how to come up with the group choice. As the group announced its choice, the experimenter would write down their group choice in the table on the white board followed by the correct answer and then the next iteration would start.

The group members were told that this correct answer was based on the survey conducted among the undergraduate students at The University of Waterloo while in fact ,as discussed above, the correct answer was either the expert's individual choice or chosen randomly.

The group answered four questions following the procedure above. After the fourth question, there was a mid-point discussion. The group had about five minutes to discuss their own performance and plan a strategy to obtain better results. After the mid-point discussion, they answered four more questions with the same procedure outlined above.

The participants were, then, asked to answer the questionnaire presented in Appendix G. In answering the questionnaire, the participants' overall senses were of interest rather than their judgments based on the results. To reduce the effect of the results on their response, the results table was hidden during the questionnaire.

In case all five individuals registered for the time slot showed up, one of them was asked to be the observer. The observer did not participate in any group discussions, but instead was asked to write an observation report on the interesting dynamics and events in the group decision making process. The observer was also asked to answer the questionnaire in Appendix H at the end of the experiment.

Chapter 4

Results

4.1 Experimental Data

The table presented in Appendix F was completed for each group during their experiment. Details of all group experiments are presented in Appendix I.

All participants completed a questionnaire presented in Appendices G and H at the end of the experiment. Data acquired from the questionnaires were divided into three categories: group members excluding experts, experts, and observers and is available in Appendix J: Table J.1, Table J.2, and Table J.3, respectively.

4.2 Expert Recognition

Question 1 in the questionnaire was designed to test Hypothesis 1. The answers to this question demonstrate that group members, including the expert, recognized the expert as the individual with the best performance. Tables J.1 and J.2 show that 98% of group members excluding the expert and 89% of the experts believed that someone was better than others in the group task. Moreover, in all cases, the person recognized by the group

as the best performer was the same person that reinforced as the expert.

Although these statistics strongly supported the first hypothesis, analysis presented in section 4.3 further confirmed the result. The influence of the expert on group members and how the expert's influence increased over iterations is discussed in section 4.3. Evidently, this would be impossible without first recognizing someone as the expert in the group.

4.3 Expert Influence

The main hypothesis of this study is the second one which discusses the expert's influence on other group members during the group decision making process. This hypothesis was tested in three different ways, each capturing a different aspect of the problem. In next sections, these three approaches are discussed.

4.3.1 Expert Followership

In order to measure the degree by which the group follows the expert in their group choice, a measure called "Expert Followership" was defined. Expert followership for each iteration is 1 or 0 representing whether the group choice is the same as the expert's individual choice or not, respectively. Expert followership for n iterations is the sum of expert followership of the n iterations. In this experiment the expert followership for the first four iterations was compared to that of the last four. I expected the group to recognize the expert gradually and, hence, the influence of the expert to increase over iterations. Therefore, I believed that the expert followership in the last four iterations should be significantly greater than that of the first four. Expert followership of all groups are presented in Table 4.1.

Table 4.2 provides the result of the t test[1]. Since the sample size (n=18) was not large, normality tests were also performed for both data sets. The normality tests confirmed that

[1]The statistical analysis was done using the SPSS package.

Table 4.1: Expert followership in the first and last four iterations

	Expert followership	
	First four iterations	Last four iterations
Group 1	1	4
Group 2	3	2
Group 3	0	3
Group 4	4	3
Group 5	1	3
Group 6	1	4
Group 7	3	3
Group 8	1	3
Group 9	2	3
Group 10	3	2
Group 11	3	3
Group 12	2	4
Group 13	3	3
Group 14	2	3
Group 15	3	3
Group 16	2	4
Group 17	3	2
Group 18	2	1

both data sets followed a normal distribution. Therefore, the t test was valid for comparing the mean of these two data sets. The t test indicated that expert followership for the last four iterations was significantly larger than that of the first four.

Table 4.2: t test for comparing Expert Followership in the first and last four iterations

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Expert Followership1	2.1667	18	1.04319	.24588
Expert Followership2	2.9444	18	.80237	.18912

Paired Samples Correlations

	N	Correlation	Sig.
Expert Followership1& Expert Followership2	18	-.340	.168

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
ExpertFollowership1-ExpertFollowership2	-.77778	1.51679	.35751	-1.53206	-.02350	-2.176	17	.044

4.3.2 Social Decision Schemes

To investigate expert's influence on other group members, the expert was the only person who was considered different from others. Since there was no difference between the other three members of the group in analyzing the data, a coding system was developed that identified the expert's individual choice and enabled the comparison of other individual choices with that of the expert.

For the purpose of this analysis, a four letter sequence was used to show each group's individual choices. The leftmost letter represents the expert's individual choice and the nest three letters represent individual choices of other group members. The expert's choice is labeled A, while, in fact, it could be either *a, b, c*, or *d*. All other member choices that were the same as the expert's were also labeled A. The remaining member choices were all labeled B if they are all the same, two labeled B and one C if two were the same and one differs, and labeled B, C and D if they were all different. The four letter sequence was constructed by ordering the labels alphabetically.

All iterations for all groups were categorized, first, based on the individual choices and, then, based on the group choice. The group choice was either the expert's choice, or a non-expert choice. A non-expert choice was further divided into three categories: majority choice, minority choice, and the choice not advocated by any group member. Tables 4.3 and 4.4 present the frequency of each category in the first and last four iterations, respectively.

Table 4.3: Obtained frequency - First four trials

Possible scenarios at Individual level	Frequency	Group Choice			
		Expert Choice	Non Expert Choice		
			Majority	Minority	Not Advocated
AAAA	3	3			0
AAAB	15	14		1	0
AABB	11	7	4		0
AABC	10	7		3	0
ABBB	7	0	7		0
ABBC	19	5	9	3	2
ABCD	7	3		4	

Eleven different social decision schemes were tested against the obtained results. Each

Table 4.4: Obtained frequency - Last four trials

Possible scenarios at Individual level	Frequency	Group Choice			
		Expert Choice	Non Expert Choice		
			Majority	Minority	Not Advocated
AAAA	4	4			0
AAAB	22	21		1	0
AABB	9	6	3		0
AABC	13	11		2	0
ABBB	6	1	5		0
ABBC	17	9	8	0	0
ABCD	1	1		0	

of these social decision schemes represents the rule by which the group combine their individual choices to reach a group choice. The Kolmogorov-Smirnov test was used to evaluate how good each social decision schemes fits the data. The Obtained probabilities for the first and last four iteration are provided in Tables 4.5 and 4.6, respectively.

Bonner et al. (2002) divided decision schemes into two categories: the standard social decision scheme, *i.e.*,the ones already discussed in the literature (*e.g.*,Davis 1973), and expert weighted social decision schemes first developed and used by Bonner (2000). The standard models tested were: (i) Majority otherwise proportionality, (ii) Proportionality, and (iii) Equiprobability. The majority otherwise proportionality model predicts that the group would choose the majority's choice if available. If there in no majority (*e.g.*,*AABB* or *ABCD*) then the probability of choosing any choice is equal to the proportion of group members advocating that choice. Foe example, if the individual choices are *AABB* or *ABCD* then the probability that the group chooses A as a group choice is 0.5 and 0.25, respectively. The predicted probabilities based on the majority otherwise proportionality

Table 4.5: Obtained probability - First four trials

Possible scenarios at Individual level	Frequency	Group Choice			
		Expert Choice	Non Expert Choice		
			Majority	Minority	Not Advocated
AAAA	3	0.042			0*
AAAB	15	0.194		0.014	0
AABB	11	0.097	0.056		0
AABC	10	0.097		0.042	0
ABBB	7	0	0.097		0
ABBC	19	0.069	0.125	0.042	0.028
ABCD	7	0.042		0.056	0

Note: An empty cell indicates an impossible choice. For example, in the last scenario there is no majority and therefore, the majority choice is an impossible group choice.

*Zero in the cell shows that the choice was possible but it did not occur in any iteration

model are presented in Table 4.7 .

