

**Information and Knowledge:**

**A Duality in the Communication Process**

by

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A thesis  
presented to the University of Waterloo  
in fulfillment of the  
thesis requirement for the degree of  
Master of Applied Science  
in  
Management Sciences

Waterloo, Ontario, Canada, 2011

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## **AUTHOR'S DECLARATION**

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.

## Abstract

Communication is very common in human life. In fact, we take communication for granted and do not think about the challenges involved except when miscommunication happens. When two people communicate, information is exchanged. Each piece of information that comes through eliminates a series of structural choices an individual has available to him. According to Shannon's information theory, information reduces uncertainty by selecting one item from a set of possible items. That is Information distinguishes between relevant and irrelevant items in a set essentially dividing the set into two categories. Knowing also implies distinction or classification. The purpose of this thesis is to investigate the relationship between information and knowledge by observing what happens when people communicate to each other in an experimental context. The focus of our observation is on three main situations: – 1. What happens when people communicate to each other in the context of known categorical attributes; 2. What happens when people communicate in the context of unknown categorical attributes; and 3. How is the communication process affected in the presence of known but misleading attributes as, for instance, in a situation of a cross-functional communication in organization? By studying the interaction between pairs of participants, we propose that information and categorical knowledge relate to each other, as in a duality, and influence the communication process. The study comprises four experimental conditions. This thesis provides a description of the experimental conditions, a brief report on what happened during people's performance, as well as some preliminary findings based on observations.

## Acknowledgements

I owe my sincere gratitude to Professor Rob Duimering for, as my supervisor and friend, providing me with guidance and motivation during the entire journey particularly when I did not believe I could. He introduced me to a so fascinated world of thought that I could not quit. The reward is much bigger than the challenge.

I extend my appreciation to Professor Frank Safayeni for letting me know that there is no authority that cannot be challenged, and that there is no good work without effort and dedication.

I am also indebted to Professor Selcuk Onay and Professor Frank Safayeni, members of my Thesis Committee, for their feedback after reading the initial draft of this thesis.

My big thank you for my friend, my love, and husband, Newton for all the patience and encouragement even when getting back from me nothing more than a “blank face” or a monosyllabic word as answer for a question, and a ricotta sandwich for dinner. I would like to extend this big thank you to my second mother, Laura, Newton’s Mom, for the financial support and acceptance for the years passed. We would be far away from here, in Brazil, if was not for her collaboration.

I owe my life to my parents who I respect the most and love the most. I thank you both for making me who I am. I would not be what I am without you, without your unconditional love and understanding.

I also thank my friends Noor, Mahsa, Mina, Walid, and others whose names are not here for being part of my life as a Master’s student.

I would like also to show my appreciation for all students who participated in the tasks used as part of this thesis. Without their help I could not have collected the necessary data for the study.

## **Dedication**

*To my father*

*In appreciation to all the deep things I have learnt from his simplicity.*

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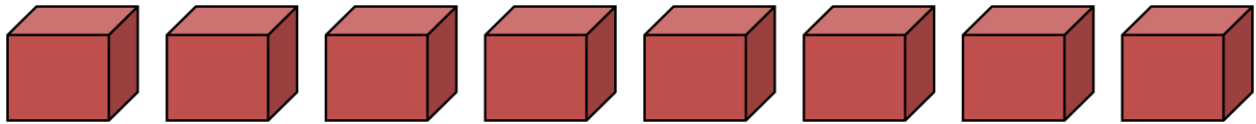
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# Chapter 1

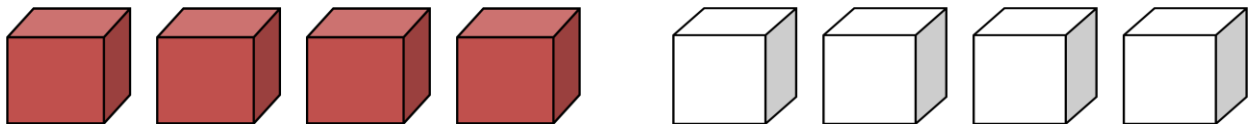
## Introduction

Suppose that some money is hidden under one of the eight boxes in Figure 1<sup>1</sup>. The experimenter wants to know the minimum number of guesses needed to find the money. The event – lifting one of the boxes – has eight possible outcomes. In order to choose the right box, someone needs information, anything that can reduce uncertainty in the outcome, i.e. anything that reduces the number of boxes from eight to one.



**Figure 1 – Money under One of the Box Example – Eight Outcomes**

A person is told that she can ask any question but the answers will be binary. She then divides the eight boxes into two sets of four, and asks the experimenter whether the money is in the set on the left-hand side or in the set on the right-hand side. The experimenter says that it is on her left side. The information given by the experimenter reduces the number of possible outcomes from eight to four.



**Figure 2 – Money under the Box Example – Four Outcomes**

Using the same principle, the person divides the boxes once more and gets two sets of two boxes each. She inquires whether the money is hidden in the set on the left

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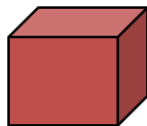
<sup>1</sup> Professor Frank Safayeni used this example in the course **Organizational Theory & Behaviour**, MSCI 605, at the University of Waterloo, during the Fall 2008.

hand-side or in the set on the right hand-side, and the experimenter informs that it is under one of the two boxes on the right hand-side. Two guesses were made up to this point, reducing the number of possible choices to two.



**Figure 3 – Money under the Box Example – Two Outcomes**

The person knows that if she has two boxes and there is no money in the first one, it has to be in the second one, *unless* the experimenter is not telling the truth. Thus, she can make the right guess. As we can see, three guesses were necessary to find the money. By using this determined way of organizing things, the least amount of guesses needed to get to one out of eight boxes is three. Even if the money had been placed under a different box, the number of guesses would still be the same, given that all the conditions to perform the task were kept the same.



**Figure 4 – Money under the Box Example – One box left**

A simple example like this can be used to consider important aspects regarding communication process. As observed, communication happened effectively because the person involved found the money with the least amount of guesses possible – three guesses.

The explanation for why the communication occurred effectively is not as simple though. If we consider only that a person needed help with reducing the number of

boxes to get a reward, it seems rather simple. In fact, we take communication for granted, and do not think about the challenges involved, except when miscommunication occurs— especially if it is significant in amount and frequency and causes problems.

In the money under the box example, we can see how valuable was the information given by the experimenter to the person trying to accomplish the task. With no information, she had eight possible outcomes to start with. The information received helped her organize or structure the boxes in a way that allowed her to reduce the number of boxes by half each time she asked a question.

Moreover, the first instruction of the experimenter provided the person with an important attribute about the structure of the task itself: questions could be asked and answers would be *binary*. By saying to her that only binary answers would be given, the experimenter himself eliminated a series of structures that the person could come up with that would not work well with binary choices – such as breaking the eight boxes into three different sets, for instance, and asking in which set the money was.

In other words, the experimenter categorized the task into binary choices. Both of them knew that attribute and the person was able to start dividing the boxes with her existent knowledge of cognitive capacity, math, and orientation, among others.

What happens to the communication process though if attributes are unknown? For instance, what would have happened if the experimenter had not said to the person that the answers to her questions would be binary? Would she still be able to organize the boxes in the same way and get the money with three guesses? Perhaps yes due to

the simplicity of our example. On the other hand, if we imagine a world where binary systems do not exist, she would not be able to organize the boxes the same way.

We could also imagine what would have happened if the situation involved an experimenter and a participant from different departments of an organization, a cross-functional interaction, where experimenter and subject would perceive the same entity quite differently from each other. Perhaps the participant, instead of being interested in finding the money under one of the boxes, would demonstrate interest in the way that the boxes were placed on the ground and start asking questions related to that matter.

Considering the above contextual situations, the purpose of this thesis is to observe in an experimental context what happens when people communicate to each other. The focus of our observation is on the relationship between information and categorical knowledge. Three main questions are investigated:

- What happens when people communicate to each other in the context of known categorical attributes?
- What happens when people communicate in the context of unknown categorical attributes?
- How is the communication process affected by the presence of known but misleading attributes, as might happen, for instance, in a cross-functional communication situation in organizations?

By studying the interaction between pairs of participants, we propose that information and knowledge relate to each other as in a duality, and influence the communication process. As suggested by the money under the box example, the

experimenter's selection of the message to be informed to the participant depends on the structural set in which that one item is embedded. On the other hand, the participant's interpretation of the message received also depends on his subjective structural set.

Only a limited amount of literature provides insight into how information and structural knowledge affect the communication process in an experimental setting. This thesis suggests that experimental study, which involves people interacting with each other, is a good method to understand the nature of communication problems.

This thesis is the first part of a twofold study. The study comprises four experimental conditions. This thesis provides a description of the experimental conditions, a brief report on what happened during people's performance, as well as some preliminary findings based on observations. It makes an important contribution to the literature by proposing a new way to look into information and categorical knowledge. It also suggests how to study the important relationship between them empirically.

No hypothesis or measurement has been developed due to the character of this part of the research. This is a twofold study that starts with a qualitative-experimental segment and continues with further development of quantitative measurements during the PhD studies.

The next chapter provides a short literature review with some theoretical background on information, knowledge, and a framework of the problem. Chapter 3 explains the methodology used in this thesis. It explains the experiments, analyses of

the tasks and observations, and closes with a discussion. Chapter 4 offers the conclusion and summarizes the limitations and suggestions for future studies.

## Chapter 2

### Theoretical Background

The distinction between cognitive thought and external language, that philosophers, scholars, and laity, have all speculated about, seems to be very important. Starting with the mind-body duality, the objective of many studies throughout the years was to discover how the human mind works and how it affects communication.

A high-speed electronic machine, a Cartesian Model, or a Homeostat, were all used as metaphors or models of the brain (Cherry, 1957). All those studies have one major objective, that is, to find reasonable explanations for human communication, which is usually taken for granted although it can be rather complicated.

Although much has been studied and said, important phenomena happening in the communication process are still obscure. Miscommunication is one of those. Why does it happen? Many researchers have focused particularly on this matter. Consequently, the massive growth of information and communication technologies changed the scientific views enormously.

The research focus somehow shifted from fundamental theoretical questions explored by philosophers to practical superficial ones, such as those addressing how to make sure that information comes through via technology. In other words, the improvement of technology and the invention of new equipment and software seemed to be the solution to the old problems that have not yet been solved conceptually. The



use of computer technology and designed software could decrease or perhaps even eliminate miscommunication.

A new era started in the 1950's. Shannon (1948) published his mathematical model of information theory. Subsequently, many researchers have tried to develop reliable theories of information. From Mathematics, Physics, Engineering, to Biology, Psychology, and Linguistics, the concept of information has been of increased interest.

Concepts such as Information Economy, Information Management, and Information Management System came into existence. More and more books and authors have discussed topics on organizational knowledge as economical resource (e.g. Stewart, 1997; Sullivan 2000; and Sveiby, 1997).

Further technological improvement made it easier to accumulate and retrieve information and the idea that accumulated information could be called knowledge and could be transferred from one person to another came about. Since then, various courses and graduate programs have been developed to teach how to deal with technological innovation, cultural multiplicity, and different people and behaviors that comes with it. Instead of questioning the nature of the problem, researchers and consultants question the difference between information and knowledge and inquire about how to make knowledge accessible through information.

Nonaka and Takeuchi (1995) for instance introduced the concept of the knowledge society. They defined knowledge as "justified true belief" (p. 21) and organizational knowledge creation as "the capability of a company as a whole to create

new knowledge, disseminate it throughout the organization and embody it in products, services, and systems” (p. 3).

To Nonaka and Takeuchi, knowledge is initially an individual creation that further becomes organizational knowledge through two dimensions, epistemological and ontological. Regarding the epistemological dimension, they divided knowledge in two different categories: explicit knowledge which can be relatively easily transferred because it can be written down and explained; and tacit knowledge that is elusive and difficult to articulate because it comes with experience or ‘know-how’.

Davenport and Prusak (1998) defined knowledge as “a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information”. According to the authors, knowledge is individual because “it originates and is applied in the minds of knowers”, and yet, “in the organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, process, practices, and norms”. (p. 5)

What do all of those authors have in common? Although apparently different from each other, all of them, American or Japanese, share the same common goal – the idea that it is possible to transfer or share knowledge. For example, Nonaka and Takeuchi suggest that the Japanese cultural environment does not favor knowledge creation or knowledge transfer due to an aversion to uncertainty. Thus, they introduced a sense of chaos or crisis to their model to encourage knowledge creation.

These authors also considerate role of the social environment in creating and sharing knowledge using teams such as, “community of practices” or “ba”, respectively, to refer to such environments. Both models emphasize that the creation, sharing and utilization of knowledge is a social phenomenon which happens in a social environment. But in their effort to discuss Knowledge Management, they are still mainly dealing with Information Systems resources such as written information, software, repositories, libraries, and others.

More importantly though, is defining or categorizing the concepts based on new buzzwords does not shed light on the fundamental problem, which concerns the complexities of the communication process. Instead of a cure for an old disease, the authors are offering a bandage to the newest wound.

We are not suggesting here that there is a true or false definition of information or knowledge. Our position on that matter is that there are more or less useful definitions depending on how or where it is used.. In other words, the concepts must be defined in the context of the supporting theories; otherwise, the theory can become a problem itself due to its own lack of consistency.

As this study is a larger project that will continue with a PhD, it is not objective of this master thesis to do an extensive literature review on the concepts of information and knowledge. Readers interested in a general overview of the concept may read, among others, Fischer (1993), Cornelius (2002), Capurro & Hjørland (2003), and Tsoukas (2001).

The study of communication should be done where it actually happens, that is, in social contexts. People communicate to each other. The objective of this thesis is to study the relationship between information and categorical knowledge in the context of the communication process. Therefore, we propose an experimental study where real people talk to real people. The next section describes what is meant by communication process in this thesis, explains the problem, and justifies the study.

## **2.1. The Communication Process**

Communication is, essentially, a social affair (Cherry, 1957). The English word communication comes from the Latin communicate, which means to make common, to share, to impart (Weekley, 1967). *Sharing* requires two individuals as well as their engagement in a communication.

*Sharing* brings yet additional connotation to the term communication. The person sharing something does not lose the shared thing. Similarly, when a message is communicated, the idea (or knowledge) is shared with someone without any loss to the speaker, as a communicator of a message can remember the information or can have a written copy of it.

Hence, communication process refers to the dynamic and continuous course of action that occurs between two individuals – a speaker and a listener. It is a shared responsibility since both persons must be involved in the activity for communication to occur. Moreover, communication involves meaning and thus, it is to some extent intentional. It is also highly contextual because the processes of message encoding and

decoding depend on both the speaker's and the listener's individual perception of the world.

Although a very complex phenomena, communication is one of the most common events in our lives, and thus it is taken for granted. The process starts even before something is said. In a very simplified and simplistic way, we can try to describe what happens during the process.

Ideas are formed in somebody's mind. One has to select ideas according to what one wants to communicate. The selected thought has to be encoded into signs or words, gestures, facial expressions, sounds, or drawings. The mind has to control certain physical mechanisms to articulate words.

However, the suggestion that words symbolize things, qualities, or actions, for example, simplifies reality. Words are highly dependent on the context or situation as well as on the period during which they are communicated. Words also depend upon the social experience of speaker and the listener of the word. The same word might even have opposite meaning in two different situations.

To further complicate the process, communication involves a listener, an active partner who has to decode and process the received information and interpret the provided words in such a way that the transmitted idea is restored. The entire process is highly dependent on the individuals involved, their skills, experiences, cultures, and many other factors. The less a speaker and a listener have in common, the lower the probability of the listener interpreting the original idea properly.

Subjective characteristics, formed early in life through contact with the physical environment, social interactions, and collective political-historical time, are important factors that should be considered in the communication process but are usually ignored. These characteristics are important because they affect the formation or expansion of subjective categorical knowledge and thus, will certainly influence the constraints organizing the individual behavior.

For example, consider a sixty-year-old farmer who has lived his entire life in a tropical country and visits Canada for the first time in the autumn. His entire life, he has been in contact with green and bare trees. He can classify the trees only into two categories, those that are alive and those that are dead. Thus, he sees some of the trees without their leaves and thinks that they have died. He has a difficult time understanding that the leaves will return again after the winter.

After this oversimplified view of the communication process, lack of understanding or miscommunication should not be a surprise at all. It is also not surprising that individuals from the most diverse disciplines have written a great amount of books, thesis, and articles on that matter. Aspects of statistical measurements, as in Shannon (1948), or cognitive sciences, as in Descartes (Cherry, 1957), or even the relationship between both measurements and thought, have been already largely explored; however, much of what happens during the communication process is still obscure.

The next section revisits the concepts of information theory and categorical knowledge. Information and knowledge are defined as a duality in the communication

process. The term duality comes from Mathematics. It is defined as a harmony of two opposite or complementary parts through which they integrate a whole. In this sense, it is suggested that information and knowledge are a duality in the communication process because although they are two different concepts, they do not exist without each other and are in a unique relation to one another. In the communication process, information and knowledge relate to each other like head and tail of the same coin.