The proportionality model predicts that in all cases the probability of a group choosing any choice is equal to the proportion of group members advocating that choice. Finally, the equiprobability model predicts that all choices have equal probability of being chosen as the group choice.

Eight expert-weighted social decision schemes were tested: (i) Majority otherwise the expert, (ii) The Expert, (iii) Proportionality with expert weighting twice the others, (iv) Proportionality with expert weighting three times the others, (v) Proportionality with expert weighting four times the others, (vi) Proportionality with expert weighting five times the others, (vii) Proportionality with expert weighting six times the others, (viii) Proportionality with expert weighting seven times the others.

Table 4.6: Obtained probability - Last four trials

Possible scenarios at Individual level	Frequency	Group Choice			
		Expert Choice	Non Expert Choice		
			Majority	Minority	Not Advocated
$AAAA$	4	0.056			0
$AAAB$	22	0.292		0.014	0
$AABB$	9	0.083	0.042		0
$AABC$	13	0.153		0.028	0
$ABBB$	6	0.014	0.069		0
$ABBC$	17	0.125	0.111	0	0
$ABCD$	1	0.014		0	0

Table 4.7: Predicted probability: majority otherwise proportionality

Possible scenarios at Individual level	Group Choice			
	Expert Choice	Non Expert Choice		
		Majority	Minority	Not Advocated
$AAAA$	0.056			0
$AAAB$	0.306		0	0
$AABB$	0.063	0.063		0
$AABC$	0.181		0	0
$ABBB$	0	0.083		0
$ABBC$	0	0.236	0	0
$ABCD$	0.003		0.010	0

The majority otherwise the expert model predicted that the group would choose the majority's choice if available. If there was no majority, the expert choice would be chosen.

The expert model predicts that the group always chooses the expert's choice. The other six decision schemes predict that the probability of choosing any choice was equal to the proportion of group members advocating that choice but, the influence of the expert is inflated by counting the expert as more than one member (*i.e.*,twice, three times, . . . , seven times). For example, in the proportionality with expert weighting four times compared to others, the expert acts as five members instead of one. In other words, in a group of four members, the expert receives a $\frac{5}{5+3}$ proportion of the influence and each one of the other three members receives a $\frac{1}{5+3}$ proportion of the influence.

Kolmogorov-Smirnov tests were conducted to evaluate if the standard and expert weighted decision schemes discussed above fit the data. An alpha of 0.20 was applied for testing which is the standard used in the literature for the testing procedure (*e.g.*,Laughlin & Hollingshead, 1995). Tables 4.8 and 4.9 present the results of the Kolmogorov-Smirnov tests for the standard and expert weighted decision schemes, respectively. Smaller $D_{statistics}$ represent better fit. $D_{critical} = 0.126$ with n=72 observations. So, any model with $D_{statistics} > 0.126$ does not fit the data and is, therefore, rejected.

Whereas two of the standard model, (i) and (ii), fitted well for the first four iterations,

Table 4.8: K-S test for standard social decision models

Model Tested	$D_{statistics}$	
	The firs four iterations	The last four iterations
Majority otherwise proportionality	0.107	0.128*
Proportionality	0.086	0.215*
Equiprobability	0.177*	0.320*

n=72, $D_{critical} = 0.126$

* Model Rejected at $\alpha = 0.20$

none of them fitted the data for the last four iterations. For the last four iterations proportionality with expert weighting six times the others was the best fit. These results supported the second hypothesis which implied that the expert is more influential than other group members.

Table 4.9: K-S tests for expert-weighted social decision models

Model Tested	$D_{statistics}$	
	The firs four iterations	The last four iterations
Majority otherwise the expert	0.186*	0.0972
The Expert	0.458*	0.263*
Proportionality with expert weighting twice the others	0.047	0.147*
Proportionality with expert weighting three times the others	0.097	0.115
Proportionality with expert weighting four times the others	0.148*	0.093
Proportionality with expert weighting five times the others	0.187*	0.076
Proportionality with expert weighting six times the others	0.217*	0.063
Proportionality with expert weighting seven times the others	0.2418	0.076

n=72, $D_{critical} = 0.126$

* Model Rejected at $\alpha = 0.20$

4.3.3 Information Analysis

Although the expert was reinforced as being correct in most iterations (6 out of 8 iterations), the answers chosen by other members were not under our control. Different answers by non-expert members resulted in different scenarios, each providing different amount of information regarding the expert. For example, compare the scenario in which one member chooses the correct answer and other group members choose the same wrong answer with another scenario in which all members select the correct answer. When the correct answer is announced at the end of the iteration the amount of information conveyed regarding the expertise level of each individual is not the same in the two scenarios. The correct individual in the first scenario stands out more than the correct members in the second scenario. Since only one person was correct in the first scenario and everyone else chose the same wrong answer, it appears that finding the correct answer was difficult and, therefore, the correct person exhibits higher expertise. Whereas in the second scenario, since all members selected the correct answer, it seems that finding the correct answer did not require a high level of expertise.

To measure the information conveyed, a pointing system was defined based on the scenario occurring in each iteration. Each group member received a positive or negative point in each iteration for providing a correct or incorrect answer, respectively. The absolute value of the point represents by how much the person stands out in the group and is based on the scenario occurring in that iteration. In extreme scenarios of standing out in which one person is correct and everyone else chooses the same wrong answer or one person is wrong and everyone else chooses the same correct answer, the person is assigned points 1 and -1, respectively. All other scenarios are ordered in order of standing out and assigned points between -1 and 1, subjectively. Table 4.10 presents the points assigned to each person in each scenario. The first column shows all possible scenarios and the second presents the points assigned to each individual in that scenario. For example, *(C,*

Table 4.10: The pointing system for information analysis

Possible Scenarios	Points assigned
(C, C, C, C)	$(0, 0, 0, 0)$
(C, C ,C ,a)	$\left(\frac{1}{6}, \frac{1}{6}, \frac{1}{6}, -1\right)$
(C, C, a, a)	$\left(\frac{2}{6}, \frac{2}{6}, -\frac{2}{6}, -\frac{2}{6}\right)$
(C, C, a, b)	$\left(\frac{3}{6}, \frac{3}{6}, -\frac{5}{6}, -\frac{5}{6}\right)$
(C, a, b, d)	$\left(\frac{4}{6}, -\frac{4}{6}, -\frac{4}{6}, -\frac{4}{6}\right)$
(C, a, a, b)	$\left(\frac{5}{6}, -\frac{3}{6}, -\frac{3}{6}, -\frac{5}{6}\right)$
(C, a, a, a)	$\left(1, -\frac{1}{6}, -\frac{1}{6}, -\frac{1}{6}\right)$
Everyone Incorrect	$(0, 0, 0, 0)$

Note: C represents the correct answer. a, b, and d stands for wrong answers.

a, a, b) represents the scenario in which one group members selects the correct answer (C), two members select the same wrong answer (a), and one member selects a different wrong answer (b). Based on Table 4.10, the member providing the correct answer receives $\frac{5}{6}$ points, the next two member receives -$\frac{1}{2}$ points, and the last member receives -$\frac{5}{6}$ points. The pointing system was designed to incorporate the difference in how much the expert stands out among different scenarios.