## **2.2. The two sides of the same coin**

### **2.2.1. Information Theory**

Shannon (1948) introduced the term information theory. Shannon was a Bell Labs mathematician who, while doing research at Bell Telephone Company, developed a mathematical model to maximize telephone line capacity while minimizing distortion caused by noise.

According to Shannon (1948), one *bit* of information is equal to the amount of information that reduces the array of equi-probable events in a set by half. In other words, information reduces uncertainty, since it decreases the array of possibilities from a finite amount to one. However, in Shannon, information does not account for meaning.

Engineering telecommunication systems, for instance, are not concerned with consistency or purposefulness of a message or with the semantic correctness of the transmitted message. From the telecommunication system's point of view, if the communication channel is working properly with minimum waste, it is assumed that the signal or the message went through with minimal loss.

In fact, social scientists (e.g. Chomsky, 1956; Roszak, 1986), have highly criticized the application of information theory in communication not only because of its mathematical origin, but also due to its concern with technical issues and lack of concern with the content of the meaning. For example, the theory ignores the existence and influence of context and social environment on communication. Even when talking about irrelevant or unrelated information, rather than relating this information to contextual influences, Shannon considers it mechanical noise that the receiver needs to filter.

Although criticized, Information Theory is undoubtedly highly significant to the development of theory of communication. It is necessary to point out that Shannon had never applied his theory directly to human communication; it was Weaver, another mathematician, who developed some philosophical thought on Shannon's mathematical model (Shannon & Weaver, 1949). In addition to the five well known elements necessary for the communication process (information source, transmitter, communication channel, receiver, and destination), other important concepts emerged from Shannon's theory.

For instance, the money in the box example used in the introduction of this thesis brought to attention the relation between information and uncertainty. According to Shannon, information reduces uncertainty, or entropy, in the sense that it makes possible to select one message "*from a set of possible messages*" (p. 1). In other words, information reduces uncertainty because information minimizes the possible number of outcomes.



Shannon's theory considers information and uncertainty decrease only when there is a finite set of choices. Shannon (1948) himself says, "If the number of messages in the set is finite, then this number or any monotonic function of this number can be regarded as a measure of the information produced when one message is chosen from the set, all choices being equally likely".

The example used in the introduction of this thesis explains the link between information and uncertainty very well. Because the experimenter informed the participant that the answers to the questions are binary, it is easy to understand that the ideal way to perform the task is to halve the amount of boxes and ask in which half the money is. Each time the set of boxes is divided, the number of possible choices is reduced by half. It is also easy to observe how the initial uncertainty decreases with each addition of bit of information. Uncertainty concerns the number of possible outcomes. Thus, initially the number of possible outcomes was eight, reduced for four, down to two, and finally to one.

If we use Shannon's log function

$$\log_2 8 = 3 ,$$

We will find that 3 bits of information were necessary to reduce all uncertainty and find the money in the box.

Hence, as can be observed from the example, our interest in Shannon's theory of information comes from his definition of information as the element which reduces uncertainty. In human communication, uncertainty is always present and varies.

Mathematical measurements *per se* do not answer all of the fundamental questions involved in communication problems though.

Comprehension is a fundamental goal for human communication. Differently from what happens to the telephony communication studied by Shannon, the way an individual organizes the world, or the individual's knowledge, has a huge effect on how an idea is selected and communicated to another individual. Human communication has to be based on the fact that human interactions are built over individual experiences, values, and beliefs. We cannot assume a common shared probability distribution between two individuals.

To make information theory more suitable to communication, researchers' works incorporated concepts such as "set structure" and "categorical set" to Shannon's mathematical model as showed in the next subsection.

### **2.2.2. Recent Research on Communication**

Purdy (1989), a PhD student at the University of Waterloo, studied the communication process as a function of a set structure in which it is embedded. She suggested that someone's selection of codes relies on the set from which the item has to be distinguished; particularly that the structure of the set affects codification of the message. According to Purdy, a set has an internal structure based on groupings of its items that have subjective probabilities of choice associated with them.

The researcher found that the average number of ways to refer to an item decreases as the similarity between the items in the set increases. In other words,

greater similarity between items within a set leads to a greater difficulty in describing them with words.

For example, differentiating an *apple* between an apple, a snow flake, and a cat is not a big deal since there is little similarity between them. the fact that an apple is *edible*, that it is a *fruit*, or that it is *red*, could all be used as attributes to differentiate an apple from a cat or a snow flake. However, if three apples were to be differentiated from each other, none of those attributes could be used. Three red apples would be highly similar to each other, thus it would be very difficult to differentiate among them.

The researcher studies were limited to a model of the encoding process of communication; no communication process was involved. However, she made some important contributions. Although no empirical tests were made, based on her experimental observations, she suspected that the grouping of items could affect communication and that communication could affect the grouping of items.

Tabatabai (2009) did a related study. Tabatabai's study linked communication to categorical knowledge. She focused on how people employ technical and non-technical language during a conversation. According to Tabatabai, if a doctor and a patient, for example, are talking about a disease, at some point, their technical and non-technical categorical sets will have to match in order for them to communicate effectively with each other.

To study the phenomena, the researcher designed a three-person task where subjects communicated to one another through the use of categories, i.e., either from a narrower category to a more general one, or from a broader category to a narrower one.

She used the numerical sets – big, small – as the more general or broader categories and the numerical sets – odd, even, prime, square root, cube root – as the narrower categories.

The objective of the task was to communicate a randomly selected number from 1 to 10 from one person to another person using predefined cards representing the preceding categories. Nobody was allowed to talk or use body expression. The third person sat in the middle and served as a translator, a middle-level knower who can facilitate the communication process between those with technical (narrow) and non-technical (general) knowledge.

The first person (A) communicated the selected number to the translator (B) using one of their cards (small, big). B translated the card to the third person (C) using their own cards also available to Person C. C then guessed the number (from 1 to 10) based on the cards he/she received from B and showed the answer to A. Person A gave feedback to the group to indicate whether or not C had guessed correctly. This example illustrates communication in the direction from non-technical (general categories) to the technical knowledge (narrowed categories). Tabatabai investigated both directions in her experiment.

The author concluded that miscommunication happens when people do not share the same categorical knowledge, and that both communicators need to adjust their categorical sets if they want to understand each other. She found that group performance improved, after the translator (B) created a third categorical set in addition to the initial ones – big/small versus odd/even/prime/square root/cube root – which B

used to translate the number communicated from A to C. This shows that adjustments within group members are an effective way of improving understanding.

Both of the preceding studies investigated the role of categorical set within the communication context. The next section is dedicated to exploring categorical knowledge, discussing its definition and importance, as well as reviewing the supporting literature.

### **2.3. Categorical Knowledge**

Communication and cognition are closely related. Language is categorical while thought is classificatory. “Because we can abstract we can classify. To classify means to recognize that certain things belong ‘together’. They are ‘alike’ in some respects and can be referred to collectively” (Rapoport, 1950, p. 70).

#### **2.3.1 Conceptualization**

The world is perceived through categories. They mediate our interactions with the world to the extent that they structure and clarify perception and cognition. The environment brings unlimited amounts of information and stimuli that the human sensory motor mechanism must organize. Categorization organizes information allowing it to be efficiently dealt with.

In order to make the world simpler, we differentiate and classify things. One way of making distinction among things, for example, is by grouping them according to similar characteristics or attributes. Different items as a shirt, a star, a cat, and a triangle can be classified in the same category if they share at least one attribute in common. If

they were all blue and all drawings belonging to the same set of cards, for example, nobody would doubt that they are in fact a category.

In the same way, in the real world, attributes such as “pieces of clothing”, “things useful to sit on”, and “things useful to cook in”, for example, might be used to group and distinguish effectively certain items. Such categories enable the memory to handle large amount of information and ease information retrieval during communication.

Examples of categories could be a family of birds, the type of tools used by carpenters, the group of words that express feelings, and many others. We classify things “to reduce the infinite differences among stimuli to behaviorally and cognitively usable proportions” and to perceive the systematic world structure, which is highly correlational (Rosch, 1998, p. 4), i.e. co-occur with some specific other things and not with others. For example, wings are associated with feathers and an ability to fly, which makes us identify birds as a category; and the lack of an association between wings, fur and underwater swimming, prevents us from organizing our knowledge of birds in a different way.

Our minds have finite capacity to process information from the environment; hence creating categories is a way of handling information based on the classification of some attributes of received information (Macrae & Bodenhausen, 2001). “Cognitive economy” refers to selecting common attributes and grouping things according to these attributes (Rosch, 1998). One or more elements are considered a common attribute of items that belong to a category based on similar attribute so that the amount of information needed to distinguish them within their own category is maximized but the

amount of information needed to distinguish them across categories is minimized (Tabatabai, 2009).

Interestingly, although the human mind has means to differentiate things to almost infinite detail, it does not differentiate beyond what is necessary or reasonable. For instance, a beam of wood with four legs and a backrest that is put together with a bunch of nails and is used for sitting on is a chair. Nobody will describe that as wood or nails or wood and nails together or as an object to sit on, except for a good reason.

### **2.3.2 Communication context**

When it comes to the analysis at the individual level, each person in contact with the world has different needs. Thus, everyone categorizes the world according to individual subjective needs. The physical and social environment we live in also influences the categorization process. Hence, the categorical knowledge is also formed based on what is actually perceived in the world and on the purpose of what is perceived. In some sense, verbal communication is an outcome of this categorical knowledge.

Far from being innate, or a fixed product of historical past, or even finite, categories as perceived by individuals are subjective products that are constantly changing. It is possible to expand an existing set, to re-categorize an entire set into subsets, to eliminate items from a specific set, and to create a new category. Many variations are possible depending on the focus of attention.

As Rosch (1998) pointed out, combinations of what people perceive as the attributes of the objects in their perceived world do not occur uniformly. For example, it

is highly probable that *house has windows is an attribute*; however, it is highly unlikely for someone to say that an *ocean has windows is an attribute*. In addition, what attributes will be perceived depend on the individual functional needs and his/her interaction with the physical and social environment.

How do we classify? Culture and historical time are important factors influencing the formation of the individual categorical system. Language, for instance, is a product of the culture at a given time. It is the conventional use of symbols used in communication. The fact that people pay attention to different things and abstract different attributes raises another important question: how does categorization affect experience and communication?

If categorical knowledge is formed based on individual needs, and if the way the individual perceives the world is highly influenced by the existent categorical set in the culture at a given time, it is reasonable to assume that different individuals will have different categorical knowledge. Hence, different individuals will communicate differently.

They will not talk the same language, i.e., the sender of the message will not select the same message to communicate and the receiver will not interpret the message the same way as meant by the sender. In this case, information and structural knowledge will not match, since their categorical sets are not alike.

Hence, the mismatch of categorical sets influence the interpretation of the information received in the communication process. At the same time, the speaker



selection of the messages to be communicated should also be affected. This duality is not yet well understood.

The greater the degree to which both individuals share the communicated attributes, the greater the likelihood the communication process will happen smoothly. However, people have different categorical sets from which they select and interpret messages; therefore, it frequently happens that the intended message does not come through.

### **2.3.3. Information, Knowledge and Ambiguity**

Shannon's information theory, however considers finite sets of choices. Even Purdy's set structure still keeps the size of the set manageable. The concept is to encode and decode the information grouped within finite sets; however, in communication, we cannot always count on finite sets of choice.

Duimering *et al.* (2006) discussed the use of uncertainty and ambiguity in the context of New Product Development projects. The authors argued that rather than uncertainty, ambiguity is a better terminology to be used when relationships between project decision variables and the variables themselves are not known in advance.

Similar to what happens in NPD projects, where "the set of tasks necessary to project completion and the relationships between tasks are initially unknown and only emerge as the development process unfolds" (p. 239), the communication process is, *per nature*, ambiguous. It happens essentially for two reasons.

First, communication always involves two different individuals, a sender and a receiver of the message, and they switch roles as they communicate. It means that two

different sets of categories and subcategories come into play. Second, communication is a dynamic process. Both information and categorical knowledge are not known in advance.

Information is unveiled as the communication process itself unfolds. However, information can simultaneously reduce ambiguity by decreasing the set of possible choices and increase ambiguity in the sense that if the received message has no match in the set, the set of possible choices increases. For this reason, the term uncertainty, as used by Shannon, would not be entirely suitable in this thesis.

Ambiguity in this thesis refers to the state of indecision that the absence of a structure brings to a person, as opposed to the level of assurance that the presence of structure gives to the communication process. In a sense, ambiguity is related to the size of the categorical set from which individuals can choose. Hence, someone could argue that as the level of ambiguity increases, so does the amount of information needed to communicate a message. The opposite would also be true.

## **2.4. Summary**

Previous research conveyed that information influences the uncertainty of communication process and that the communication process outcome is a function of the categorical knowledge of those involved the communication process.

By knowledge, we mean the system of categorical sets formed by individuals, consisting of a bunch of items from which individuals choose when they communicate or which they use to interpret messages communicated to them. We say that information and knowledge form a duality in the communication process because both are present

in communication, and they depend on each other as well as on the contextual situation.

Knowledge denotes “the individual ability to draw distinctions” (Tsoukas, 2001) or to categorize and subcategorize within a group of things. Knowledge thus has a similar character to information. It concerns drawing distinctions among different things. When we do it within larger systems, we create categories and subcategories.

However, the opposite also happens. The information that we interpret can create new categories or enlarge those that are already existent. How those processes occur, has not been focus of the research.

Chapter 3 describes the development of the experiment, shows interesting findings during the performance of participants, and presents some -preliminary analysis and discussion of findings.

## **Chapter 3**

### **Method**

#### **3.1. Study**

We conducted a pilot test to examine the stimuli used to manipulate the experimental conditions of this study and to make necessary adjustments to the experimental tasks. The aim was to check whether we used the adequate stimuli in our study. What happens to the communication process if people can clearly identify categorical attributes? What if they could not? Would the communication process be affected if the attributes were misleading?

The pilot test and its initial conditions will be commented on in the following sections. Next section introduces the methodology of this study.

##### **3.1.1. Method**

###### **3.1.1.1. Participants**

Overall, 80 undergraduate and graduate students from the Management Sciences Department of the University of Waterloo participated in the experiment.

###### **3.1.1.2. Apparatus and Materials**

The experimental conditions were run in the Uncertainty Lab in the Management Sciences Department at the University of Waterloo with pairs of subjects at a time. The lab is equipped with five digital cameras and a sound system composed of three microphones and a multiplexer. It also has a round table and a set of chairs.

The round table was set up with two chairs facing each other. A barrier was set up to separate the two sides of the table, that is, two pieces of wood were put together to prevent individuals from seeing each other's cards and hands.

Four cameras were used, three from different angles and one suspended overhead. Two cameras focused on the two subjects, and other two focused on two halves of the table where the task stimuli were placed.

Participants ranked different sets of cards specially printed for the purpose of this study in a sequence and communicated those sequences to their partners.

### **3.1.2. Procedure**

The pairs of participants were invited to the laboratory to perform some experimental tasks that were designed to last from one hour to one-hour-and-a-half. After arriving to the laboratory and giving their consent, the participants received verbal instructions on the tasks performance (See Appendix A).

They were told that they would perform five rounds of seven different tasks using four different sets of cards. At the end of each round, they completed a questionnaire (See Appendix E). Person 1 was either given a predefined randomized sequence of cards or asked to come up with his/her own card sequence. Then, Person 1 attempted to communicate that card sequence to Person 2. The task ended when both of them had the same sequence of cards on the table.

During their performance, the participants were labeled as Person 1 – the one given the instructions or the main communicator – and Person 2 – the one following the

instructions. No gestures or other body expressions were allowed. They could talk about anything they wanted, ask questions, help each other, or give suggestions.

Person 1 was asked to make her sequence before talking. They were not allowed to change the sequence after they had initiated talking. The participants were not made aware of any kind of increase of difficulty or complexity between the tasks. Additional instructions were given before each round. In general, there was no time constraint for the tasks performance. This exception will be commented on when appropriate.

### **3.1.2.1. Description of the Tasks**

Participants were each assigned 5 of 7 tasks as indicated in Table 1. Task 1a used stimulus 1 (black geometric shapes of different sizes) with cards given to Person 1 in predefined, randomized sequence. Task 1b also used stimulus 1 but Person 1 came up with her/his own sequence.

Task 2a used stimulus 2 (clothing pieces and blue shades) and was given by the experimenter to Person 1 in predefined, randomized sequence. Task 2b used stimulus 2 but Person 1 created her/his own sequence.

Task 3 used stimulus 3 (random lines drawn on the cards) and the sequence was made by Person 1. Finally, task 4 used stimulus 4 (apples and cats heads), and Person 1 came up with his/her own sequence and communicated that sequence to Person 2.

Task 4 was performed in two different ways. Some pairs could get two hints, if necessary, and other pairs could have only one hint. Task 4a was performed with two

hints. After 10 minutes of trying to complement their cards with no success, the participants were given a verbal hint. Ten minutes later, if necessary, an additional hint was given to Person 2. She would receive a second set of card with supplementary attributes on them.