This pointing system was applied to all the groups in all iterations. I expected that expert recognition and, as a result, expert followership (the concept is discussed more in section 4.3.1) in each iteration depends on how much the expert stood out relative to other group members. To measure this, an "expertise score"was defined for each group member as the sum of all points received during the past iterations. Based on the experiment's design, the expert's expertise score was always the highest score in the group. The difference between the expert's expertise score and the second highest score was named as the "expert's standing out score"since it shows how much the expert stands out relative to others

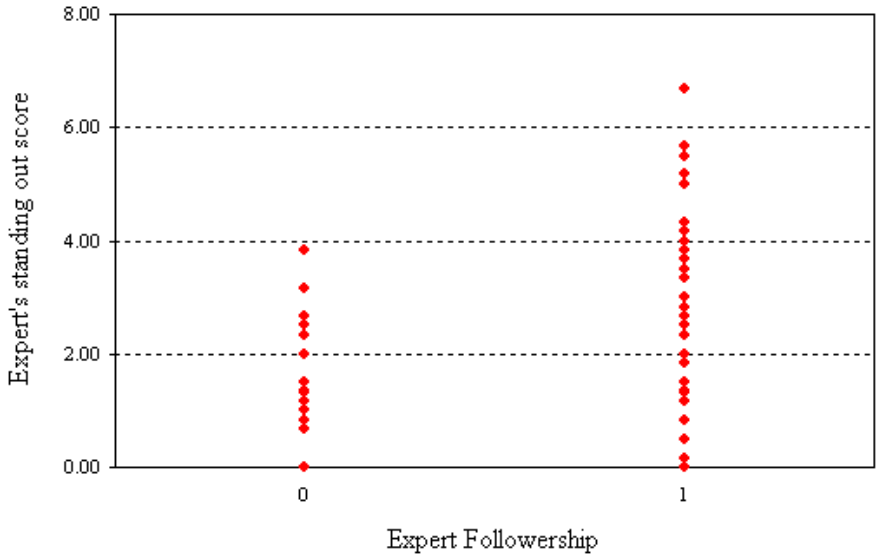


Figure 4.1: Expert standing out and followership

in the group. I predicted that the probability of the group choosing the expert's choice as the group choice would be higher when the expert's standing out score was higher. The first iteration was excluded from the analysis due to unavailability of expertise scores. Figure 4.1 displays the relationship between the expert's standing out score at the beginning of an iteration and the expert followership at the end of the iteration for all groups. As the expert's standing out score increased, expert followership was more frequent. As can be seen in Figure 4.1, the groups in this study always chose the expert choice beyond a threshold expert's standing out score of 4.

A t test was also conducted to investigate whether the expert's standing out score differs between iterations that groups followed the expert and the ones that groups did not follow the expert. My prediction was that the expert's standing out score in iterations in which expert followership equals one is greater than that of the iterations in which expert followership equals zero. The result of the t test is summarized in Table 4.11. The t test supported the prediction.

Table 4.11: t test- expert's standing out score under different EF

Group Statistics

	N	Mean	Std. Deviation	Std. Error Mean
EF0	39	1.4662	.84642	.13554
EF1	87	2.0913	1.47896	.15856

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
					Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	t	Sig.	df				Lower	Upper
Equal variances assumed	11.840	.001	-2.46	124	.015	-.62511	.25394	-1.12774	-.12248
Equal variances not assumed			-2.99	116.6	.003	-.62511	.20859	-1.03823	-.21199

4.3.4 Expert Influence at the Individual Level

Sections 4.3.1, 4.3.2, and 4.3.3 discussed the expert influence on the group choice. However, I predicted that the expert influences not only the group choice but also the individual choices of the group members. Based on the survey results discussed in section 3.2, one can assume that all choices have equal probability to be chosen at the individual level in all eight questions. This means that the individual choices should be distributed evenly over different choices. Moreover, there should not be a significant difference in the distribution

of individual choices between the first and last four iterations. Thus, a significant difference can be attributed to the effects of the expert on individual choices. I predicted that group members try to understand and mimic the expert's logic in answering the questions and, therefore, in the last four iterations the individual choices would converge to some degree. The number of unselected choices in the first and last four iteration were counted as a measure of convergence. Having more unselected choices means that the individuals are converging on some choices and their selections are not distributed evenly among all choices. The result of the t test conducted is summarized in Table 4.12. The t test supported the hypothesis indicating that the individuals convergence on the same answer in the last four iterations was greater than that of the first four.

4.4 Other Results

This section presents the analysis on the questionnaire that individuals completed after the experiment (Appendix G).

4.4.1 Reason for Expert's Performance

All participants, including the expert, were asked in the questionnaire to indicate, on a scale, whether the expert's choice was based on "pure luck" or "good judgment". Experts were judging their own performance while other members were judging the expert. I expected to see a difference between the answers provided by the experts and those provided by other members. Therefore, a t test was conducted, the result of which is presented in Table 4.13. As shown in Table 4.13, the difference was not significant and the hypothesis is not supported.

Table 4.12: t test for comparing convergence in the first and last four iterations

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Unselected choices1	5.7778	18	1.21537	.28647
Unselected choices2	6.4444	18	1.46417	.34511

Paired Samples Correlations

	N	Correlation	Sig.
Unselected choices1& Unselected choices2	18	.422	.081

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Unselected choices1-Unselected choices2	-.66667	1.45521	.34300	-1.39033	.05699	-1.944	17	.069

4.4.2 Enjoying Group work

Another question was whether there was any difference between the amount of enjoyment that experts experience during the experiment and that of other members. Did being correct most of the times result in more enjoyment from the group work? The questionnaire asked if the group members enjoyed the group work. The participants could choose on a scale of -3 to 3 ranging from "Not at all" to "Very much". A t test was performed to

Table 4.13: t test for comparing the reason for expert's good performance

Group Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Expert	16	1.6875	1.35247	.33812
Other Group Member	53	1.5472	1.10185	.15135

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
					Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	t	Sig.	df				Lower	Upper
Equal variances assumed	1.161	.285	.423	67	.674	.14033	.33165	-.52165	.80231
Equal variances not assumed			.379	21.36	.709	.14033	.37045	-.62925	.90991

compare the experts' responses with that of other group members, the result of which is summarized in Table 4.14. There was no significant difference between the expert and other member's in terms of enjoying the group work.

Table 4.14: t test for comparing the enjoyment of group work

Group Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Expert	18	2.3889	1.14475	.26982
Other Group Member	54	2.0741	.90807	.12357

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	t	Sig.	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.549	.461	1.19	70	.238	.31481	.26424	-.21219	.84182
Equal variances not assumed			1.06	24.53	.299	.31481	.29677	-.29699	.92662

Chapter 5

Discussion and Conclusion

5.1 Discussion

This section discusses the results presented in Chapter 4 and additional observations from the experiment.

5.1.1 Expert Recognition

As mentioned in Section 4.2, group members including the expert were successful in recognizing the expert. Furthermore, the group believed that the expert's good performance was more due to good judgment rather than luck, yet another evidence that group members accepted the expert as someone with good performance. Although it seems that the feedback system and the presentation of results on the board helped the group recognize the expert, it is interesting that group members attributed the expert's performance to the good judgment of the expert. In addition, this result confirmed that the experiment setting was appropriate and that group members did not suspect any manipulation. My observation of the group discussions also support the face validity of the experiment.

5.1.2 Expert Influence

Data analysis in Chapter 4 supports the second hypothesis that the expert has more influence on the decision making process than any other group member. In the first four iterations the expert is identified gradually and, therefore, in the second four iterations the group has already recognized the expert and, as a result, follows the expert. The influence of the expert is seen in two different ways:

First, other group members try to understand the expert's logic and apply it at the individual level. I observed so many examples of this behavior in the group discussions, *i.e.*,The group asked the expert about his/her reason for selecting the (correct) answer in each iterations. The analysis presented in section 4.3.4 marginally supports this idea, as well. Although the questions were designed such that all choices had equal probability to be chosen at the individual level, the group's convergence on the same answer increased in the last four iterations indicating that group members were trying to understand and apply the expert's logic in answering the question. I believe that the convergence could have been greater had the expert had a clearer and more understandable reason for his/her choices. In some cases, the expert was not able to provide any reason for selecting an answer when asked to do so by other group members. Thus, following the expert's logic at the individual level was not an easy task for the group. Since the group recognized and followed the expert simultaneously in the last four iterations, one can conclude that the group was trying to mimic the expert at the individual level. Certainly, further investigation is needed to support this idea.

Second, regardless of being successful in understanding and applying the expert's logic, the groups followed the experts in their group choices. Several instances were observed that the group trusted the expert's choice even when the expert did not mention a certain logic for his/her choice. Three different approaches applied to analyze the data confirmed that the expert's influence on the group decision making increased over iterations.