Task 4b provided one hint with added visual information. After 10 minutes of trial without successfully getting the complementary idea behind the task, Person 2 received her first card of the sequence that corresponded to the first card of Person 1 organized sequence.

### **3.1.3. Experimental Conditions**

Due to the experimental nature of this thesis, unique stimuli conditions were designed to allow observation, comparison, and analysis of the communication process between pairs of people during tasks performance. All conditions contained five rounds of tasks. The tasks were designed to be performed by pairs of participants using specific set of cards, which varied according to the motivational stimuli. Table 1 summarizes the four conditions and the five rounds contained in each condition.

Although observations and analyses were made throughout the entire experimental process, the comparisons were mainly made within the established conditions. Hence, the comparison between task 1a, pre-defined random sequence, and task 1b, non-prearranged sequence (condition 1), is of interest as well as the comparison between task 2a, non-prearranged sequence, and the task 3 (condition 3). All the comparisons will be explained when appropriate.

	Task 1a pre- defined random sequence	Task 1b non pre- arranged sequence	Task 2a pre- defined random sequence	Task 2b non pre- arranged sequence	Task 3	Task 4a Two hints	Task 4b One hint
Stimulus	Black Shapes and Sizes	Black Shapes and Sizes	Clothing Pieces and Blue Shades	Clothing Pieces and Blue Shades	Random Lines	Apples and Cats Heads	Apples and Cats Heads
Condition 1	X	X		X	X	X	
Condition 2		X	X	X	X	X	
Condition 3	X	X		X	X		X
Condition 4		X	X	X	X		X

**Table 1 – Experimental Conditions**

### 3.1.4. Tasks Stimuli

Tasks 1 and 2 were designed with different stimuli but the same type of categorical knowledge – two different categorical attributes clearly identifiable by both participants. The objective of the tasks was to observe the effect of those attributes on the communication process between two different dimensions. It was decided to test the effect twice using two different stimuli with similar structural properties.

For tasks 1 and 2, two different ways of performance were designed – one random sequence pre-defined by the experimenter (1a and 2a) and another non-prearranged sequence organized by Person 1 (1b and 2b) (see Table 1).



Due to the study objective, task 3 required another sort of stimulus to study information in the context of a knowledge structure with not well-defined categories, i.e., no attributes would be intentionally obvious on the cards.

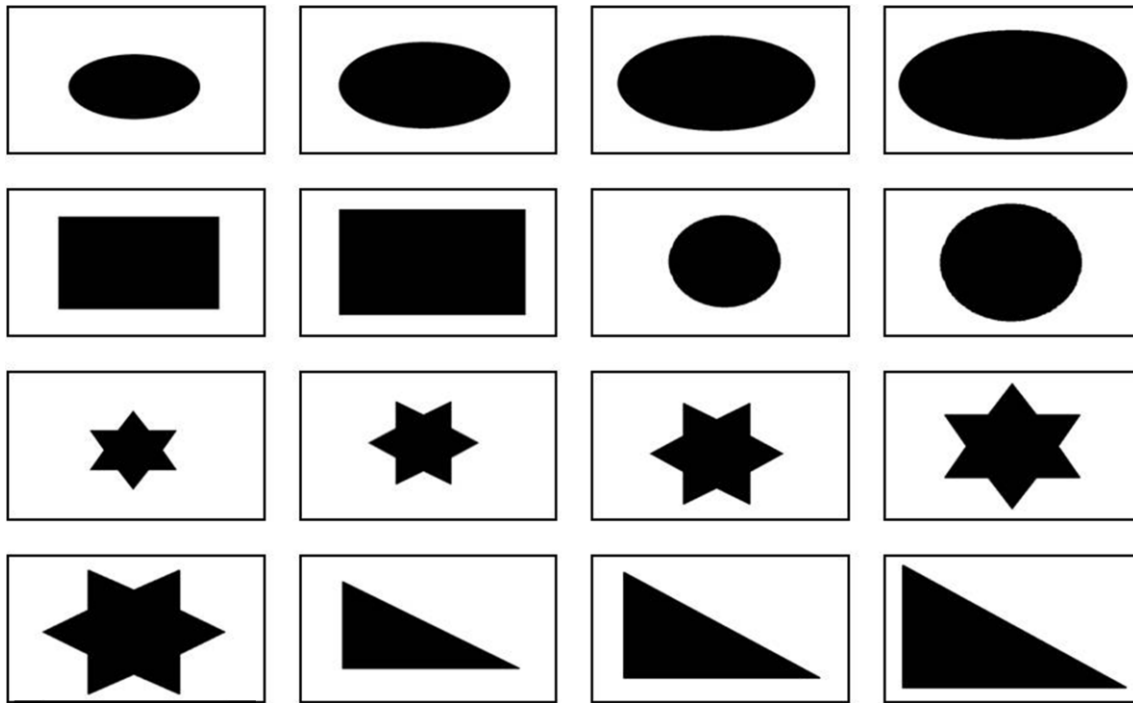
Task 4 stimulus was very peculiar. Different from the previous tasks, the participants were given complementary rather than equal sets of cards. The idea was to simulate the situation that often occurs in cross-functional communication among specialists – an interaction in which, even when talking about the same entity, each individual involved has a particular view of situation that is motivated by their own perception.

Different sets of cards were drawn for each task according to the provided stimuli.

### **3.1.5. Cards Descriptions**

#### **3.1.5.1. Stimulus 1**

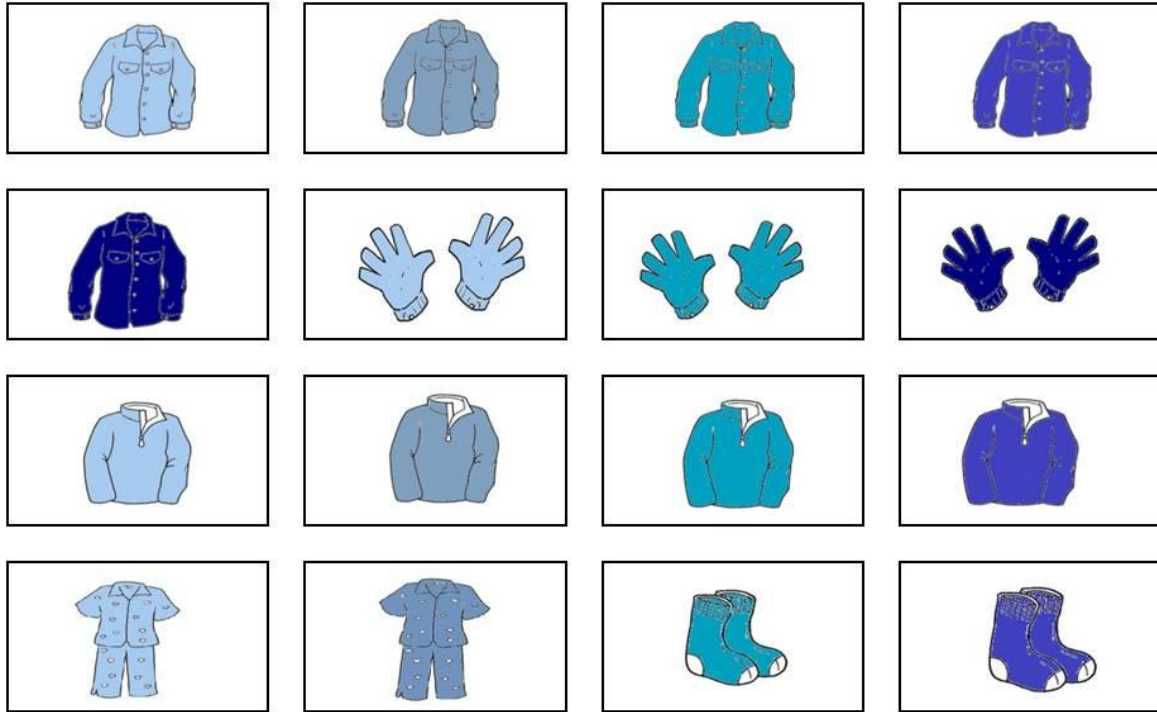
Task 1 involved two sets of 16 cards. Each person was given one set of cards with black shapes printed on them in different sizes. They were 5 stars, three triangles, two circles, four ovals, and two rectangles. The following figure shows the shapes in their respective sizes.



**Figure 5 –Task 1 Cards**

### **3.1.5.2. Stimulus 2**

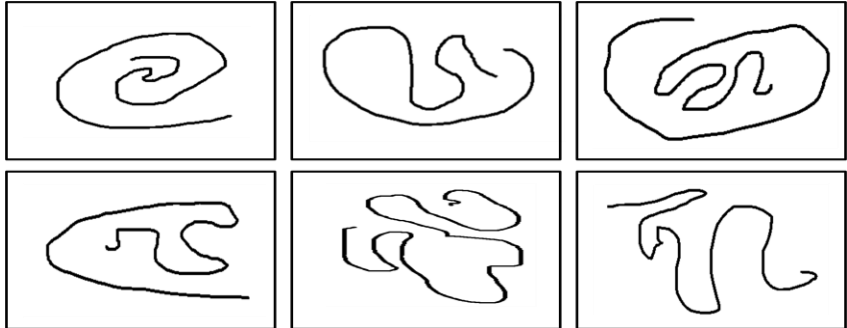
Task 2 also involved two sets of 16 cards and 2 clearly identifiable categorical attributes– clothing items and blue shades. Five cards pictured shirts, 4 cards pictured sweaters, 3 cards pictured pairs of socks, 2 cards pictured pairs of gloves, and 2 cards pictured pajamas. The blue shade of each clothing piece varied from very dark to light blue (see figure 6).



**Figure 6 – Task 2 Set of Cards**

**3.1.5.3. Stimulus 3**

Task 3 cards pictured randomly drawn lines. When designing the cards, we made sure that the line did not cross, touch, or connect to avoid formation of known attributes, such as a cross, a balloon, or similar things. Our initial expectation was that this task would be more difficult; therefore, we decided to decrease the number of the cards. After the pilot tests, the number was decreased even more.



**Figure 7 – Task 3 Cards named “The Things”**

### 3.1.5.4. Stimulus 4

Task 4 was designed based on the idea of complementary cards. Each one of the participants received a set of 6 cards. Different from the previous tasks, the cards were not equal; there were the complement of each other. Person 1 got cards with apples and Person 2 got cards with cat's heads. Each card had either five elements or four elements on it. One of Person's 1 cards had to complement one of Person's 2 cards. If Person 1 had card with 5 apples, Person 2 would necessarily have a complementary card with only four cats' heads. (Compare Figure 8 and Figure 9 to see how the six cards with apples complement, one to one, the six cards with cat's heads.)

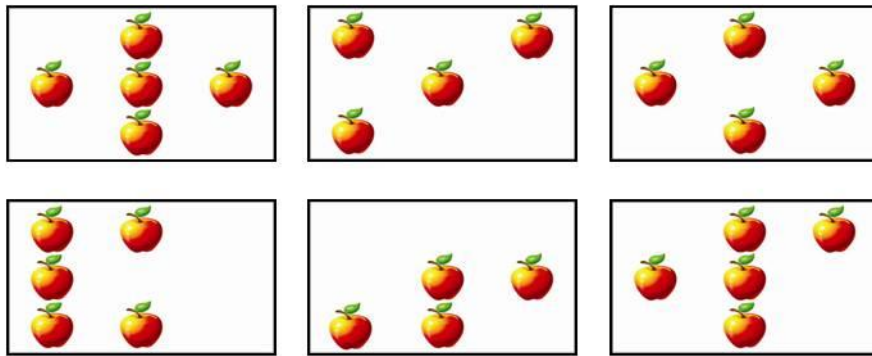


Figure 8 – Task 4 Person 1 Apples set

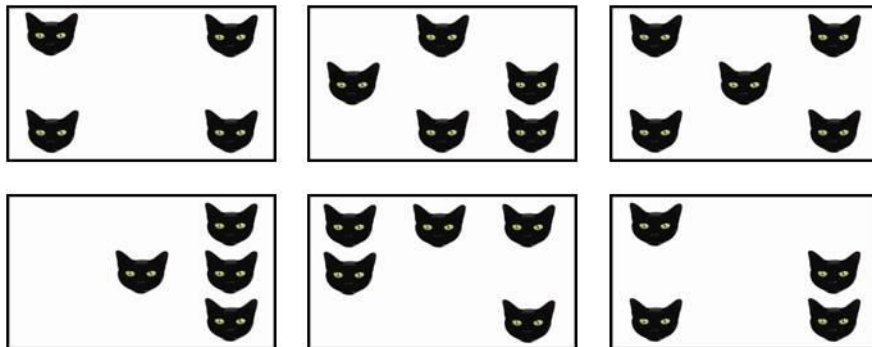


Figure 9 – Task 4 Person 2 Cat Heads set

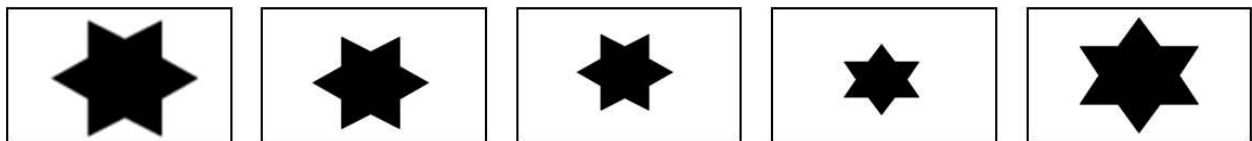
### 3.1.6. Pilot Tests Observations

The pilot test was created mainly to observe whether the tasks and stimuli were effective in answering the theoretical questions of this study. Three pairs of graduate students participated in the pilot tests.

Stimuli 1 and 2 were designed to observe the communication process in the context of known categorical attributes. On the contrary, stimulus 3 comprised cards with no evident attributes. Stimulus 4 design misled the participants with a partial structure, somehow disguised by other possible structures, given to each participant.

In general, the tasks and the stimuli supported our initial thoughts; however, some fine adjustments were necessary. In the first task, Person 1 was given a random prearranged sequence to communicate to Person 2, which was no problem. Person 1 first distinguished the shapes and then he used comparatives and superlatives to explain the sizes of each shape.

Due to a design mistake, if the cards were placed on the table all in the same orientation displayed on the landscape worksheet horizontally, for example, as in Figure 10, people could notice two different types of stars. This set up did not really matter since the cards still illustrated six point stars of different sizes.



**Figure 10 – Two set of stars**

Person 1 was the first participant to notice that the stars were positioned differently on the cards. Although they were all stars and had different sizes, he created

two categories of them – the ones that had “90° picks like triangles” and the others “45°”. Although he could recognize that there were 5 stars of different size, he persisted in pointing out the difference between the stars.

**P1: There are five in total. If we can categorize from the biggest one to smallest one, this would be the second one.**

**P2: OK.**

**P1: Another thing that I can notice from this star is like ah the star is oriented ah like a 90°. Like the first pick is ah 90° ahm the second one is like ah 45°.**

**P2: So is the second biggest.**

**P1: Yeah, it's the second biggest, but the biggest biggest is not ah, ah, the pick, the picks are not oriented like ... ah, straight is like, kind of turned a little bit, right?**

**P2: Humhum.**

**P1: So the one I'm saying, I'm telling you is the second biggest.**

**P2: OK.**

**P1: Right?**

**P2: OK.**

**P1: OK, the next one is another circle, this is the biggest circle.**

**P2: Is just the biggest.**

**(Part of transcription Pilot Test Pair 1, University of Waterloo, 2010)**

In the second task, no prearranged random sequence was given to Person 1. Person 1 received all 16 cards, had to make his own sequence, and then communicate that sequence to Person 2. While Person 1 was organizing his cards, he/she asked the experimenter how to call the female blouses or “tops” present on the cards to avoid making a mistake (see Figure 27, page 131). The “mistake” will come up again with the second pair in the pilot that actually named the “tops” as bras. An alteration in the cards was necessary to avoid embarrassment – the two tops were switched by two sets of pajamas.

Task number 3 was very difficult. Person 1 spent about 180 seconds (3') analyzing his cards to make his sequence. After the interaction started, it took 26' 39" to

complete the task. Person 1 first attempted to distinguish rounded cards from non-rounded ones.

The last task was the most difficult though. It required 45 minutes to complete the task. Both participants thought that the task would be easier compared to the previous one since they were again dealing with attributes that they knew. Due to the obvious struggle of participants during their performance, Task 4 was modified the most after the pilot test.

The amount of cards was decreased to 6, and the hints were changed. Since those alterations were very substantial, only general behavior that became a trend later during the study will be reported here.

### **3.1.7. Second and third pairs of the pilot test**

The second pair participating in the experimental condition of the pilot test performed similarly to the first pair.

The following table compares all three pilot trials. The first two trials tested the first condition. The last one tested the second condition. The second and the third trials were performed after making changes to tasks 3 and 4.

As noticed, the difference between the performances on the tasks before the change and after the change was huge. Another change was made after the performance of Pair 2.

	Task 1 (random sequence)	Task 1 (non- random sequence)	Task 2 (random sequence)	Task 2 (non- random sequence)	Task 3	Task 4 (2 hints)
Performance Time: Pair 1	5'47"	1'32"		3'35"	26'39"	45'38"
Performance Time: Pair 2	4'15"	1'50"		4'45"	9'56"*	30'49"*
Performance Time: Pair 3		3'55"	5'57"	2'22"	7'23"*	16'01"*

\*Tasks 3 and 4 had already been altered to contain 6 cards each.

**Table 2 - Pilot Test Pairs and Performance Time per Task**

The second pair performed the task with fewer cards but with two different sets of cards added as hints given only to Person 1. The Person's 1 first card set portrayed two cats of Person's 2 cards and the second set of cards added the lines of the grid. The hint was given by the experimenter to Person 1 and Person 1 had to communicate that hint and the grid structure to Person 2.

### 3.1.8. Changes in the Tasks Design

Some design alterations were necessary after the pilot tests. Task 2 initially comprised two cards with tops on them. During the first pilot test, both participants experienced difficulties talking about that clothing piece. It resembled a bra, which made participants uncomfortable; therefore, 2 cards with set of pajamas substituted those tops.

The number of cards used in task 3 performance was overwhelming. All the tasks were estimated to be completed in about one hour-and-a-half. One hour and forty minutes had passed and the participants were still performing task 3. There was yet



another task to be initiated. Consequently, the decision was made to reduce the set of cards from 9 to only 6.

The last changes were made to task 4 cards and hints. The first alteration decreased the number of cards from 9 to 6 for the same reason as in task 3. The second alteration occurred to the hints. For the first pair of the pilot test, both participants received a second set of cards with one of each other's entity – the entity was the hint. (See Appendix D)

The second hint was also given to both participants. It was a third set of cards with additional information on the lines forming a grid, a 3X3 matrix. (See Appendix D) The discussion on the last hint tried to determine whether it really provided additional information. Perhaps the presence of the lines was not informative. On the contrary, it could have been misleading to the participants.

Decisions were made, and Pair 3 of the trial performed well on the task with two new hints adopted for the official study. The first hint suggested that participants should pay attention not only to the card contents but also to the empty spaces; and, second, another set of cards given to Person 2 with her cats and two of Person 1 apples on each one of them. (See Figure 23, page 92) The length between the beginning of the task and each hint was 5 minutes.

The variation for the task, the one hint used in task 4b was given to Person 2 the first card of the sequence made by Person 1 – a straightforward hint, which could be compared to the ones used in tasks conditions 1 and 2.

## **3.2. Study General Description**

The stimuli, tasks, and cards discussed in the pilot tests resulted in four different experimental conditions in the main research. Eighty students from both undergraduate and graduate programs participated in the study. The majority of undergraduate students were from the MSCI 311, a third year course of the engineering program. The received either extra course credits or CA\$15.00 as incentive for participating in the study. All graduate students were offered CA\$15.00 as incentive.

Eighty individuals were divided into 40 pairs. There was no special requirement regarding the formation of the group, i.e. gender of subjects, age, background, native language, or friendship. Each pair was scheduled to arrive at a certain time to the Uncertainty Lab.

They were told that the study would take between 45 to 90 minutes and that it would be recorded. The participants were aware that the study was being held in the Uncertainty Lab and that the lab was equipped with cameras and microphones. All students authorized the use of their images and voices for the sake of the research. Each pair of participants was sequentially assigned to an experimental condition (see complete Table in Appendix D).

### **3.2.1. Communicating known attributes**

Tasks 1 and 2 were designed to observe how people communicate clearly identifiable attributes. The main objective of the two tasks was to assess the relationship between information and knowledge structure in the communication

process, i.e., the effects of known structures on the choice of words, number of sentences, and repetition. Although no numerical measurement has been developed to calculate the effectiveness at this point, some preliminary analyses are considered.

### **3.2.1.1. Task 1 design**

Task 1 was designed to observe how people would communicate in the context of known categorical attributes. Thus, there were two sets of sixteen cards each and two categories of attributes – geometrical shapes and sizes. The cards used during the study were the same used in the pilot test.

### **3.2.1.2. Procedure**

Task 1 was performed in two different ways so that 20 pairs were used in the predefined random task and the non prearranged task 1 and 20 pairs were used only in the non-random task 1(See Figure 11 and 12, page 42). Two randomly prearranged sequences generated by a computer program were used to prevent bias or the presence of any known factor in the sequence that could have an effect on performance. Thus, out of 20 pairs performing the random sequences, 10 worked with the first generated random sequence and the other 10 worked with the second one.

For the random sequences, Person 1 received 16 already prearranged cards, as seen in Figure 11 and Figure 12 the cards were arranged in two rows of eight cards each. Person 1 communicated that sequence to Person 2. Person 2 had to sort all cards alone. Person 1 could not change the prearranged sequence. After both of them arranged their cards in the same sequence and answered the questions in the

questionnaire, Person 1 reorganized their cards and communicated the new sequence to Person 2.

Those working with the non-random sequence did not receive a prearranged sequence. Both students of a dyad had to sort their cards alone. Person 1 arranged their cards in a sequence and communicated that sequence to Person 2. There was no restriction and no further instruction regarding the sequence. Usually, Person 1 would ask the experimenter about what kind of sequence was expected or if Person 2 had the same cards she/he had.

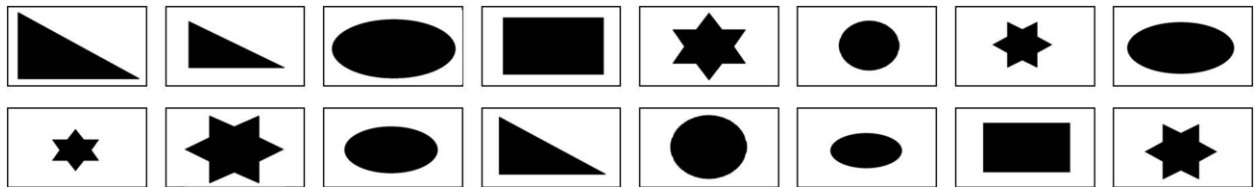


Figure 11 – Task 1 random sequence a

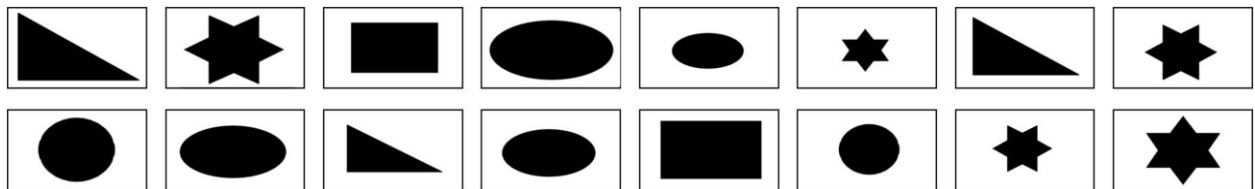


Figure 12 – Task 1 random sequence b

### 3.2.1.3. Observations and Preliminary results

It was not a surprise that out of all 40 participants who were asked to come up with a sequence, 38 organized the cards based on shape (main category) and size (subcategory). Only 2 of them, one group performing the condition with two rounds and the other group performing the condition with one round, organized the cards randomly and communicated the random sequence

to the other person in their dyad. The following transcription piece is an example of what was observed the most.

**P1: OK ... It's like... uhmm ... it's like a random sequence, and uhmm, could you spread out all your cards on the table first?**

**P2: Sure.**

**P1: Yeah I see no pattern with this, so I'll have to describe each one I guess...**

**P2: OK.**

**P1: Uhmmm... there are certain shapes, right? Triangles, squares, uhm stars, and two circles, two perfect circles, and three, four non-perfect circles.**

**P2: Yeah ovals.**

**P1: Yeah, ok, can you arrange them by size? Like... small to big, I think that's the easiest.**

**P2: Uhh... Okay... from smallest to big.**

**P1: Smallest to largest.**

**P2: OK.**

**P1: Okay, so for triangles, there are three, and for rectangles there are two, stars there's tilted one and non-tilted one, right? So for normal stars, there are two? And tilted one there are three, right?**

**P2: What... what do you mean by tilted... Give me the orientation.**

**P1: Uhmm... It has two edges down.**

**P2: Are you putting the paper in landscape? Or like, you know vertically, or...**

**P1: Oh, horizontally.**

**P2: Okay, that's why they're tilted, okay.**

**P1: Yeah, so you've got it.. so three tilted ones, and two non-tilted ones, and for perfect circles there are two? And non-perfect one there are four, right?**

**P2: Yep yep.**

**P1: Okay, the first one is the biggest triangle.**

**P2: First one's the biggest triangle, okay, oh triangle is it, ok.**

**P1: Like a slope, and the second one is the smallest...**

**P2: Smallest, smallest what?**

**P1: Smallest triangle, and the third one is the biggest non-perfect circle?**

**P2: OK.**

**P1: And the fourth one is the biggest rectangle.**

**P2: Alright.**

**P1: And the next one is... the bigger perfect star, non-tilted one, the bigger one in non-tilted star.**

**P2: Yes but bigger one? to say that it's the one in the middle?**

**P1: No this is... we only have two perfect stars.**

**P2: Oh okay, yeah yeah yeah so the bigger ones.**

**P1: Yeah, and then the smallest circle, uh perfect circle, there are only two, so the smaller one.**

**P2: Yeah yea yea.**

**P1: And the smallest, smaller star, perfect star.**

**P2: Uh that's why I'm getting confused, cause what do you mean by like tilted?**

**P1: Uhhh okay, I'll give you a definition.. uh the perfect one is having only one edge at the bottom.**

**P2: OK the bottom, so... landscape... OK, OK, OK**

**P1: So the horizontal bottom, and the tilted ones have two edges at the bottom.**

**P2: OK, OK, OK**

**P1: So where you go up to.**

**P2: So after the smaller circle, what's the next one?**

**P1: The next one is perfect star, the smaller version, the only one left**

**P2: Ok, I got it.**

**P1: And then this one is a little confusing, this is the biggest non-perfect circle you have now.**

**P2: OK.**

**P1: So we used the biggest already, so this is the biggest left**

**P2: Yup**

**P1: And the next row, this the next row now.**

**P2: OK.**

**P1: Uhhh... the smallest non-perfect star, and then the biggest non-perfect star.**

**P2: OK.**

**P1: And then the biggest non-perfect circle you have now, the bigger one.**

**P2: Yep**

**P1: And then any triangle you have left now, and the perfect circle**

**P2: Uhuh**

**P1: The non-perfect circle, rectangle, and star.**

**(Transcription of prearranged random sequence – Condition 1 Pair 6, UW, 2010)**

We can notice that, although in the beginning, Person 1 said that there was no structure behind the organization of the cards, i.e., the cards sequence did not follow any kind of attributes; this person could identify different shapes and different sizes on the cards. This person knew that he could not move his/her cards but Person 2 could; therefore, in order to make the task easier, he asked Person 2 to sort out their cards based on shapes and then organize them from smallest to biggest.

The number of shapes was then counted and the language was checked: “two perfect circles and four non-perfect ones”. Person 2 called the non-perfect circles “ovals”. Person 2 perceived the triangles in their horizontal position as “slopes”. The stars were perceived in two ways – “the tilted” or “normal” and “the non-tilted” ones. These perceptions along with the cards’ position, either horizontal (landscape) or

vertical (portrait), will be the main cause of ambiguity during all tasks, even after the completion of the first part and after Person 1 made his own sequence and communicated it to Person 2, as shown in the next transcription.

P2: So what are you doing now?  
P1: I'm making my own sequence? And then we do the same thing, right?  
P2: OK  
P1: I know you're gonna swear at me if I make it hard. Haha...  
P2: Ok, I'm gonna... wait...  
P1: You're gonna what?  
P2: I'm just gonna rearrange my stuff so we can start over...  
P1: OK, but probably it's best if you arrange them in shapes, cause I'm gonna...  
P2: OK, just like last time.  
P1: Yeah cause I'm sequencing in shapes..... Okay, ready?  
P2: I think so. Yeah.  
P1: Okay. Uhhh, so I'll just give you description of shapes.  
P2: OK.  
P1: And arrange them in smallest to largest and so on and so on like that...  
Okay the first one is triangle, so smallest to largest, and... rectangle.  
P2: OK  
P1: and perfect star  
P2: OK that's where it's confusing all the time...  
P1: I know... haha I know...  
P2: Which one is perfect and which one isn't?  
P1: And ah...  
P2: No I mean you gotta keep uhm explaining it...  
P1: Oh didn't I tell you? The uhhh... non-tilted star, in horizontal way...  
P2: OK, I remember now... Yeah... Yeah...  
P1: Soo... then circles?  
P2: All in one row?  
P1: All in one row so far... and the next one starts now, the next row starts here with non-perfect circles...  
P2: Oh the stars aren't yet, the circles, Yeah... Yeah... Okay I got it.  
P1: And then the remaining tilted star.  
P2: OK.

(Transcription of non prearranged sequence – Condition 1 Pair 6, UW, 2010)

It is clear from the transcripts that Person 1 was confused with the “**tilted**” and “**non-tilted**” stars even after performing the prearranged sequence of cards. Person’s 1 explanation is context related “**Oh didn’t I tell you? The uhhh ... non-tilted star, in**

**horizontal way ...**". It was not an attribute of *the star* itself since it was related to the position of *the card* on the table.

Exception made for the stars, participants experienced small difficulties when communicating the shapes for the first time. Some subjects would not remember the name of the geometrical figures and thus would try different nouns until their partners either named the figures or described them in a way suitable to both of them. For example, the oval form was called: egg, egg-shaped, not regular circle, ellipse, not normal circle, rounded shape, and other words.

**P1: It's kind of tough to... OK... cause**

**P2: The one that's not tilted I guess?**

**P1: Well... Yeah... Sure.**

**P2: The Magen David?**

**P1: What?**

**P2: Jewish star?**

**(Part of Transcript of prearranged random Condition 1 Pair 9, UW, 2010)**

The above example offers three different ways to call the same star. Following, some examples of names describing the ovals included elongated circles, ovals, circle-ish, ellipse.

**P1: So uhmm I'm gonna do a column the right, of ah, cards with elongated circles.**

**P2: OK, just the ovals?**

**P1: Just the ovals yes... and then another column of just circles ... you got it?**

**P2: Uhm, are they the same way?**

**P1: Uhhh... yes, they're not the same size, but they look pretty circle-ish...**

**P2: No, I mean number of cards.**

**P1: Oh! Ah, no you don't have the same number of cards for all the shapes.**

**P2: Alright. Uhhh is there an order for the ellipse?**

**P1: Uh, no not particularly ... all I have mine is the bigger one on top and the small one on bottom ... how many do you have?**

**P2: Ah... Four ovals, two circles.**

**P1: OK. Just go from biggest to smallest, I guess.**

**P2: All right.**

**P1: For all shapes.**



**(Part of Transcript of non pre-arranged sequence Condition 2 Pair 9, UW, 2010)**

The previous example can also be used to illustrate how Person 1 participants ranked their cards. Except for three cases, all subjects selected shape as the main categorical attribute to organize their cards. Size came next as a subcategory. It was never used by the participants as a salient category. The three participants who did not use shapes to organize their sequences created random sequences.

The sequence could be arranged from the biggest to the smallest shape or from the smallest to the highest. Thus, it could be, for example, that the sequence contained all four ovals first, then circles, rectangles, triangles, and stars, all of them arranged from the biggest to the smallest shape. If one or two cards did not fit the formation, Person 1 would assume the mistake, correct it, or ask the experimenter if he/she could rearrange that card. If Person 2 was the one pointing out the mistake, Person 1 could rearrange it or pretend that it was intentionally ordered that way and just leave it.

As observed, distinguishing the cards according to their size was a matter of negotiation. In general, Person 1 disclosed the number of cards with a specific shape and their sizes, respectively, and then specified which card followed in the sequence. For example, “there are four ovals, one is the biggest and one is the smallest. I am not talking about them, I am talking about the second smallest”. Superlatives such as smallest, biggest, second smallest, second biggest, and comparatives as smaller one, third bigger one, and similar were used in this communication context.

It is worth to mention here that in almost all the cases, as soon as the participants playing Person 2 role got their cards, they sorted them out and grouped

them in terms of shapes and, within each shape, in terms of size. . This configuration of their cards on the table allowed them to have a complete vision of the 16 cards. After that, they started to rank the cards according to the direction given by Person 1.

#### **3.2.1.4. Discussion**

Task 1 was designed to allow the use of information in the context of a knowledge structure with well defined categories. Shapes and sizes were explored as categorical sets. How would people react to those attributes when facing a communication challenge? In other words, known attributes were intentionally given to the participants as alternatives to help them rank their cards and communicate that ranking. How would people use this knowledge? Given the categorical alternatives, what kind of attributives would they select to communicate the sequence to the other person?