The first approach compared expert followership in the first and last four iterations. The t test presented in Table 4.1 indicates that expert followership in the last four iterations were significantly higher than that of the first four, meaning that group members selected the expert's choice as their group choice more often when they recognized the expert.

The second approach, based on Table 4.8, revealed that the best decision scheme model fitting the data set in the last four iterations was the proportionality model with expert weighting six times the others and none of the standard decision scheme models was a suitable fit to the data. Although, the exact number of six is not very reliable and might change in different settings, comparing this model with the ones that fit the first four iterations confirms that the influence of the expert increased substantially in the last four iterations. Two standard and two expert-weighted decision scheme models fit the data set for the first four iterations. The reason that expert-weighted models were a goof fit for the data in the first four iterations is that the expert was emerging gradually over iterations. So, the effect of the expert existed even in the first four iterations. The expert's emergence in the groups happened over time. A clear frontier that distinguishes between the time that groups did not follow the expert and the time they did was not found. Moreover, the expert recognition happened at different times in different groups based on the amount of information conveyed regarding the expertise level of the expert (This concept is discussed in Section 4.3.3).

The third approach used to analyze the data was information analysis. As discussed in Section 4.3.3, the analysis showed that the amount of information conveyed to the group regarding each individuals expertise level is important in recognizing and following the expert. It is not only the expert's performance that is important, rather it is the difference between the expert's performance and the second best performer in the group. For example, if the expert was correct in eight out of eight iterations and other group members were correct in seven, seven, and six iterations, there is no significant difference between the expert and other members and, consequently, the group might not recognize anyone as

the expert. In contrast, assume the scenario in which the expert was correct in six out of eight iterations while other group members were correct in one, two, and three iterations. Although the expert was correct in fewer iterations in the latter scenario comparing to the former, the expert stands out more and is recognized more often in the latter scenario.

5.1.3 Reason for Expert's Performance

For the Expert's good performance, the t test presented in Table 4.13 indicates that there is no significant difference between the reason provided by the expert and the one by other members. Both groups, experts and other group members, attribute the expert's performance to expert's good judgment more than to pure luck. This result is analyzed in two aspects: expert's perception and other group members' perception.

It is interesting that experts attributed their own performance to good judgment. It seems that experts were successful in finding a logic for answering the question. Therefore, the experts believed that it is not his luck but rather their good judgment that makes them experts. *Attribution theory* can help in explaining the experts' behavior in this matter. This theory categorizes the way people attribute causes to events into two types: the internal (dispositional) attribution and the external (positional) attribution. An internal attribution assigns causality to factors within the person, *e.g.*,one's intelligence. Whereas, External attribution assigns causality to an outside factor, *e.g.*,the weather. In addition, *self serving attribution* occurs when people want to claim responsibility for a success. If something good happens to them or someone they like, they tend to see it as a result of their own characteristics. In this study, when experts were asked to find a reason for their good performance, based on the self serving attribution, they attributed it to the internal factor, *i.e.*,their good judgment rather than the external factor, *i.e.*,luck.

Self serving attribution also declares that if something good happens to someone that one like, one tend to see it as a result if the internal (dispositional) causes. This explains

why other group members also attributed the expert's good performance to the expert's good judgment. One might question the good relationship between the expert and other group members. However, in the current study, the answers to Questions 4 and 5 of the questionnaire (Appendices G and J) implicitly confirmed that there was a good relationship between all the group members.

5.1.4 Enjoying Group work

The result of the t test presented in Table 4.14 indicated that there was no significant difference between the experts' enjoyment and other group members' enjoyment from the group work. At first glance, one might expect that the person with the best performance, *i.e.*,the expert, should experience more enjoyment compared to other group members. But, the analysis results did not support this expectation. My explanation of this result is as follows. First, since the group also received bonus marks based on their group choice, all members benefited when the group followed the expert in their group choice. So, the satisfaction form finding the correct answer was not exclusive to the expert but shared by other group members, as well. Second, as discussed further in section 5.1.5, the expert experienced pressure from the group members to deliver the correct answer. This pressure decreased the expert's satisfaction from group work.

5.1.5 Other Observations

In addition to the results discussed in previous sections, other observations were made during the experiment. This section discusses these observations that can be regarded as starting points for future research.

First, most of the groups recognized the expert in the mid point discussion after the fourth iteration. 75% of the recognized expert at this point were the actual experts. The main reason for this fast expert recognition could be the direct feedback provided at the

end of each iteration and also the presentation of all results on the board. The purpose of the mid point discussion was to find a strategy that helps the group improve their performance. Most of the groups looked at the board during the mid point discussion to see how well their group and each individual has performed. In a few groups expert recognition happened even before the mid point discussions. It seems that in a vague tasks, *i.e.*,one that the group has no clue about the answer and has no obvious way of finding it, group members are desperately looking for a pattern or a person to follow. This might have fostered the process of expert recognition. Certainly, further investigation is needed to test this prediction.

Second, a common observation in most groups was that the experts experienced pressure from other group members to deliver the correct answer. Group expectation from an expert increased with the gradual recognition of the expert. The experts dealt with this pressure in different ways. In some groups the experts needed more time to select their individual choices after being recognized by the group compared to before. The experts were clearly trying their best to choose the correct answer. In some other groups, as the groups identified the experts and decided to follow the experts' individual choices, the experts tried to persuade them that they are not confident about their choices or in some cases the experts changed their choices in favor of the majority during the discussion. One might argue that there was a majority pressure on the expert. Although this might be correct to some extent, it is not the main reason for the experts' behavior because in this case the majority did not put any effort into persuading the expert (minority). In fact the majority was willing to select the expert's choice due to the expert's previous performance. I believe the main reason for the experts' behavior was that they did not want to be blamed if the answer was wrong. In other words, the experts preferred to change their answers in favor of the majority to distribute the blame among the majority if the answer was wrong.

Third, since the task assigned to groups was vague and no specific logic existed for answering the questions, group members were seeking a pattern to answer the questions.

Different groups examined different kind of patterns. Some groups analyzed the previous questions and answers and found simple patterns, *e.g.*,a pattern suggesting that Canadians are obsessed with money so they should choose the proverb that is somehow related to money or the shortest proverb among the choices. In other cases, group members analyzed the scenarios that happened before in their group. For example, they looked at whether the majority was correct in previous iteration or whether a certain individual was correct. In fact, this was the case that resulted in recognizing and, consequently, fallowing the expert. Some groups also found meaningless patterns such as that the answers follow a (*e.g.*,*a b a b*) pattern or that the correct answer is among the choices that have not been chosen in previous questions (*e.g.*,one group member mentioned: "choice *b* has not chosen in last five questions so we have to choose it this time"). It seems that our mind is looking for a pattern to make sense of things or answer questions. In some cases the pattern is meaningful (*e.g.*,math problems) and in vague problems, such as ours, that our mind is not successful in finding a reasonable pattern it ends up with less meaningful or even meaningless patterns. Certainly, understanding this dynamic requires more research in the area.

Finally, although a certain logic for answering the questions did not exist, the group members, especially the experts, in most groups came up with different logics that they believed were helping them in answering the questions. In some cases, they were so loyal to their logic that they did not change their logic even after choosing the wrong answer but rather they thought that they did not apply the logic correctly. For example, the expert in one of the groups told the group: " To pick the correct answer, I read all the proverbs pretty quickly and then I pick the catchy one. You are thinking too much in to the proverbs". He did not suspect his logic even when he was wrong in the third iteration rather he told everyone: "I guess this time I thought about the proverbs longer than I should".

5.2 Research Contributions

This study contributes to the group decision making literature in the following ways:

- **Emergence of the expert**

  In this study the expert emerges gradually by the performance feedbacks provided to the group. Group members used the information generated by the feedback system at the end of iterations to build their perception about the expertise level of each group member. Comparing the expertise level of group members resulted in expert recognition. This study attempted to capture this idea by using information analysis that measured the expertise level of each group member at any point of the group work based on the member's performance in the current and previous iterations. This methodology of analyzing the data is a novel contribution of the current study.

- **Influence of the expert in a judgmental task**

  Another main contribution of this study is using a judgmental task instead of an intellective task. Intellective tasks such as mathematical proofs possess objectively correct answers that can be shown to be correct to other individuals having the same conceptual system (Bonner 2000). In contrast, judgmental tasks either do not have an objectively correct answer or it is not possible to demonstrate which answer is correct. Therefore, it is harder for the expert to persuade other members to follow him/her in a judgmental task. The group follows the expert not because they accept his/her reasoning but rather because of the previous performance of the expert.

  Another aspect that made this study unique is that although it benefited from the characteristics of a judgmental task, the correct answer for the task was also announced that enabled the reinforcement of the expert. Therefore, on one hand, it was impossible to demonstrate to other members why the correct answer was in fact

correct and on the other hand, a correct answer existed for each question by which the expert was reinforced.

5.3 Limitations of the Study

Our study has limitations that need to be addressed in the future. First, the number of iterations and the time of the experiment were limited. Having eight iterations, the experiment took about 90 minutes for each group. Certainly, interactions in a realistic setting are occur in much longer time periods. Therefore, longer experiments would be more revealing. This leads to the second limitation. Similar to most studies in the field, the ad hoc groups of undergraduate students was used for this experiment. Moreover, the number of groups in this experiment was 18. Additional replications of this experiment would help achieve more reliable conclusions.

Third, the feedback system used in this study was very direct and quick which made the expert recognition easier. However, feedbacks in realistic settings are more implicit and with some delay. Since the time of the experiment was limited, delay could not be replicated accurately. In addition, I believe that a direct feedback in shorter interactions is an acceptable replicate of the real setting which has less direct feedback in longer interactions.

Fourth, the students were not assigned to groups randomly. Therefore, the groups that participated in the study could be either newly formed (*i.e.*,students don't know each other), or already established (*i.e.*,students know each other and possibly have collaborated before). Having previous working experience with some group members might have some affects on individual's perception regarding their expertise levels. Although, based on observation, most of the group members were new to each other, it would be better to control this factor in future experiments.

Finally, The experiment was designed such that a random person was reinforced as the expert. Therefore, a correct answer did not exist and the answer provided to the group

as a feedback was fake and based on the expert's choice (or random in two cases that the expert was supposed to be wrong). This lead to the use of deception in the study. Using deception helped in providing more control over the experiment. However, it would certainly be better if deception can be avoided in future experiments.

5.4 Areas of Future Research

The current study explored some aspects of the expert emergence and influence in group decision making with a judgmental tasks. But, at the same time it has raised many questions that need to be addressed in the future.

First, the study showed that as soon as group members recognize the expert, the expert's influence on the decision making process increases and group members follow the expert in their individual decision making. But, what if the task is changed after the group recognized the expert? Would they still follow the expert in a completely different subject? Or do they consider that being expert in one subject does not guarantee expertise in another subject. How about the experts' behavior? Do experts consider themselves as an expert in the other subject, as well? To summarize, how much does expertise transfer from one subject to another?

Second, in the current study being correct in 6 out of 8 iterations was enough to reinforce someone as an expert. But, the study does not show to what extent one can reduce the correctness rate or how quickly the group recognizes the expert. The observations should that most groups recognized the expert in the mid point discussion. But, further investigation is needed to answer this question. Clearly, the information analysis used in section 4.3.3 would be helpful to answer this question.

Third, this study investigated the emergence of an expert in a group. However, another interesting question would be: how long would it take to establish that the recognized expert is no longer an expert? If feedbacks are given that the expert's choice in no longer

correct, how many iterations would it take for the group to change their mind about the expert. What are the similarities and difference between recognizing someone as an expert and deposing an expert?

Fourth, as mentioned in Section 5.3 the feedback system used in this study was direct comparing to a realistic setting. Therefore, it merits to design a feedback system which is not as explicit as the current one and then measure the expert recognition followed by the expert's influence in the group decision making.

Fifth, interestingly, I observed that experts experienced pressure from other group members to deliver the correct answer. The pressure, mentioned briefly in Section 5.1.5, affected the expert's behavior and, subsequently, the group's behavior. However, further investigation is needed to understand the source of this pressure and how it affects the expert's and group's behavior.

Finally, the task structure has a great effect on the result of this study. Using another judgmental task will not necessarily give the same results. Therefore, to shed more light on this subject, it is worth investigating it using different judgmental tasks and different group settings.

Appendix A

Survey Questions

Which proverb do you think Canadians would like the most?

Question 1

a. It is not the knowing that is difficult, but the doing.

b. Marriage is a lottery.

c. He who has once burnt his mouth always blows his soup.

d. Some people are masters of money, and some its slaves.

Question 2

a. Proof rather than argument.

b. Tell not all you know, believe not all you hear, do not all you are able.

c. When we sing everybody hears us, when we sigh nobody hears us.

d. Fat hens lay few eggs.

Question 3

a. There are many paths to the top of the mountain, but the view is always the same.

b. Ingratitude is a kind of weakness, clever men are not ungrateful.

c. Sit a beggar at your table and he will soon put his feet on it.

d. Give neither counsel nor salt till you are asked for it.

Question 4

a. The reputation of a thousand years may be determined by the conduct of one hour.

b. If the patient dies, the doctor has killed him, but if he gets well, the saints have saved him.

c. Friends are lost by calling often and calling seldom.

d. The wise adapt themselves to circumstances, as water moulds itself to the pitcher.

Question 5

a. A wise fox will never rob his neighbor's hen roost.

b. The coffin is the brother of the cradle.

c. An enemy will agree, but a friend will argue.

d. To endure what is unendurable is true endurance.

Question 6

a. A man without a smiling face must not open shop.

b. A healthy man is a successful man.

c. Anger without power is folly.

d. Write down the advice of him who loves you, though you don't like it at present.

Question 7

a. To know the road ahead, ask those coming back.

b. God heals, and the physician takes the fee.

c. He who holds the ladder is as bad as the thief.

d. To kick with sore toe only hurts foot.

Question 8

a. The Gods cannot help those who do not seize opportunities.

b. A throne is only a bench covered with velvet.

c. Only a fool will make the doctors his heir.

d. He who wants a great deal must not ask for little.

Question 9

a. A needle is not sharp at both ends.

b. It is not enough to run, one must start in time.

c. No matter how much you feed a wolf he will always return to the forest.

d. Wisdom and virtue are like the two wheels of a cart.

Question 10

a. He who asks is a fool for five minutes, but he who does not ask remains a fool forever.

b. A country can be judged by the quality of its proverbs.

c. Don't worry if you borrow, but worry if you lend.

d. Have an open face but conceal your thoughts.

Question 11

a. With money you are a dragon; with no money, a worm.

b. Who begins too much accomplishes little.

c. Small children give you headache; big children heartache.

d. A single arrow is easily broken, but not ten in a bundle.

Question 12

a. Fortune is a woman; if you neglect her today do not expect to regain her tomorrow.

b. Beware of a silent dog and still water.

c. As long as a child does not cry it does not matter what pleases it.

d. Everyone loves justice in the affairs of another.

Question 13

a. The pleasure of love lasts a moment, but the pain of love lasts a lifetime.

b. Happiness is not a horse, you cannot harness it.

c. Trouble rides a fast horse.

d. If you wish to learn the highest truths, begin with the alphabet.

Question 14

a. Learning is a treasure that will follow its owner everywhere.

b. Many who have gold in the house are looking for copper outside.

c. No pear falls into a shut mouth.

d. Wine is the best broom for troubles.

Question 15

a. Love makes the time pass. Time makes love pass.

b. A teacher is better than two books.

c. The lucky man's enemy dies and the unlucky man's friend.

d. When ill luck falls asleep, let no one wake her.