Participants could perform the task in two different ways. The experimenter gave a random prearranged sequence to Person 1 or Person 1 ranked the cards him or herself. All 40 participants performed the non-random sequence, and half of them performed also the random task one.

Based on the task performance and observation of the participants, we can conclude that categorical attributes are important to the communication process. The use of shapes or sizes definitely simplified the process. Accurate measurement to investigate the use of those attributes has yet to be developed. For instance, measures could compare the performance of participants performing task 1 in a random

prearranged sequence and those performing the task in non-random sequence. This is will be focus of future work.

This thesis involved mostly qualitative work. It should however suffice to show that from the three participants who did not rank their cards based on either size or shapes but rather on random description of their cards still ranked their cards in terms of the categorical attributes. The following is one of the examples.

**P1: OK. You will have two rows... Ah each of eight, OK? So I will start with the second row and it will be your right hand... OK?**

**P2: OK.**

**P1: We'll start with the star with the big star... Yeah, OK? And then a small ah small star... now the small star ah there are two small stars, right?**

**P2: Yeah.**

**P1: OK, one with head? Like two on like outside, right?**

**P2: Yeah.**

**P1: and... just a second... yeah... OK?**

**P2: I, I can talk?**

(Experimenter: Yeah.)

**P2: And one with two, two heads.**

**P1: OK, so you do the two, two heads.**

**P2: So they're all, they're all with two heads?**

**P1: The second row you start with the big star and then the two heads.**

**P2: OK.**

**P1: OK? That's from right to left.**

**P2: So the... again? Repeat it?**

**P1: OK... start from right to left... On the right hand... OK?**

**P2: OK.**

**P1: The first one will be the biggest star... with one head.**

**P2: OK.**

**P1: Big star with one head... and then small star with two heads... and then a circle... OK?**

**P2: The size.**

**P1: The size... of the size of circles? I think uhm... The small circle...**

**P2: OK.**

**P1: And then square? The big square... ah... and then the... the small egg... not the small... Three of them right?**

**P2: There is four.**

**P1: Ah no three... yeah four... OK... so you would go with the... OK What is it... the... the second largest one. It's not the smallest one, the second one... OK? So it's not the smallest, but the, the bigger one... and then...**

**P2: The egg shape I have four**

**P1: Yeah...**

**P2: OK.**

**P1: So you have four, there's the smallest, and then bigger than smallest, and then bigger, the third and the fourth. You will go with the second one.**

**P2: OK.**

**P1: And then there's triangle.**

**P2: There's three of them.**

**P1: Yeah three, three. Just a minute... let me see which it... Yeah smallest one, two, three, usually and 1 is the smaller.**

**P1: OK. Yeah. So, it is the small.**

**P2: OK, so find the 1?**

**P1: Yeah ... ah... oh... here... so... yeah find in the same sequence... OK and then the... there are two big eggs? Or no... yeah OK... the third yeah the third one.**

**P2: OK.**

**P1: The third one put in the...**

**P2: Yeah...**

**P1: And then... a circle, which is the only one left...**

**P2: Yeah only one left now, OK.**

**P1: Now the first row.**

**P2: OK**

**(Part of transcript non-prearranged sequence Condition 1 Pair 9, UW, 2010)**

Person 1 did not make his sequence based on shapes or sizes at all. It was a random sequence starting with two stars followed by a circle, a square, an oval (or egg shape), and so on. However, the language used is still the same. The cards distinction happen within the known categorical items – triangles, stars, egg-shapes, circles, squares; and then within each item - the second biggest star, a big star, the small star, the bigger one.

The fact that the subjects demonstrated almost no difficulties when communicating the sequence to each other indicates that structural knowledge does reduce uncertainty in the communication process. In other words, if the sender and the receiver of the message structurally share only small amount of ambiguity, it is easier for both of them to select and interpret the information.

In some sense, the differentiation made among stars brought unexpected ambiguity to the task. There were 5 stars, all of them different in terms of sizes.

However, suddenly the fact that they could be grouped in “two different forms” – one with two edges pointing up and down and the other one only with one edge pointing up or down – made them not only *stars* but also *regular stars* and *non-regular stars*, *one head*, or *two heads*. The category *star* was broken in subcategories, and those who could not see the difference between them had a very difficult time trying to figure out what their partners suggested.

The description of the subcategories of stars generated task ambiguity. It seems that the description “tilted” or “non-tilted” star was context related since Person 2 says, “**I mean you gotta keep uhm explaining it...**”. Person 1 replies “**Oh didn't I tell you? The uhhh... non-tilted star, in horizontal way...**”. Person 1 answer and Person 2 acceptance (**OK, I remember now... Yeah... Yeah...**) indicate that the language was a part of a previous agreement between them, and it was related to the position of the card on the table.

Nothing in the instructions suggested that orientation or position of the cards were important. In fact, some participants asked if that was a task requirement, while others just assumed that it was and pointed that out to their partners. Even those who had decided not to pay attention to the card orientation would change their minds if their partners started questioning them about the positions and directions of triangles and stars. The following example shows how far this question could go and what kind of features participants used to discuss the issue.

(Question from P1 to the Experimenter “so we both have the same cards?”)

**P1: So, I have two rows... with one, two, three, four, five, six, seven, eight columns... You have that?**

P2: Yep.

P1: OK... so in the top left hand side as the first one, on the top side... ahmm... that's the first one for me... ahm... It's like a half page, with the top of it being in the top left hand side... so, ok, it's like a triangle, so you see the one that looks like a triangle? And it takes up half the page, so it's like half the rectangle?

P2: Yep.

P1: And like, so the shaded part, the black part, is facing like a gradient, kind of like a ramp, but with the back of the ramp on your left-hand side... so the top would be the left-hand side, the bottom is on the right.

P2: So...does it go... is it long, from top to bottom? Or from side to side?

P1: No, the longest part is gonna be diagonal, right?

P2: OK

P1: OK, so like, picture an incline...

P2: Right.

P1: So if you have an incline, if you were walking on that incline, from the bottom to the top, the bottom would be on your right-hand side, and the top on your left.

P2: So I'm walking from the left to the right.

P1: No, you're walking from right to left. OK, so like the top of the incline is on the left... oh ahm... by the way, you have three sizes of those, and it's the biggest one that I'm talking about, that's the first one on the left hand corner.

P2: But the longest is from top to bottom, right?

P1: Ahmm?

P2: The longest part of the card is from top to bottom?

P1: Ahm the longest part of the card? No, no, the longest part of the card is...

P2: From side to side...

P1: OK depends on... in terms of... OK I'm talking about the diagonal... On the size of the diagram?

P2: The size of it...

P1- The size of the diagonal? The size of the card itself?

P2: Yeah, yaeah...

P1: The size of the card, you have a small side and a long side? Uhhh, the long side is facing... is facing me, and perpendicular to that is the short side.

P2: OK, and I'm going down the hill.

P1: Right, so... based on the picture on the card? Like, if it's a hill? The hill is starting from the left hand side and going down to the right hand side...

P2: OK.

P1: And that's the biggest one. The biggest one of those things that you have.

P2: Yeah.

**(Part of Transcript Predefined Random Sequence Condition 1 Pair 3, UW, 2010)**

It seems that what really happened was the addition of the third structural dimension, orientation of the cards, to the two existent ones, shapes and sizes, to help participants sort out and organize the cards in order to perhaps improve the communication process. This addition helped to clarify the differentiation of the stars. If

the cards were squares, not rectangles, and the items on them were centralized, perhaps the difference would not be noticed.

This thesis will not focus on the measurements at all. A good method for measuring accurately the effectiveness of the communication process still needs to be developed. Future research needs to focus on quantitative measurements. All further comparisons, including participants' performance utilizing random and non-random sequences, are need to be addressed in future studies.

### **3.2.1.5. One odd example**

In this study, an odd example concerns the shortest task performance using the first stimulus. While all other performances comprised repetitions and redundancies that we commented on in the previous sections, this one is odd due to its simplicity and brevity.

**P1: OK, so again two rows, ahm, eight cards in each, starting at the leftmost card of the row closest to the barrier, uhm are the three stars that are oriented with the stars pointed left and right? And with the biggest star on the left and ends with the smallest star on the right and it goes on descending order of size.**

**P2: OK.**

**P1: Ahm. Next are four ovals, ahm oriented in the same way going largest to smallest ...**

**P2: OK.**

**P1: Ah... Next two circles again largest to smallest, ahm next are three triangles, going largest to smallest.**

**P2: These are the second row?**

**P1: Yes, and I should just for clarification, ahm the two circles are split between two rows, so that...**

**P2: I was wondering about that.**

**P1: there are, there are eight, eight, eight each row.**

**P2: OK**

**P1: Yeah. Hahaha. Ahm... Then after the triangles, are the two stars that are oriented up down? Uhm biggest to smallest ... and then the remaining are the two rectangles going biggest to smallest.**

**(Transcript non-pre-arranged sequence Condition 3 Pair G5, UW, 2010)**

The task was finished, and participants did not miss any details. They were able to separate even cards with the stars. The pair had performed a random prearranged sequence task with the same set of card. Of course, it made the task easier since they had solved some of the communication problems before.

For example, they already knew that both of them had the same set of cards. They knew how many cards of each shape they had. They also knew how to name the cards. They have made the necessary agreements regarding the cards orientation, the two types of stars, and their labeling.

By comparing performances on both random prearranged sequence task and non-random sequence task, it becomes clear that the second one happened smoother and faster than the first one. The number of the repetitions and questions asked decreased considerably in the second round.

### **3.3. Task 2 a and b**

Similar to task 1, task 2 was designed to observe the communication process between two individuals talking about categorical attributes easily recognizable on some cards.

#### **3.3.1. Task 2 design**

Two sets of 16 cards each were designed for this task. Two categorical attributes could be identified by both individuals without difficulty: clothing pieces and blue shades. Except for the two sets of pajamas used as substitutes for the two tops, all the cards

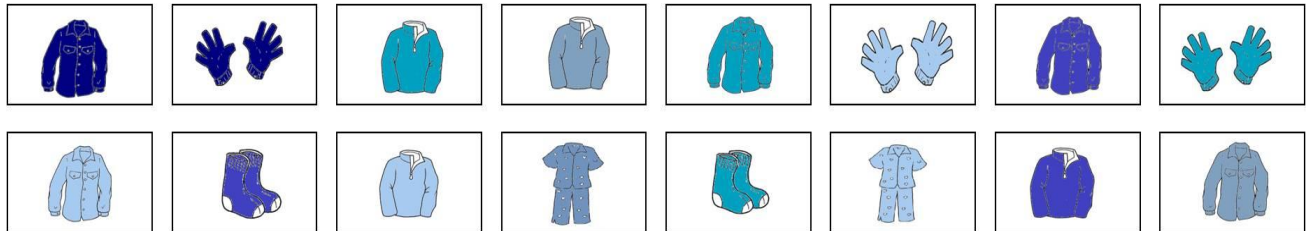


were the same as those used in the pilot test. Figure 13 and Figure 14 show all five clothing pieces in their different shades of blue.

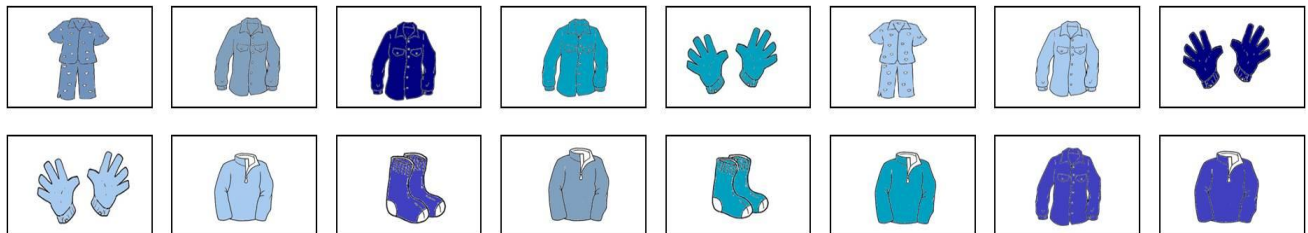
### 3.3.2. Procedure

The same 40 pairs that performed task 1 also performed the second one. Similar to Task 1, Task 2 could be performed in two different ways, a random prearranged sequence and a non-random sequence. Table 3 on page 58 describes four different conditions. A random sequence generator was used to create two prearranged sequences. Ten groups performed one of them and 10 groups the other one.

The non-random sequence was organized by Person 1. Person 2 always had to sort out cards individually. The task was considered finished when both participants had gotten their cards in the same sequence and completed their questionnaire. Figure 13 and Figure 14 illustrate the two sets of random sequences given by the experimenter to Person 1.



**Figure 13 – Random Sequence Task 2a**



**Figure 14 – Random Sequence Task 2b**

### 3.3.3. Observations and Preliminary Results

The stimuli used in both tasks 1 and 2 were intentionally very similar. There were 5 clothing items, each presented in 5 different shades of blue. The shades varied from a very dark blue to a very light blue.

All participants were asked to come up with a sequence and communicate that sequence to the other person who was asked to arrange the cards based on the observable features, clothing type or color shade. Dissimilar to what happened during task 1, none of them randomized their cards. The majority of participants organized their cards in terms of clothing pieces while other participants organized their cards by color, which also from the performance on the first task.

**P1: If you can ... just organize all your clothing with whatever you have.  
P2: Alright... So darkest to..  
P1: Humm... well organize by type.  
P2: But in type, organize by colour, darkest to...  
P1: Well you could but you gonna tell me what we did?  
(Part of transcript non-pre-arranged sequence Condition2 Pair 5, UW, 2010)**

Thus, for example, Person 1 would have a sequence of buttoned-up shirts from lightest to darkest or darkest to lightest followed by the sweaters, socks, gloves, and pajamas, all in the same shade sequence. However, another person could have all light-blue clothing pieces first, for example, followed by all grayish pieces, greenish pieces, navy blue pieces, and purplish pieces instead. The following example shows a structure based on color and describes the way in which Person 1 communicated this structure to Person 2.

**P1: Ok, so I first started with the, I did them by colour.  
P2: OK.**

**P1: So I started with the light blue. So there will be like, so the ones that have the pyjs, so the light blue pyjs?**

**P2: Ok.**

**P1: I have first. Then I have the light blue in everything. So the light blue bottom-up shirt, which is the one without trimming on it.**

**P2: Ok, So the next cards will be like the blue pyjamas.**

**P1: yeah, then I have the light blue zip-up front shirt. And then, the light blue gloves.**

**P2: Yes.**

**P1: And then I have the indigo colours, so the four of those things.**

**P2: Yes.**

**P1: I have the socks first, then the bottom-up shirt, so this one has trimming.**

**P2: Yes.**

**P1: And then the zip-up front shirt.**

**P2: Humhum.**

**P1: And then the gloves.**

**P2: So I have like all of them in the first row.**

**P1: Yeah. And then I have those three grey things. Greyish.**

**P2: You have the three?**

**P1: Yeah. So I have the pyjs first.**

**P2: Pyjs, in?**

**P1: In the second row, so they are under that row. Then I have the bottom-up front shirt.**

**P2: Yes.**

**P1: And then the zip-up front shirt.**

**P2: Yes.**

**P1: And then there is three like, royal blue things.**

**P2: Yeah, the socks, the zip-up and the bottom-up.**

**P1: Yeah, so I have the socks first, in the second row.**

**P2: Yes.**

**P1: Then the bottom-up, and then the zip-up.**

**P2: Ahm... Ok.**

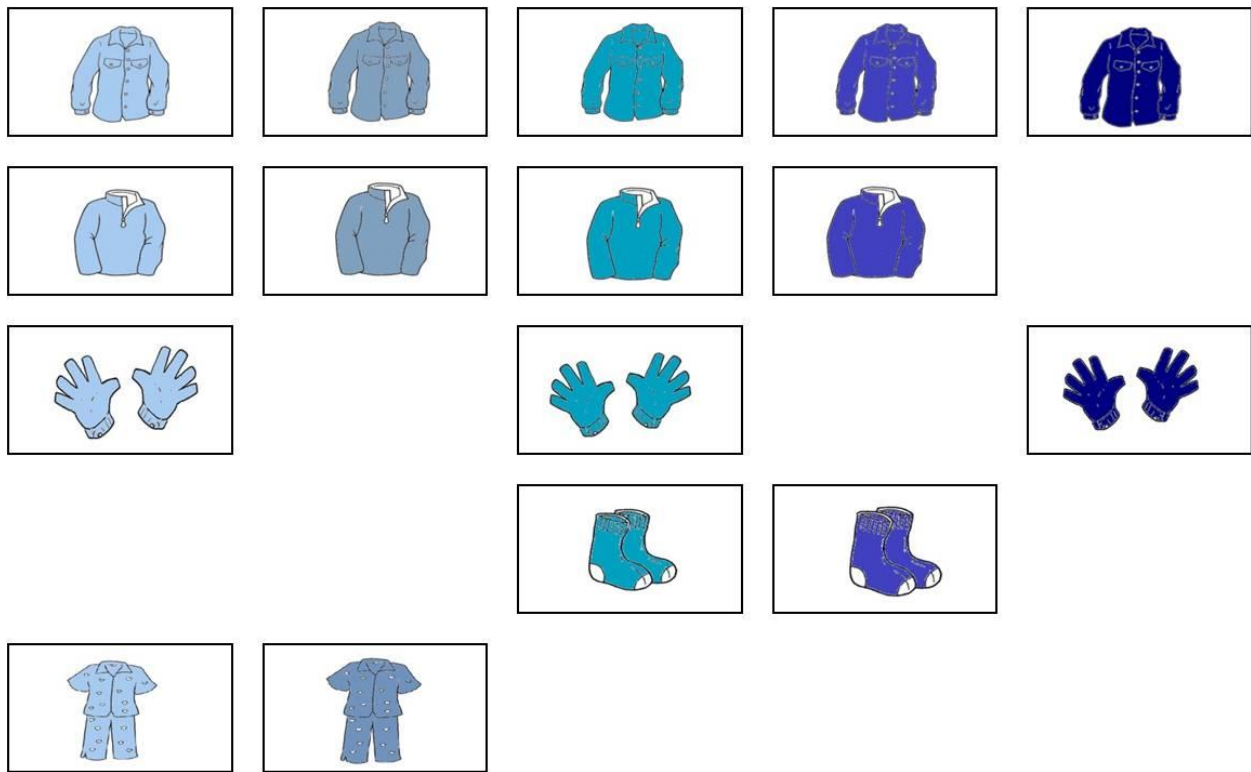
**P1: And then the two purple things in the end? I have the gloves, and then the button-up.**

**P2: OK.**

**(Transcript of non-pre-arranged sequence Task 2 Condition 4 Pair 8, UW, 2010)**

According to the example, the color sequence could not follow a shade scale. In that case, Person 1 chose to put indigo blue (greenish) cards instead of the grayish cards after the light-blue cards. The grayish came in the third column, followed by the royal blue and purple (royal).