Question 16

a. A diamond with a flaw is worth more than a pebble without imperfections.

b. It is only the tree loaded with fruit that the people throw stones.

c. They bow to you when borrowing; you bow to them when collecting.

d. One may have good eyes and yet see nothing.

Question 17

a. Be not afraid of going slowly; be afraid only of standing still.

b. Cats like man are flatterers.

c. An old loan repaid is like finding something new.

d. Anger can be an expensive luxury.

Question 18

a. I was angered, for I had no shoes. Then I met a man who had no feet.

b. Sorrow for a widow is like pain in the elbow, sharp and short.

c. When you live next to the cemetery you cannot weep for everyone.

d. Better give a penny than lend twenty.

Question 19

a. Only he that has traveled the road knows where the holes are deep.

b. Love is the dawn of marriage, and marriage is the sunset of love.

c. Some people are masters of money, and some its slaves.

d. Tell not all you know, believe not all you hear, do not all you are able.

Question 20

a. The best soldiers are not warlike.

b. And old rat is a brave rat.

c. Write down the advice of him who loves you, though you don't like it at present.

d. Many who have gold in the house are looking for copper outside.

Appendix B

Survey Instructions

Your involvement in this survey would be entirely voluntary and there are no known or anticipated risks to participation in this study. If you agree to participate, the survey should not take more than 30 minutes in length. All information you provide will be considered confidential and will be grouped with responses from other participants. Further, you will not be identified by name in any report resulting from this study. Your name is only required to make sure you receive the participation bonus mark.

Name:

Instructions

This survey has five questions. Each question has four proverbs from other countries. Please read them carefully. You are to compare the proverbs and pick the one that you think Canadians would like the most. You also need to provide a brief reason for your choice. The reason is an important part of the survey. In order to receive course credit for the survey, please make sure that you don't forget to write it down.

Appendix C

Experiment Questions

Which proverb do you think Canadians would like the most?

Question 1

a. The pleasure of love lasts a moment, but the pain of love lasts a lifetime.

b. Happiness is not a horse, you cannot harness it.

c. Trouble rides a fast horse.

d. If you wish to learn the highest truths, begin with the alphabet.

Question 2

a. Only he that has traveled the road knows where the holes are deep.

b. Love is the dawn of marriage, and marriage is the sunset of love.

c. Some people are masters of money, and some its slaves.

d. Tell not all you know, believe not all you hear, do not all you are able.

Question 3

a. With money you are a dragon; with no money, a worm.

b. Who begins too much accomplishes little.

c. Small children give you headache; big children heartache.

d. A single arrow is easily broken, but not ten in a bundle.

Question 4

a. A diamond with a flaw is worth more than a pebble without imperfections.

b. It is only the tree loaded with fruit that the people throw stones.

c. They bow to you when borrowing; you bow to them when collecting.

d. One may have good eyes and yet see nothing.

Question 5

a. Fortune is a woman; if you neglect her today do not expect to regain her tomorrow.

b. Beware of a silent dog and still water.

c. As long as a child does not cry it does not matter what pleases it.

d. Everyone loves justice in the affairs of another.

Question 6

a. A needle is not sharp at both ends.

b. It is not enough to run, one must start in time.

c. No matter how much you feed a wolf he will always return to the forest.

d. Wisdom and virtue are like the two wheels of a cart.

Question 7

a. The reputation of a thousand years may be determined by the conduct of one hour.

b. If the patient dies, the doctor has killed him, but if he gets well, the saints have saved him.

c. Friends are lost by calling often and calling seldom.

d. The wise adapt themselves to circumstances, as water moulds itself to the pitcher.

Question 8

a. A wise fox will never rob his neighbor's hen roost.

b. The coffin is the brother of the cradle.

c. An enemy will agree, but a friend will argue.

d. To endure what is unendurable is true endurance.

Appendix D

Online Registration

Invitation to Participate in the Research Study on Group Dynamics

You are invited to participate in a research study conducted by Golnaz Tajeddin (A Master's student in the Department of Management Sciences) under the supervision of Professor Frank Safayeni. This study investigates the differences between individual and group performance in the judgmental tasks. If you volunteer as a participant in this study, you will be asked to work with other students as a group. The session will be videotaped and would take at most 2 hours. I think you will find the task interesting. The study will take place in the Uncertainty Management Lab in CPH 4366.

As a participant in this study you will receive a 2 bonus towards your MSCI311 course mark. You also have a chance to earn additional 2 bonus based on your individual and group performance. If you are interested in participating, please click "REGISTER FOR THE STUDY" and fill out the required information. You should sign up for the experiment before Friday February 23rd.

If you have any questions about this study please contact Golnaz Tajeddin at gtajeddi@engmail.uwaterloo.ca.

Thank you.

Registration for the Research Study

Thank you for considering participating in the research study on group dynamics! Please fill out the registration form below carefully and ensure that all fields have the required information. All fields are mandatory; please fill in your first name, last name, student ID, and your e-mail address. The student ID will be used to assign bonus marks. The e-mail address you provide will be used to send you the confirmation e-mail after you register, to contact you in case the study date/time has to be rescheduled. Your contact information will not be used in any other way and will not be released to any party. Then, select a convenient date and time from the drop down menu (*i.e.*,"Study Date" and "Time"). Each study is estimated to last at most two hours and no prior preparation is required on the participant's part. The study will take place in the Uncertainty Management Lab in CPH 4366.

You will receive a confirmation email after a successful registration.

To cancel or change your appointment, click on the link "Click here to cancel your existing registration" and follow the prompts.

Please make all cancellations and modifications at least 24 hours prior to your scheduled appointment.

Please contact Golnaz Tajeddin at gtajeddi@engmail.uwaterloo.ca if you have any questions or require clarification.

If you are interested in participating in this study but there are no time slots available that work for you, please send an email to gtajeddi@engmail.uwaterloo.ca with the subject of "Experiment future scheduling". Please provide me with your first name, last name and your contact number. I would let you know if any time slots became available due to cancellation or future scheduling.

Appendix E

Experiment Instructions

Introductions

In this experiment your job is to select the proverb that you think Canadians would like the most. You will repeat this task for eight times. Each time, initially you choose the proverb individually and then you have an opportunity to do a group discussion and choose your group choice. After that you get feedback.

The purpose of this study is to see how well you can predict a Canadians' choice among proverbs from other countries.

Every time I give you the feedback based on the statistics I got from undergraduate students at University of Waterloo.

After repeating the task for four times, there is also a mid-point discussion in which your group can discuss their performance and the possible ways to improve it.

Now, let me explain the instructions for you:

Instructions

- Task

  You will receive four proverbs from countries other than Canada. Your task is to choose one of them that you think Canadians would like the most. You will repeat

this task for eight times. Each time you will receive a new set of four proverbs.

The task consists of two parts: individual part and group part.

In the individual part you should choose one proverb that you think Canadians would like the most and write your choice a,b,c or$d$ down on the piece of paper, fold the paper and give it to me after you are finished. You shouldn't talk to any of your group members during this part.

After all of you have finished your individual part, your group should discuss what would be the best choice for the group and come up with the group choice that all of you agree, unanimous.

After you announce your group choice, you will receive a feedback on the correct answer. The correct answer is based on the statistical preference of undergraduate students from University of Waterloo.

- Mid-point discussion

  After finishing the first four iterations, you would get 5 minutes to discuss your performance and ways in which you could potentially improve your prediction.

- Bonus Marks

  Now, let me tell you about the bonus marks you can get: By participating in all the eight iterations you will earn two bonus marks. You can earn up to two additional bonus marks based on your individual and group performance:

  - Individual Performance:

    You will get an additional 0.5 bonus mark if your individual answer is correct in at least 2 of the first four iterations (before mid-point discussion) and another 0.5 mark for being correct in at least 3 of the last four iterations.

  - Group performance:

All the members of the group will earn an additional 0.5 bonus mark if the group choice is correct in at least 2 of the first four iterations and another 0.5 mark for being correct in 3 of the last four iterations.

Appendix F

Results Table

Question	Individual Choice				Group Choice	Correct Answer
	Blue	Green	Red	Yellow		
1						
2						
3						
4						
5						
6						
7						
8						

Appendix G

Questionnaire - Participants

Your code: Date:

(Use the code given to you during the experiment)

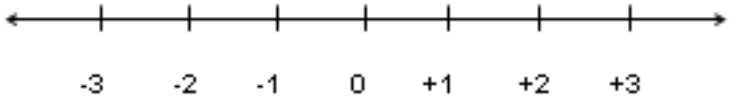
1. Did you find anyone in your group who was better than others in the task of choosing proverbs? ☐Yes ☐No

   If your answer is "Yes", choose the person who did better:

   ☐Blue ☐Green ☐Red ☐Yellow

   Why do you think he/she did better?

   I don't know

   Pure luck  Good Judgment

   -3 -2 -1 0 +1 +2 +3

2. Was there any leader in your group **before** the mid-point discussion, during the first part? ☐Yes ☐No

   If "Yes", who was the leader?

   ☐Blue ☐Green ☐Red ☐Yellow

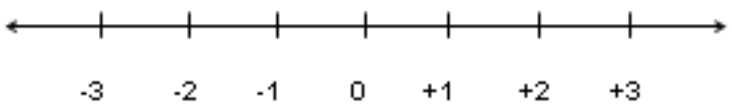
3. Was there any leader in your group **after** the mid-point discussion, during the first part? ☐Yes ☐No

   If "Yes", who was the leader?

   ☐Blue ☐Green ☐Red ☐Yellow

4. Did you enjoy working with your group members?

   Indifference

   Not at all  Very much

   -3 -2 -1 0 +1 +2 +3

5. If you were asked to participate in another group experiment, are you willing to work with the same group?

   ☐Yes ☐No

6. Do you feel your performance got better as the experiment went along?

   ☐Yes ☐No

Appendix H

Questionnaire - Observers

Date:

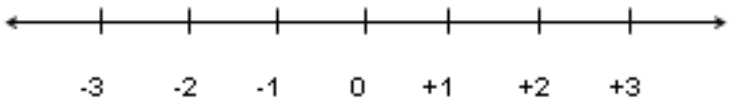
1. Did you find anyone in the group who was better than others in the task of choosing proverbs? ☐Yes ☐No

   If your answer is "Yes", choose the person who did better:

   ☐Blue ☐Green ☐Red ☐Yellow

   Why do you think he/she did better?

   I don't know

   Pure luck  Good Judgment

   -3 -2 -1 0 +1 +2 +3

2. Was there any leader in the group **before** the mid-point discussion, during the first part? ☐Yes ☐No

   If "Yes", who was the leader?

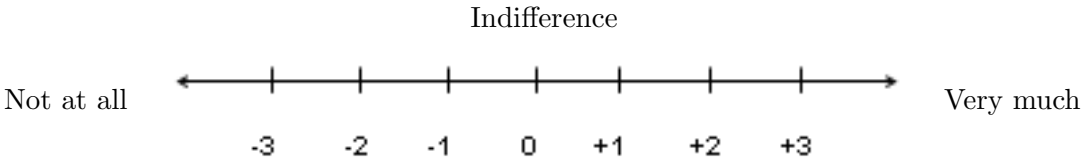
   ☐Blue ☐Green ☐Red ☐Yellow

3. Was there any leader in the group **after** the mid-point discussion, during the first part? ☐Yes ☐No

   If "Yes", who was the leader?

   ☐Blue ☐Green ☐Red ☐Yellow

4. Based on your observation, did the group members enjoy working with each other?



5. Based on your observation, if the group members were asked to participate in another group experiment, do you think they are you willing to work in the same group?

   ☐Yes ☐No

6. Do you feel the performance got better as the experiment went along?

   ☐Yes ☐No

Appendix I

Details of All Group Experiments

* The individual chosen as an expert in the group

Group Number	Question	**Individual Choice**				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
Group 1	1	a	a	d	b*	d	b
	2	c	a	a	c	c	c
	3	a	d	b	b	d	c
	4	d	b	d	a	d	a
	5	d	c	c	b	b	b
	6	a	b	c	b	b	b
	7	c	a	d	a	a	a
	8	d	a	c	c	c	d
Group 2	1	a	a*	a	a	a	a
	2	c	d	c	c	c	d
	3	d	d	b	d	d	a
	4	a	a	b	d	a	a

Continued on next page

Table I.1 – continued from previous page

Group Number	Question	Individual Choice				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
	5	a	d	a	d	a	d
	6	b	d	d	d	d	d
	7	d	d	d	d	d	d
	8	d	a	d	d	d	b
Group 3	1	a	a	a	b*	a	b
	2	a	c	a	a	c	a
	3	b	a	d	d	b	a
	4	d	d	c	b	a	b
	5	a	a	b	b	a	b
	6	d	d	c	d	d	d
	7	d	a	d	d	d	d
	8	d	d	a	a	a	c
Group 4	1	c	a	a	d*	d	d
	2	d	c	c	a	a	a
	3	d	d	b	d	d	b
	4	c	d	a	a	a	a
	5	d	c	a	a	a	a
	6	d	b	b	b	b	b
	7	a	a	a	d	a	d
	8	d	d	a	d	d	c
Group 5	1	b	a*	d	b	b	a
	2	c	c	a	a	c	c

Continued on next page

Table I.1 – continued from previous page

Group Number	Question	Individual Choice				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
	3	a	b	d	d	d	d
	4	a	c	a	d	a	c
	5	a	a	d	a	a	a
	6	b	b	c	a	b	b
	7	c	b	c	c	c	b
	8	d	c	b	c	c	a
Group 6	1	d	a*	c	b	b	a
	2	a	c	b	b	a	c
	3	d	b	b	d	b	d
	4	b	d	a	c	c	d
	5	a	a	a	b	a	a
	6	b	c	b	a	c	c
	7	b	a	d	c	a	a
	8	c	c	c	d	c	b
Group 7	1	d	a*	d	b	d	a
	2	b	a	a	b	a	a
	3	c	c	d	c	c	d
	4	d	d	c	d	d	d
	5	a	a	a	d	a	a
	6	c	b	c	b	c	b
	7	d	c	c	c	c	c
	8	c	c	a	d	c	b

Continued on next page

Table I.1 – continued from previous page

Group Number	Question	Individual Choice				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
Group 8	1	a	d*	a	a	a	d
	2	d	b	c	a	a	b
	3	d	d	a	d	d	a
	4	d	a	d	a	d	a
	5	a	a	a	a	a	a
	6	d	d	d	d	d	d
	7	d	d	c	b	d	d
	8	c	c	d	c	d	a
Group 9	1	d*	a	a	a	a	d
	2	c	a	c	c	c	c
	3	c	d	b	d	b	b
	4	d	b	a	c	d	d
	5	a	b	a	a	a	a
	6	b	b	b	d	b	b
	7	a	b	a	c	a	a
	8	c	d	b	d	d	a
Group 10	1	a	a	c*	a	a	c
	2	a	a	d	c	d	d
	3	d	b	b	a	b	d
	4	d	d	d	d	d	d
	5	c	a	a	d	d	a
	6	b	b	c	d	b	c

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Table I.1 – continued from previous page

Group Number	Question	Individual Choice				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
	7	d	b	a	b	a	a
	8	c	c	d	d	d	a
Group 11	1	a*	b	d	c	a	a
	2	c	c	b	c	c	c
	3	d	b	d	a	d	b
	4	d	a	a	a	a	d
	5	d	a	a	b	a	d
	6	c	c	d	d	c	c
	7	a	b	d	b	a	a
	8	a	b	c	c	a	d
Group 12	1	d*	b	c	a	d	d
	2	b	a	a	c	a	b
	3	d	d	a	d	d	a
	4	b	c	d	d	a	b
	5	c	a	d	d	c	c
	6	d	c	b	b	d	d
	7	a	a	b	a	a	a
	8	c	c	c	d	c	d
Group 13	1	a*	c	b	d	b	a
	2	c	c	a	a	c	c
	3	d	d	b	d	d	b
	4	a	a	a	d	a	a