A matrix format was the third physical structural method used by the subjects to organize their cards. Both members of a dyad, Person 1 and Person 2, would sort their cards using this format. Since there were 5 items of clothing all presented in 5 different shades of blue, only few groups organized the cards in a 5X5 matrix, by color and by clothing piece in rows and columns, respectively. When there was no piece of a specific color, the space was left empty (see Figure 15 bellow).



**Figure 15 – Clothes Arranged in a Matrix Form with Colors in Columns and Clothing Pieces in Rows**

A variation of the above structure also organized cards in 5 rows and 5 columns but the empty spaces were left at the end of each row. The following example illustrates how a participant communicated that structure.

**P1: How many cards do you have?**

**P2: 16 cards.**

**P1: OK we both have 16 cards. OK the overall arrangement will be...**

**P2: OK we can communicate, yeah?**

Experimenter: Yeah.  
 P2: OK so let's kind of...  
 P1: Yeah, yeah... I arrange it, for the overall we have 1, 2, 3, 4, 5 rows... five rows, OK?  
 P2: Yeah.  
 P1: And each colour will be in a column... so... how many colours do you have?  
 P2: You arrange them by colour I arrange them by shape...  
 P1: Yeah, we will arrange by shape here, but just how many colours do you have?  
 P2: Uh, the first based on the shape so there's uh 5 main colours...  
 P1: 1, 2, 3, 4, OK good... we'll start with the first row... go from the bright? to the dark, darkness one with the zipper... the, the one with the zipper  
 P2: OK I did it.  
 P1: You did it? This is the first row... from right to left...  
 P2: OK from right.  
 P1: Right to left  
 P2: Brighter to darker  
 P1: Yeah... brighter to darker... with the zipper... OK? Good?  
 P2: Yeah... uhuh...  
 P1: Now second row...  
 P2: There's a total of four, yeah?  
 P1: Yeah exactly  
 P1: Second row? You start from brighter to darker, OK?  
 P2: Yeah.  
 P1: And with each one under... which colour, same colour, the pyjama one  
 P2: Pyjama. So there's two  
 P1: Pyjamas...  
 P2: Two beside each other.  
 P1: Exactly!  
 P2: OK.  
 P1: Yes that's it... this is a ... uh now we will go to the third one!  
 P2: Yeah... so this is uh... gloves? socks?  
 P1: no... it is uh the, the top  
 P2: with buttons  
 P1: Yeah.  
 P2: OK... there's uh five of them  
 P1: You will start from bright to darkness one...  
 P2: OK.. OK I did it.  
 P1: So this is the third? row right?  
 P2: Yeah.  
 P1: So.. uh can you do.. with the last one is there something in the top of that one?  
 P2: No uh nothing above...  
 P1: You're... exactly... let's go now to the fourth row... now here's the gloves... do the same with the gloves... from brighter to the darkest one  
 P2: So it's one, then one empty, then one, then one empty...  
 P1: Perfect  
 P2: OK.  
 P1: The last one is the socks with the same...

**P2: It will be number three? If we go from right to left? Number three and number four**

**P1: Yeah, exactly! That's it!**

**P2: So we're finished now.**

**(Transcript of non-pre-arranged sequence Task 2 Condition 3 Pair 9, UW, 2010)**

Independently of the format chosen by Person 1 to rank the cards, whether using a 5X5 matrix, 2 rows of eight cards, or 4 rows of 4 cards each, the 16 cards were ranked in the sequence. When a card was misplaced, she/he would point that out and ask the Experimenter to put the card in the right position. Otherwise, Person 1 would excuse herself to Person 2 and move on. The following example illustrates that.

**P1: And then after that I have the one that looks like grey, and then there's one remaining one which is going to be in the other row? So the first part in the second row, right?**

**P2: OK.**

**P1: Actually I think I did it wrong ... Sorry ... OK, the one that matches the gloves?**

**P2: Yeah.**

**P1: The one that matches that ... the first one in the second row matches the second gloves which is like the second gloves, which is like the medium blue, is that that you have?**

**P2: Yeah... So I have the blue blue. And then the light blue, and then the grey-blue.**

**P1: Yeah... so then in the first row is the medium blue that matches the middle gloves.**

**P2: The middle gloves. OK.**

**P1: Now, I'm going to do is buttoned-up shirts. So the first one that I have is the matches the dark purple-looking blue.**

**(Part of transcript of non-pre-arranged sequence Task 2 Pair G3, UW, 2010)**

In this example, Person 1 organized his/her cards by clothing item from the darkest to lightest. He started with two sets of pajamas followed by three pairs of gloves and four sweaters (the transcription starts when he is describing the grey sweater). He pointed out a mistake in the ranking of the sweaters. He broke the order "from darkest to lightest," leaving the third darkest blue sweater (the same color of the second pair of gloves) to the last position.

This time, no problem occurred with orientation of the cards. Few asked whether the gloves should point up or down. The participants experienced difficulties distinguishing between different cards because of two different factors. One of them was the different shades of blue and the other one was the two types of shirts.

Participants talked about shades in two different ways. They used superlatives or comparatives and other colors to create a scale by approximation. Superlatives, such as the darkest one, the lightest, the very dark, the third darkest, and comparatives as darker, lighter, brighter, and so on were very used by the participants but even those participants developed a sort of blue scale using a known *color* and adding *-ish*, such as *greenish* or *grayish* for some cards. In general, the subjects renamed them as following: violet or purple-blue, navy-blue or normal blue or blue, greenish-blue or teal, grayish-blue, light-blue or baby-blue.

**P1: Ahm... This is difficult...**

**P2: You can do it.**

**P1: It's... I'll do it by colour... ahmm... ahmm... ahmm... OK**

(Experimenter: Yeah, Start.)

**P1: OK! So you have we'll do button shirts again, OK 4X4 matrix.**

**P2: OK.**

**P1: Uhm... first row, first column you have your navy blue,**

**P2: OK**

**P1: Actually no, the second shade of blue.**

**P2: The second one, OK.**

**P1: So just blue, haha.**

**P2: OK.**

**P1: First column, we're still at the first column, going down you will have your light blue uhm shirt?**

**P2: OK.**

**P1: The same shirt, so button shirts, we are doing button shirts.**

**P2: Right.**

**P1: And then the third row you have turquoise? First column.**

**P2: OK.**

**P1: And then fourth row first column, you have your grey-ish button shirt.**

**P2: OK.**

**P1: And then your darkest button shirt will be on the fourth row, fourth ... first row, fourth column ... so you've got your five shirts?**

**P2: Right.**

**P1: Right... ahm... OK. Now... second column first row will be the zipped-up shirt?**

**P2: OK.**

**(Part of transcript pre-defined random sequence Condition 2, Task 2, Pair 3, UW, 2010)**

In one example, Person 1 referred to the different blue shades using superlatives and the blue scale. “Navy blue” or “just blue” corresponds to the second darkest blue card, “turquoise” is the third darkest shade, “gray-ish” is the fourth darkest blue card, and “light blue” is the lightest blue. Person 1 did not name the darkest blue in the example. Person 1 referred to that specific card only as the “darkest button shirt”.

Participants experienced difficulties because of the shirts. There were two different types of shirts; both of them had long sleeves, but one model had buttons and the other had zipper. Looking at them, they were very different. Communicating them, however, was challenging. Some participants had a hard time differentiating them.

Many characteristics were used by the subjects to describe the shirts: long sleeves (although both types were long), number of buttons (only one type had buttons), half zipped (only one had zipper), two pockets (extra detail for the buttoned-up), trimmed/not trimmed (detail of the buttoned-up shirts that only few people noticed), pajamas with little hearts (there were two sets of pajamas both with little hearts).

**P1: OK... So there should be two sets of shirts, or full-sleeve sweaters? So uhm one is pretty obvious there is four? Full sleeve shirts with buttons ... all blue-ish colours...**

**P2: There's four?**

**P1: Uhhh... Yeah... Sorry, five... five... OK?**

**P2: Five, yeah.**

**P1: So all of them have buttons and collars and everything?**

**P2: Mhmm.**

**P1: So therefo.... and there's another set which is full sleeve sweaters? Kind of thing, and there, there are only four of them?**

**P2: Yeap.**



**P1: OK, so let's start with the four-of-a-kind.... so they're all sweaters, so arrange it from light ... to brighter and darker colours, starting with the lightest blue, and then you have the grey?**

**P2: Yep.**

**(Part of transcript non-prearranged sequence Condition 2, Task 2, , Pair 9, UW, 2010)**

### **3.3.4. Discussion**

As in the previous task, task 2 was also designed to study how people would communicate visible attributes. Two categorical attributes were used: clothing items and blue shades. The objective was to observe how participants would communicate those attributes to each other, and compare the results with the first task. However, as mentioned before, although this study is two-folded, only the qualitative part of the work is reported here.

The experimental conditions were kept the same: two known categorical attributes (clothing pieces and blue shades) printed on 16 cards were ranked and communicated by Person 1 to Person 2. The task could be performed in two ways, in a random pre-arranged sequence given by the experimenter and in a non-random sequence organized by Person 1.

Participants who performed random and non-random sequences in task 1 performed only the non-random sequence in task 2. Those who performed only the non-random sequence in task 1 performed both sequences in task 2 (see table 1, page 30). Given that the stimuli and conditions were maintained, would the subjects' performance still be the same?

As there was no control group in the experiment, we were interested mainly in observing whether the presence of categorical attributes was important to the

communication process. As discussed in the beginning of the chapter, task 2 worked somehow as a control for task 1.

Although no accurate measurement has yet been developed to better investigate the effectiveness of the use of attributes, such as the clothing pieces and blue shades in task 2, in the communication process, the observation of people interacting with each other while performing tasks has been very valuable.

All 40 participants playing Person 1 role ranked their sequences based on either shade of blue or type of clothes. None of them made random sequences. From the observation, and from comparing random pre-arranged sequence in task 2 with sequence organized by Person 1 in task 2, it seems that the presence of attributes does ease communication process, as happened before with performance on task 1.

However, it seems that performing task number 2 was a little more complicated than performing task 1. Communicating clothing items and specially shades of blue seems to involve some level of uncertainty that is not present when communicating shapes and sizes. Although more studies needs to be done, it seems that the availability of more words to describe blue shades rather than sizes contributed to the ambiguity of the task. Instead of using superlatives and comparatives, participants felt compelled to approximate similar colors; however, by doing that, they added extra complexity to the task.

The distinction was not made within the category anymore, i.e., the physical cards were not the only things used to make the distinction. Other means were used, such as common knowledge, for example, certain blue shade is known as Navy blue, or

teal is a medium blue-green color or even purplish. It seems that compared to task 1, which involved sizes, participants needed more mental representations in this case. Discriminating between big and small seems easier than discriminating between different shades of blue.

Although different shades of blue were very perceptible, it was not easy to communicate them. Some of the participants who experienced difficulties differentiating or communicating the blue shades to their partners when performing the random sequence organized their new sequences by color to ease the process. By putting in the entire set of items of the same color into the same row or column, participants were able to communicate each color separately, which was less confusing.

For example, one of the pairs performing the two sequences, the random prearranged sequence and the sequence organized by Person 1 organized their cards in the way described above. Person 1 had difficulties to communicate certain shades, especially the two darkest blues, to Person 2 during the random sequence performance. Thus, this person organized the sequence in terms of colors.

**P1: And then there's the, there's the... there's two other blues, like very similar?**

**P2: Humhum.**

**P1: the one is a bit darker than the other?**

**P2: Yeah, yeah, I see what you are talking about.**

**P1: Ahm, are these the same colour? They kind of look, like there is two sets of PJs, right? There is the dark ones, and the light ones**

**P2: Hold on... Ahm, I have one, OK. Yeah, yeah.**

**P1: OK, so the first card is the darker set of PJs.**

**P2: Humhum.**

**P1: And then the next card is ahm, ahm, it's a shirt that, ahm, like, it looks almost exactly the identical colour?**

**P2: Oh, yes.**

**P1: It's anything like maybe two shades brighter, but they are pretty much like the exactly same colour.**

**P2: Yeah.**

P1: Ok, so that's the next one.  
P2: OK, hold on, so we've identified the purple ones.  
P1: Yes, the purple...  
(...)  
P1: Oh, yeah, yeah. You should. I don't think we can get far with classifying the colours. Ok, let start it. Anyway, so the first one is the, the darker of the two pyjamas.  
P2: Darker of the two pyjamas? Yeah, that's the first one?  
P1: That's the first card, yeah.  
P2: OK.  
P1: The next one is, there is four shirts. I'd say, it's the second lightest, not the light colour.  
P2: Four shirts, the four dress shirts, right?  
P1: Yeah.  
P2: It's not from the colour from the PJ, right?  
P1: It matches one of the sweaters.  
P2: One of the sweaters?  
P1: It doesn't match anything else.  
P2: Ok, ahm, OK, it's a dress shirt.  
P1: Right.  
P2: Which... the category that the drop shirts belongs to, in terms of colour?  
P1: It's not the... it's not there...  
P2: How many other pieces of clothing are there?  
P1: There's just, there is only this one shirt. It's not in the shirts, for what I can see. If anything, it almost matches the PJs. But I don't know if my eyes or not. For what I can see it's slightly off from the PJs  
P2: Are you sure there isn't also a sock? With that same colour?  
P1: I don't know, I have a pair of socks with the more teal. Like they are more greenish.  
P2: You have two pairs of socks, right?  
P1: Yes. There is the dark blue, and there's the, like the blue that's slightly green.  
P2: Oh, and this dress shirt is not of that dark blue category?  
P1: No it's not from either these categories.  
P2: Ok.  
P1: It's, it matches one the sweat-shirts. I am seeing what you might to compare, you may not.  
P2: I don't know what you mean by it matches one of the sweat-shirts.  
P1: There is only, like, like this shirt.  
P2: Humhum.  
P1: There is only another card that matches it. And it's a sweater.  
P2: And it's a sweater?  
P1: So, line up all the sweaters.  
P2: Aham.

**(Part of transcript non-pre-arranged sequence , Condition 4, Task 2, Pair 6, UW, 2010)**

When the description of the shades is not clear, the participants try to use different features of the cards to help them differentiate the blue shades. For example,

they compare the color with a card that is already placed in the sequence. Person 1 says, “There is only another card that matches it. And it’s a sweater” referring to a grayish sweater. The card that Person 2 had to rank was the grayish dress shirt (the male shirt). In this case, the difficulty increased because Person 1 had noticed a slight difference in the grayish blue shades.

Due to a printer variation, one card showing one set of grayish- blue pajamas had a slightly different almost unnoticeable hue from the other grayish-blue clothing items cards (see Figure 1). Person 1 ignored not only one other sweater but also the pajamas were also grayish-blue. Person 2 got lost when Person 1 said that there was only one other piece of that color.



**Figure 16 – Grayish Blue Clothing Pieces with little color variation**

After Person 2 finished arranging their cards according to directions of Person 1, Person 1 reorganized the sequence.

**P1: OK, so the bottom row, basically I did them by colour.**

**P2: Humhum. Good.**

**P1: Like five rows of colour?**

**P2: OK.**

**P1: So the bottom row.**

**P2: Yeah.**

**P1: Starts with the gloves, the one that there’s only gloves and shirt?**

**P2: Gloves and shirt. I’m gonna categorize them by colours though. Ok.**

**P1: Yeah. Do you have a category for that?**

**P2: Yeah.**

**P1: Ok, so that’s the first row with the gloves and shirt.**

**P2: That’s the bottom row, or?**

**P1: Bottom row, bottom row.**

**P2: Ok.**

**P1: I’m going bottom-up.**

**P2: Oh, bottom-up?**

**P1: Yeah.**  
**P2: Ok... Ok.**  
**P1: Alright?**  
**P2: Yeah.**  
**P1: Now the next row is the one which is gloves, sweater, shirt, and socks.**  
**P2: Sorry, ah, glove.**  
**P1: Glove.**  
**P2: Sweater.**  
**P1: Sweater, shirt.**  
**P2: Shirt and socks?**  
**P1: And socks.**  
**P2: Ok, in what order?**  
**P1: That order.**  
**P2: Ok.**  
**P1: So, gloves,..**  
**P2: Gloves.**  
**P1: Sweater.**  
**P2: Sweater.**  
**P1: Shirt.**  
**P2: Shirt, which is left from right, right?**  
**P1: Yeah.**  
**P2: The one, the row before that is just shirt and glove? In that order? Or glove and shirt?**  
**P1: No, glove then shirt.**  
**P2: Glove then shirt. Ok.**  
**P1: Got it? OK. Now the third row...**  
**P2: Yeah.**  
**P1: Is glove, sweater, shirt, and pyjamas.**  
**P2: Glove, sweater, shirt, Pyjamas, Uau. Sweater, shirt, Pyjamas, yeah.**  
**P1: Done? So the second row should pretty much be in the same order except for the last item, or the different sweater, do you agree with that?**  
**P2: Yeah. Hold on. So the next one is exactly the same things but the glove?**  
**P1: No, except for the socks, like I am not talking about your next row at all.**  
**P2: Oh.**  
**P1: I'm just confirming what you already have.**  
**P2: Oh, yeah, yeah, yeah, the one that I just put down?**  
**P1: Yeah.**  
**P2: Instead of sock, it's a PJ, right?**  
**P1: Yeah. And it's exactly same way as the other row?**  
**P2: Yes.**  
**P1: Ok, now the fourth row.**  
**P2: Yeah.**  
**P1: It's sweater, shirt and socks.**  
**P2: Sweater... sweater, shirt and socks. Done.**  
**P1: Alright, then the next one is sweater, shirt and PJs.**  
**P2: Sweater, shirt, PJs. And then are they all line-up at the left side?**  
**P1: Yep.**  
**P2: OK.**

**(Part of transcript pre-defined sequence Condition 4, Task 2, Pair 6, UW, 2010)**

Person 1 reorganized the cards in five rows so that each row contained a different shade of blue, making the communication process easier. This new ordering addressed even the difficulty with the grayish-blue cards.

By observing the structure, it is possible to presume that Person 1 was concerned about getting the blue shades correctly. On the other hand, it seems that he/she was not so worried about the clothing items. They were not ranked as well as they could be. It led to some miscommunication between the participants.

Once Person 2 understood the scheme behind Person 1 structure of cards, he/she started expecting cards that did not come. Three categories of clothing were often put close to each other, male shirt, sweaters, and pairs of gloves. All were presented in the same colors, light blue, grayish, and greenish. If two rows contained a shirt and a pair of gloves but were not under each other respectively, the other Person expectation failed and a miscommunication occurred. Participants used repetition, redundancy, and questions to clarify and emphasize the change of course.

**P2: The one, the row before that is just shirt and glove? In that order? Or glove and shirt?**

**P1: No, glove then shirt.**

**P2: Glove then shirt. Ok.**

In addition, dealing with clothing pieces was also a source of some problem, especially with the shirts. One person would call the buttoned-up shirt as jacket while the other person would call the zipped– up shirt as jacket. They would not notice this until the completion of the task or the “last checking” as they called. Others would use a big number of “unnecessary” qualifiers, meaning non-distinguishable features, such as long sleeves, and repeated themselves to exhaustion to be sure that they were not

wrong. Perhaps, two or three additional features that would be distinguishable, including button and zipper, one type had five cards and the other one only four, and the shades of color, would be more appropriate.

### **3.3.4.1. One odd example**

Communication is a complicated process. Sometimes, people involved in the process think that they had not communicated enough information when they did or vice-versa. Sometimes, to avoid confusion, the less people say the better. Repetition is not always needed.

The following transcript is an odd example due to its character. Person 1 did not provide Person 2 with enough information to complete the sequence. By checking the videotape, it was possible to observe that Person 1 did not use gestures or another form of communication during the performance; however, little information that Person 1 provided seemed sufficient for the other person to finish the task. The transcription is complete.

**P1: Uhm ...OK, So there are three lines, and each one I sequence them from the... th... from the colour, which is the light colour to the dark...**  
**P2: the dark blue**  
**P1: So the first line, there are like two pyjamas, so the first one is the light and then the darker one next to that one,**  
**P2: OK**  
**P1: next are three jackets which is from the ligh**  
**P2: uhm first uhm how many, how many jackets?**  
**P1: OK uhm there are some buttons, there are two types of jacket, yeah?**  
**P2: Yes**  
**P1: the one of them with buttons, and there are five of them...**  
**P2: Yes, five.**  
**P1: Just choose the three which are the light colours OK. So just from...**  
**uhm ...**  
**P2: and uhm... uhm**  
**P1: From the light to the dark ...**  
**P2: OK, so just choose three ...**



**P1: Yeah**  
**P2: And uhm you know, I'm not sure about uhm colours in this ... So first you have jacket with like the sky blue, right? Sec**  
**P1: second is like, a little bit grey**  
**P2: grey?**  
**P1: this feel little bit like**  
**P2: uhm I think the second one has a little purple uhm no, uhm green**  
**P1: OK yeah, and the third one is... blue**  
**P2: Yea it's blue ...**  
**P1: So that's the first line.**  
**P2: OK ...**  
**P1: And the... third line... So the third line.... oh no, the second line, OK?**  
**there are two jackets there, right?**  
**P2: mm yea also button one**  
**P1: So button one, from the light, to the dark**  
**P2: hmm... So...**  
**P1: OK? then the other type of jacket? also uhm**  
**P2: from**  
**P1: yeah from light to dark... then you have three uhm gloves, right?**  
**P2: also from light to dark one, right? is... is in the second line?**  
**P1: no, is in the third line**  
**P2: and two socks...**  
**P1: yeah**  
**P2: like... that... OK**

**(Transcript non-pre-arranged sequence, Condition 4, Task 2, Pair 8, UW, 2010)**

In the case transcribed, Person 1 did not communicate information to Person 2 card by card. She stated at the beginning how she organized the cards, giving Person 2 the big picture of the structure. There are three lines from light to dark – simple and straightforward. Based on the general structure, Person 2 asked Person 1 questions to clarify this structure.

The first question Person 2 asked, “How many jackets”, was meant to distinguish the shirts. There were two sets of shirts; one was part of a set of four cards and the other part of a set of five. By asking one question, Person 1 was distinguished between the two sets, eliminating the ambiguity.

Next question referred to colors. Person 2 was confused about which color Person 1 considered darker, the greenish or the purple one. A couple of sentences eliminated the ambiguity. The last question regarded the number of cards per line (row). Which card was the last one in the each row? Person 1 clarified the point and the task was finished.

Hence, authentic interaction – the dynamic act of switching roles between sender and receiver of the message – seems the best way of miscommunication avoidance. Ambiguities are managed when they occur and unnecessary repetition or redundancy is avoided.

In the previous sections, we have discussed how people communicate when they have a clear attribute to “guide” them. In the next section, we will discuss how people communicate without those attributes. Instead of describing features of something they already know about, they have to first make sense of the thing, then form and communicate a sequence somehow.

### **3.4. Communicating unknown attributes**

Previous tasks could at least two dimensions, shapes and sizes in the first one, and clothing and shades in the second. The main objective of the two tasks was to observe the effects of known structures on the communication process. Task 3 differed from tasks 1 and 2 in that it was designed with no intended structural attributes clearly identifiable on the cards.

The idea behind the task was not to observe whether people would use existent attributes to improve communication or how they would use them but what attributes

they would “build” from the cards and how they would “develop” during the communication process between the two communicators. In other words, in the absence of a clear structural knowledge, what would Person 1 use to better communicate their cards to Person 2 if their cards do not contain any attributes to ease the process? Would a structure emerge?

### 3.4.1. Task 3 design

The 6 cards were composed by lines drawn almost with no care. The only concern when drawing was not allowing the lines to cross, touch, or connect at any point, avoiding the formation of such a thing that could be identified as a cross, or a balloon, or something else that could be easily named and recognized by both subjects (see Figure 17).

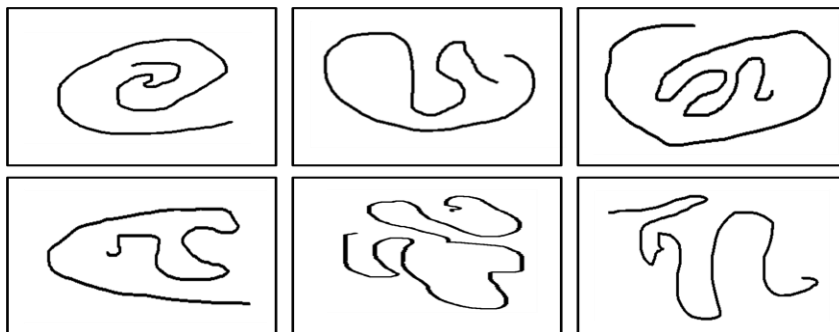


Figure 17 – Task 3 Cards named “The Things”

### 3.4.2. Procedure

The same pairs of participants who performed tasks 1 and 2 participated in task 3. There was only one round. Very simple instructions were given. Person 1 received a set of 6 cards, had to come up with a sequence, and then communicate that sequence to Person 2. Person 2 received their set of six cards, had to follow Person’s 1 instructions according to which he had to build the same sequence as Person 1.

### 3.4.3. Observations and Preliminary Results

For this task, no attributes dimension was previously set up. In fact, immediately after receiving their cards, both Person 1 and Person 2 would use expressions such as “oh my gosh”, “wow”, “my goodness” to show how surprised they were with what they were seeing. A quiet moment would come next, usually followed by a reticent “how can I describe it?” coming from Person 1. Sometimes, Person 2 would take the lead and suggest a way to go about describing the cards. If features were important before, when performing tasks 1 and 2, what would participants do now to perform the new activity without anything but lines?

Because of the absence of clearly identifiable features, participants wondered not only about how to communicate the cards but also about how to make a sequence. On previous tasks, participants organized cards based on their shared knowledge about shapes, sizes, clothing items, and color shades. Now, the absence of attributes made the organization difficult. Some participants, as those in the following example, looked for something that they could not see a hidden structure or order perhaps.

**P2: It's just random order, isn't it?**

**P1: Do you see any order in that?**

**P2: No .... I think just put them anywhere and just try to explain them.**

**P1: Yeahh .... So ....**

**P2: Well .... there's some that end kind of both on the outside versus some where its end is more on the inside.**

**P1: OK, so start with the one that like, like is almost a circle .... and inside is like, like**

**(Part of transcript Condition 3, Task 3, Pair 8, UW, 2010)**

Other groups tried to spot the uniqueness of each card. To those, the communication process would be facilitated if they could identify each one of the cards

with something else. The majority of those tried different images. They compared the lines with animals, tools, letters, or anything that could bring to their minds common categorical sets to decrease ambiguity and build their conversation. The following example shows that the interaction between both participants in this case was necessary and that the sequence became less important than the act of communication.

**P2: I can see something different in each view.**  
**P1: Yeahh, maybe, maybe, uh maybe you can sta(rt) if you can**  
**P2: Can I can I start? Or no, no.**  
**Experimenter: Do you have your sequence?**  
**P1: Not yet.**  
**Experimenter: OK, sequence them first.**  
**P1: The sequence is not important because anyhow I need someway ....**  
**P2: You can do it.**  
**P1: Yeahh .... to communicate my sequence.**  
**P2: Yeahh .... you can do it.**  
**P1: So .... uhm**  
**Experimenter: She can help you, of course.**  
**P2: I**  
**P1: So we should start to point something in each card that we can address it exclusively. I mean there should be something in each one that is unique.**  
**P2: OK, unique. Ah, I can see, for example, we can start for the roll, cinnamon roll. Haha.**  
**P1: Ah, good, a roulette? Just like, ahm, roulette?**  
**P2: Yeahh.**  
**P1: Yeahh. One of them is like a roulette. I can see that easily.**  
**P2: Yeahh? Cinnamon roll?**  
**P1: So let's put it at the.... put it at the .... put it at the ....**  
**(Part of transcript Condition 3, Task 3, Pair 8, UW, 2010)**

As observed in the example, even after the experimenter asked Person 1 to make his sequence first and then communicate that sequence to Person 2, Person 1 found that the sequence was secondary, i.e., the primary action was finding a way to communicate the cards, and then the sequence would come as the following activity. Person 1 did make his sequence though, and as they identified the “cinnamon roll” or “roulette” the card was placed accordingly.

Some “attributes” were created and named by participants. Some of these labels included fetus, a high heel boot, a dog, a letter A, @ symbol, a hurricane, and so on. Each one of the groups developed a common language on which they built the communication process. They started communicating about things they both knew about, and their understanding about the cards evolved from that. Similar cultural background, similar university program and courses, common knowledge about animals and objects, everything was used by the participants to describe the cards in terms of their uniqueness.

**P2: There’s one that kinda looks like an @ sign.**

**P1: Yes, the little swirl? Yeahh, put that @ sign first.**

**P2: Looks like an @ sign with a birds head in the middle if we have it up the same way that I do.**

**P1: Yeahh .... OK, there’s a similar one to that? I guess but this .... it’s going in the opposite direction? And it’s got a little**

**P2: claw in the middle?**

**P1: claw .... Yeahh .... humm .... keeping with the swirly themes I guess.**

**P2: The one that looks like a fetus?**

**P1: Ahm, ahm.**

**P2: Is that what you’re talking about?**

**P1: I think you’re referring to the same one, like, big bulb, and then little bulb?**

**P2: Like little hands? Like a little half– created embryo?**

**P1: Yeahh .... OK .... There’s a big U with a little, I don’t know ....**

**P2: Looks like a dinosaur .... I am way more imaginative than you are.**

**P1: I have no idea how you come up .... I don’t see any of those shapes ....**

**P2: Really?**







**P1: Yeahh ....**

**P2: OK .... OK .... If you flip that bird thing around, you can kind of see it looks like a dinosaur head but with a little paw and then the big round tail wrapped around the bottom.**

**(Part of transcript of Condition 1, Task 4, Pair 4, UW, 2010)**

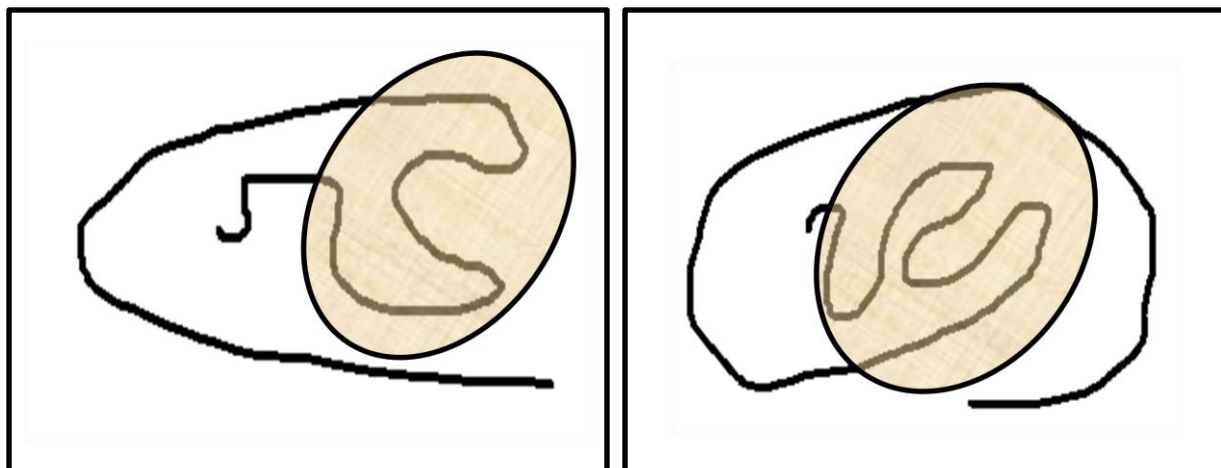
For example, one of the participants could say, “I can see a baby inside her Mom’s belly” resembling a fetus. The other person could agree and correctly identify the same image; or could agree but incorrectly identify cars; or could see nothing like that at all, even while looking at the same card. Participants perceived and compared some figures much easier than other figures. As Table 3 shows, cards number 1 and 2

were very often recognized correctly. About 30% of the participants perceived the first card as some type of a spiral or a tornado, and about 27% of participants perceived the second card as an embryo.