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Table I.1 – continued from previous page

Group Number	Question	Individual Choice				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
	5	a	a	d	a	a	a
	6	c	b	b	d	b	c
	7	b	a	a	d	b	b
	8	c	d	a	d	c	d
Group 14	1	d	d	a*	b	d	a
	2	c	a	c	a	c	c
	3	a	d	b	b	b	d
	4	a	d	a	d	d	a
	5	a	a	a	d	a	a
	6	b	a	d	d	d	d
	7	a	c	c	d	c	c
	8	c	c	b	c	c	d
Group 15	1	a*	d	b	d	a	a
	2	c	c	d	c	c	c
	3	b	c	c	d	c	c
	4	a	d	a	d	a	a
	5	d	b	a	b	b	b
	6	b	a	b	b	b	b
	7	c	c	c	a	c	c
	8	c	c	c	c	c	c
Group 16	1	c	d	b	c*	d	c
	2	a	c	a	b	a	b

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Table I.1 – continued from previous page

Group Number	Question	Individual Choice				Group Choice	Correct Answer
		Blue	Green	Red	Yellow		
	3	c	d	d	d	d	b
	4	d	d	b	d	d	d
	5	d	a	d	d	d	d
	6	a	b	a	a	a	a
	7	a	c	c	a	a	a
	8	d	c	c	c	c	a
Group 17	1	b	b*	a	a	a	b
	2	a	a	a	a	a	a
	3	c	c	b	d	c	b
	4	c	d	b	c	d	d
	5	d	c	a	d	d	c
	6	c	c	d	b	d	c
	7	b	c	b	b	c	c
	8	c	c	d	d	c	a
Group 18	1	a	a	a	c*	a	c
	2	c	a	c	c	c	c
	3	c	a	c	a	c	b
	4	d	a	b	d	d	d
	5	b	b	c	a	b	a
	6	d	c	c	d	d	d
	7	a	b	a	d	a	d
	8	c	c	c	a	c	b

Appendix J

The Result of Questionnaires in Detail

The questions of the questionnaire for group members and observers are presented in Appendix G and Appendix H, respectively. The answers to this questions are coded as follows:

Yes=1, No=0 (For questions 1, 2, 3, 5, and 6)

Expert=1, Any group member other than expert=2 (For questions 1a, 2a, and 3a)

the number chosen on the measure (For Questions 1b and 4)

Table J.1: Summary of questionnaire completed by group members excluding experts

Group Number	**Question**									
	1	1a	1b	2	2a	3	3a	4	5	6
1	1	1	2	1	1	1	1	3	1	1
	1	1	2	0		1	1	3	1	0

Continued on next page

Table J.1 – continued from previous page

Group Number	Question									
	1	1a	1b	2	2a	3	3a	4	5	6
	1	1	3	1	1	1	1	3	1	0
2	1	1	2	0		0		2	1	0
	1	1	3	0		1	2	2	1	1
	1	1	3	0		0		2	1	1
3	1	1-	2	1	2	0		3	1	1
	1	1	1	0		0		1	1	1
	1	1	2	0		0		1	1	1
4	1	1	3	1	1	1	1	2	1	1
	1	1	2	0		0		3	1	0
	1	1	2	1	2	0		2	1	0
5	1	1	1	0		1	1	3	1	0
	1	1	3	1	1	1	1	3	1	0
	1	1	2	0		1	1	2	1	0
6	1	1	3	1	2	1	1	3	1	1
	1	1	2	0		1	1	3	1	1
	1	1	2	0		1	1	2	1	1
7	1	1-	1	1	2	0		0	1	1
	1	1	2	0		0		1	1	1
	1	1	1	0		0		2	1	1
8	1	1	1	0		0		2	1	1
	1	1	2	0		0		2	1	1
	1	1	1	0		0		3	1	1

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Table J.1 – continued from previous page

Group Number	Question									
	1	1a	1b	2	2a	3	3a	4	5	6
9	1	1	2	1	1	0		2	1	1
	1	1	0	0		0		1	1	0
	1	1	2	0		0		3	1	0
10	1	1	2	0		1	1	2	1	0
	1	1	2	0		0		3	1	0
	1	1	2	0		0		2	1	0
11	1	1	2	0		0		3	1	0
	1	1	1	0		0		1	1	0
	1	1	2	0		0		2	1	0
12	1	1	3	0		0		3	1	1
	1	1	2	0		0		2	1	1
	1	1	2	0		1	2	3	1	0
13	1	1	0	0		1	2	3	1	1
	1	1-	2	1	1	1	1	0	1	0
	1	1	1	0		1	1	1	1	1
14	1	1	2	0		0		2	1	1
	0			1	2	0		1	1	0
	1	1	1	0		0		0	1	0
15	1	1	1	0		0		3	1	1
	1	1	1	0		0		3	1	0
	1	1	2	1	1	0		1	1	1
16	1	1	2	1	1	1	1	2	1	0

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Table J.1 – continued from previous page

Group Number	Question									
	1	1a	1b	2	2a	3	3a	4	5	6
	1	1	1	0		0		2	1	1
	1	1	1	0		0		2	1	1
17	1	1	2	1	2	1	2	3	1	0
	1	1	2	1	2	1	2	2	1	0
	1	1	1	1	1	1	1	2	1	0
18	1	1	1	0		0		2	1	0
	1	1	0	0		0		0	1	0
	1	1	2	0		1	1	3	1	0
Total	53	53	82	16	9	21	16	112	54	26
Percentage	98.2%	98.2%		29.6%	16.7%	38.9%	29.6%		100%	48.1%
Average			1.55					2.07		

Table J.2: Summary of questionnaire completed by experts

Group	**Question**									
Number	1	1a	1b	2	2a	3	3a	4	5	6
1	1	1	-1	0		1	1	3	1	0
2	1	1	3	0		0		2	1	0
3	0			0		1	1	-1	0	0
4	1	1	2	0		0		3	1	1
5	1	1	3	1	2	1	2	3	1	0
6	1	1	2	0		0		3	1	1
7	1	1	0	0		0		3	1	0
8	1	1	1	0		1	2	3	1	1
9	1	1	3	0		1	1	3	1	1
10	1	1	-1	0		0		2	1	0
11	1	1	3	0		0		3	1	0
12	1	1	3	0		0		3	1	1
13	1	1	2	1	2	1	1	2	1	1
14	1	1	2	1	1	0		0	1	0
15	1	1	2	0		0		3	1	1
16	1	1	2	0		0		3	1	1
17	0			1	2	1	2	2	1	0
18	1	1	1	0		0		3	1	1
Total	16	16	27	4	1	7	4	43	17	9
Percentage	88.9%	88.9%		22.2%	5.6%	38.9%	22.2%		94.4%	50.0%
Average			1.69					2.39		

Table J.3: Summary of questionnaire completed by observers

Group	**Question**									
Number	1	1a	1b	2	2a	3	3a	4	5	6
3	1	1	3	1	2	1	1	1	1	1
4	1	1	0	0		1	1	2	1	0
5	1	1	3	1	2	1	1	1	1	1
6	1	1	2	1	2	1	2	2	1	1
7	1	1	1	1	2	1	2	2	1	1
8	1	1	2	1	2	0		2	1	1
11	1	1	2	0		0		3	1	0
12	1	1	3	1	2	1	2	3	1	1
14	0			0		0		2	1	0
15	1	1		1	1	1	1	2	1	0
17	1	1	2	1	2	0		3	1	0
Total	10	10	18	8	1	7	4	23	11	6
Percentage	90.9%	90.9%		72.7%	9.1%	63.6%	36.4%		100%	54.5%
Average			1.63				2.09			

*Group 1, 2, 9, 10, 13, 16, and 18 did not have an observer.

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