	1	2	3	4	5	6
						
<b>Image used</b>	40	40	40	40	40	40
Spiral /hurricane/tornado	12	11	3	3	4	2
Fetus/ Embryo/ Baby						
Small letter "e"	4	3	5	3	6	5
Balloon						
Claw/ lobster						
Letter "C"						
Dinosaur/ dog						
High heel shoes/ boot						
@ sign	3	1	3	1	3	3
Letter "F"						
Two fingers and half						
Bullet						
Monster/ Ghost						
Letter "U"						

**Table 3 – The Things as they were referred**

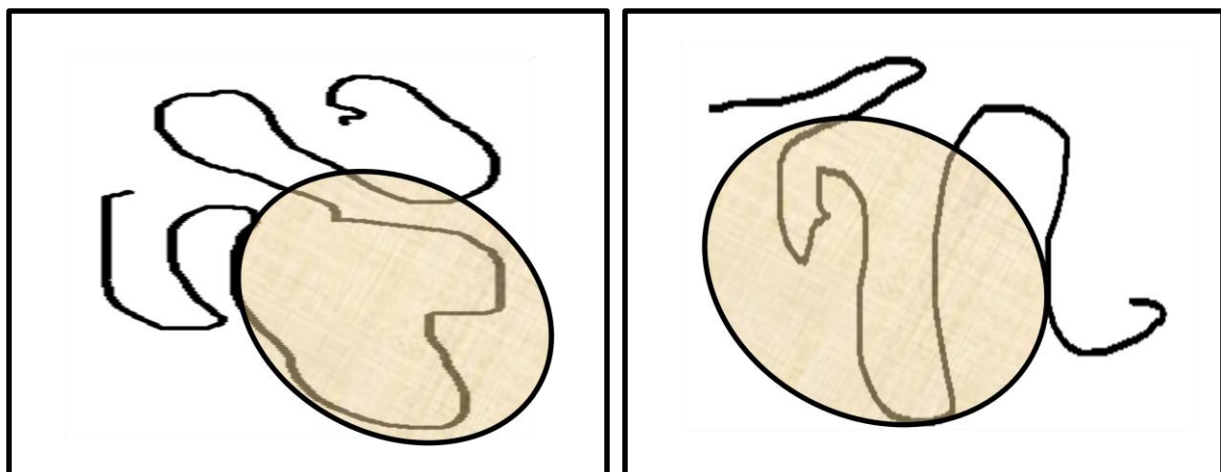
Cards number 3 and 4 were separated from the others because of a similar feature. One part of both cards was recognized as a “wrench” or a “claw”.



**Figure 18 –The Things with “Wrench” Details**

Those who grouped the two cards used a second way to differentiate them. Some used the orientation of the cards saying, for example, that one of the wrenches was pointing to the right side of the card and the other pointed towards the top. Others would try to describe where the lines started and ended or the type of line, whether it finished with a straight line or a curved one. Yet others used other images, such as letters to differentiate the first one from the second. The following letters were used: “C” (if the card was horizontally oriented as showed in the figure), “A” (if the card was moved around to the vertical position), or “V” (if the card was moved to vertical position upside).

Similarly, cards number 5 and 6 were separated from the major set and grouped together as they belonged to the same category – the category of not rounded cards, or only random lines. They were put together by some participants as they were both either shoes or boots. They were also compared to monster, ghosts, or dogs. One person would say, “I see a shoe” and the other one would agree while looking at the other card.



**Figure 19 –The Things with Not Rounded Shape**



It could take a while to solve the misunderstanding. Sometimes the participants could even say that they had finished the task without realizing the mistake. However, if one of them decided to confirm the cards and used another way to describe them, they could notice the mistake. The following example shows how the two participants figured out their mistake with the cards. Person 1 was describing the second card from Figure 19 while Person 2 was looking at the first card.

**P1: I don't know how Florida looks like.**  
**P2: You don't know how Florida looks like?**  
**P1: Why should I care how Florida looks like.**  
**P2: Ahmmmm.**  
**P1: It looks like a shoe.**  
**P2: Ha?**  
**P1: It looks like a shoe.**  
**P2: No, I don't see this, like a shoe?**  
**P1: A high heel shoe.**  
**P2: A high heel shoe? But like going to the right. So, like, the pointing part of the high heel shoe goes on the right, and the heel is like broken.**  
**P1: And the heel is broken, yes.**  
**P2: Are you sure?**  
**P1: Yes, OK, maybe I have that on the other way around, can you turn it upside down? Is it better?**  
**P2: It doesn't look like shoe anymore.**  
**P1: It doesn't look like a shoe anymore? OK, all right, let's do this, we will come back to this later.**  
**P2: OK.**  
**P1: All right, let's go, let's see the other two.**  
**P2: Ah, wait, wait, wait. If you flip, turn it around, it starts from the left, right?**  
**P1: Yeahh.**  
**P2: Does this left thing starts like kind of like a, it starts and then it bends up?**  
**P1: It bends, I am not sure what you're saying.**  
**P2: Yes, I mean like it goes.**  
**P1: Yes.**  
**P2: Ahh. And then it makes like kind of a letter U.**  
**P1: Yes.**  
**P2: And then it turns right and it goes down**  
**P1: Yes, it is another upside down U?**  
**P2: Well, Yeahh, the end, and then it goes up, and then it kind of curves a little to the right.**  
**P1: Yes, I figured that out.**  
**P2: And then it go up, and then go down, and then it goes left, way to the middle of the end.**

**P1: Yes.**  
**P2: And then it goes, turn right.**  
**P1: Good.**  
**P2: OK. How did you place that, like, place it like that, OK?**  
**P1: Yeahh, place it like that.**  
**P2: OK**  
**P1: OK, all right second one.**  
**P1: OK, second one, how do we gonna flip it, OK, start to the left.**  
**P2: OK.**  
**P1: And then you have a little kick up and you curl it down curve out and then you keep going straight until it hits one third of the card, you go down, and then you go to the left.**  
**P2: OK**  
**P1: you go straight down**  
**P2: This is going down straight or it's like slanted?**  
**P1: It's curved, like it's slanted, it's curved, it's**  
**P2: OK**  
**P1: Yeahh, it's slanted.**  
**P2: OK**  
**P1: And then it forms like a little bout and then goes up, side up.**  
**P2: And then there is straight, a very tinny straight line at to the right?**  
**P1: Yes.**  
**P2: OK. And then it makes it looks like a upside down big shoe.**  
**P1: Upside down big shoe? Oh**  
**P2: It's like a heel there.**  
**P1: Yes, yes. And then it go all the way up to the middle of the card, and then it flatten down and move right, right?**  
**P2: Flatten up and then go down and then right.**  
**P1: Yes.**  
**P2: Which makes the heel of the shoe.**  
**P1: OK, all right. OK, I know what you mean by the big shoe.**  
 (Part of transcript Condition 4, Task 4, Pair 1, 4G1, UW, 2010)

In the above example, the position or orientation of the cards on the table became crucial in task 3. During task 1, some participants had noticed that although the task performance would not be affected, placing the widest part of the card horizontally or vertically on the table would make difference on how the stars and triangles were viewed.

However, in task 3, because of the absence of something easily distinguishable and communicable, both subjects recognized that the way they had put their cards on the table would affect their view and their description of the card. Hence, long

discussions about how the cards were positioned were normal. Below is an example of how the participants tried to prevent possible problems by a previous agreement about the cards orientation.

**P1 – right.... OK. So, and you're still, still keeping them, you're still keeping the cards in the same orientation that we had before, so, like the long side is facing me, so basically what I'm saying is, if you have the card, and if you flip it upside down, or flip it the other way you want to try and make it like I said, so the most exposed one the one in the outside is facing to the right hand part, right? So, you find that you have three cards that kind of do that, right?**

**(Part of transcript Condition 1 Task 1 Pair 3, 1G3, UW, 2010)**

The expression “exposed one” refers to the “most exposed end of the line”, as mentioned by Person 1 a little earlier in the conversation.

#### **3.4.4. Discussion**

Different from task 1 and 2, task 3 was designed to study how people would communicate with each other in the absence of identifiable attributes. Six cards were specially drawn to be used during the task. The objective was to observe how participants would put the cards in a sequence and then communicate that sequence to their partners. Observations of what happened during the process and, to some extent, of group performance to finish the task were compared to observations from previous tasks.

The conditions between tasks were slightly different. Instead of 16 cards, as in tasks 1 and 2, each participant was given a set of 6 cards to complete task 3. During the pilot trials, the number of cards was 9, but since the tasks were designed to be performed by the same group of people progressively, we understood that it was unreasonable to keep that amount of cards.

Task 3 was a one-round task. The lines were excessively random; therefore, the experimenter did not have to provide a “random sequence” as in tasks 1 and 2. The cards were mixed up after each group was finished and then given to the next group to perform the task. All other conditions were kept the same. The same 40 pairs who participated in tasks 1 and 2 performed task 3 and answered the questionnaire.

Would the subjects’ performance vary given the change in the stimuli? Could we compare the results in terms of communication effectiveness? What would happen with the communication process in the absence of features? How would they make their sequence after all?

From observing all tasks and comparing the previous tasks with task 3, it seems that the presence or absence of features or attributes has a huge effect on the communication process. Even working with a small number of cards, 6 compared to the 16 cards used to complete tasks 1 and 2, the participants spent considerably more time on task 3 organizing and then communicating their sequence to their partners. Task 3 performance was more complicated compared to tasks 1 and 2 performances, even when comparing task 3 to performances on random sequences of tasks 1 and 2 .

The majority of the 40 participants playing Person 1 role made their own sequence first and then communicated that sequence to their partners. A few of them made the sequences while talking though. Yet, few participants, although they were asked not to, made changes in their sequence during the communication process to match their card sequence to the card that Person 2 was describing.

Some groups would organize the six cards into two distinct sets: the rounded things or circular lines, and the non– rounded ones. Four cards were found in the first group and two cards in the second one. Yet the groups that at the beginning of the task did not start working this way ended up reorganizing and restarting.

Among the four rounded cards, another subdivision would happen differentiating these rounded cards by images. There were four circular or rounded cards, two of them with fingers or with wrenches on them. The two other cards were described as “having free ends” or “not rounded”.

**P1: I have two groups. Group with lines, with circles.**

**P2: Humhum.**

**P1: There are four cards like this, whether they are upside down or same as I have it's gonna be like there is a certain shape .... and then the remaining two have uhm .... something .... OK? OK, the first one .... hum .... uh, let's say for the circles, I've divided them into two groups, one uhm .... it is connected from the the upper side and the lower side .... and the second one only connected on one side on the second, second side there is a space  
(Part of transcript Condition 1 Task 1 Pair 3, UW, 2010)**

If in the previous tasks, Person 1 somehow monopolized the conversation, task 3 was much more democratic. Interaction was vital here, thus the need of agreement between both persons increased noticeably. Person 2 would even suggest the sequence if it would help the communication process. Compared to tasks 1 and 2, participating dyads took turns frequently and smoothly. Cooperation and teamwork became necessary more than before.

The degree of ambiguity brought into play was so high that it was interesting to observe what happened after both subjects had agreed on one card, especially because their agreement about a card did not mean they were right. For example, both

of them saying, “I see a claw” did not mean that they were necessarily seeing the same claw.

With no categories that would allow making distinctions, participants had to bring other means to sequence and communicate the cards. They used imagination, creativity, cultural background, shared knowledge about religion, academic knowledge, common sense, and other common things.

Cards are oriented in some way; “there is a bird”, questions are raised; participants laughed at each other, quiet moment; Person 1 would then say, “it goes down and turns to left in a big loop”. Person 2 had cards turned in a different direction and said, “I cannot see it”. The dynamics of the task with high ambiguity often leads to misunderstanding. Very similar to a child learning to differentiate a dog from another animal with four legs, the participants start testing different “language” until they have something in common, i.e., something that they agree with, which then evolves into something a little bigger, and so on.

After they have agreed that they both had the same card, they could decide to move on, and confirm the sequence in the end of the task, or if one of them was still a little confused try another way of describing that same card to make sure that did have the same card. In this case, they could be stuck on that card for a long time. If they disagreed, they would go back to the card and rethink how to describe it effectively. Yet others could leave it aside and describe other cards until something different comes to mind.

Some individuals simply could not see the images at all and would realize that that kind of language would not work. Usually, for those who could easily compare the things on the cards to known objects, tools, or animals, it would take some time to figure out another way of describing the cards to the other person. In most cases, Person 2 would suggest a method that would work or even describe the cards and Person 1 would only tell the position of the card in the sequence.

Both participants frequently used repetition to assure that they had the same sequence or that they were talking about the same card. Both communicators used repetition to clarify and emphasize what they were saying, or simply to keep the conversation going while they were still thinking about or looking for a card.

#### **3.4.4.1. One odd example**

The following example is the complete transcription of the shortest conversation between a pair performing the third task. They got their cards and both of them quietly studied the six cards for 78 seconds. After that, Person 1 decided to build the sequence with Person 2 during the conversation. Person 2 suggested one way – the best for her – but Person 1 did not get the idea. Person 2 thought that talking about the “lightest” thing noticeable on each card would be the best strategy. Perhaps by lightest she meant detail, something less noticeable. For her, the cards seemed to have single details, it was their job to find those and communicate them.

**P1: OK, the first card that I want to start off with.... is.... I don't have any sequence over here, so haven't thought up any sequence over here so I'm going try to imagine, going to try and see if you and me get the same card, OK?**

**P2: Yeahh....**

**P1: Uh, the first card that I have, it's uhm, it's a letter E kind of, kind of .... like ....**

P2: Can you, I think it's better for me, to tell me just like uhm, the lightest thing that I see in the card, like four of them are the line, OK?

P1: Four of them ....

P2: Four of them the lightest thing that I see .... at the end there is a line

P1: Yeahh

P2: So.... All four of them has line under it, and it ends on the right side? And the two of them, like a circle .... Yeahh?

P1: mm.... mmm... two of them are like a circle? I have.... three?

P2: And they're at the side...

P1: I have uh.... OK... So if we .... If we first start ....

P2: OK.... one of them, one of them look just like a dog, he just

P1: A dog?

P2: Yeah .... kind of

P1: Yeah a kind of dog, a face of a dog, OK, so let's just start with this one first,

P2: OK.... so.... And another one just like a baby? Or just the face, his head off?

P1: Yeah.... Yeahh for the second one there, OK .... and the third one, it's a E.... It looks like an E? Or umm ....

P2: The letter "e"?

P1: Yeahh the letter "e".

P2: The small "e"

P1: Yeah small "e".... OK? The third one is that one.... the fourth one.... is uh.... it's like a umm... If you see Uhm....

P2: You know, one of them is like a shoe, the heel of the shoe if you look like, the other way

P1: Yeah, Yeah, Yeahh

P2: OK, forth.... And two of them

P1: Two.... one is like um like uh the one you use to uh tie a screw? like uh....

P2: One of there's a line on the right, right side,

P1 : Yeah.... There's a line that goes down.... Yeahh.... let's go that and final ....

P2 : Done.

(Part of transcript Condition 1 Task 1 Pair 7, UW, 2010)

By looking at the images recorded, it is possible to see that she had her cards separated into two sets – the four cards with rounded lines, and the two cards with no rounded lines. Once Person 2 realized that describing the cards by the end lines would not work, she moved on to another way. The use of mental images worked better for both of them. A dog, a baby, a small letter "e", a shoe, something used to "tie a screw", and the last card was not even described. They finished the task in 135 seconds.



Some interesting questions could be raised from this example. If someone reads the transcription of their conversation without watching the video or hearing their voices, it seems that finishing the task so quickly was pure coincidence. Was that mere accident, or did the structure they worked out ease their communication process?

### **3.5. Communicating Complementary Attributes**

Task 1 and 2 stimuli were very similar, and the idea was to observe the way people communicate attributes that they could easily identify on 16 cards given to them. Task 3, on the hand, was created with the opposite goal: to observe how people would communicate 6 cards without noticeable attributes. Task 4 had yet another stimulus behind it.

Suppose that two individuals from different departments of a company are talking about the same entity. They both deal with the same product – a car, for instance – but the engineer perceives only the engineering aspects of the vehicle while the marketing specialist is concerned with features that make the car attractive to the potential buyer. The cross-functional communication between both of them reflects different aspects of what they perceive, given their own specialized knowledge domains.

Task 4 was designed to give to the two individuals a partial or a complementary structure. The sequence could still be made but only if Person's 1 set of cards was put together with Person 2 set. How would the misleading structure affect their communication process? How would the participants resolve the difficulties to find a structure that would work for both of them? What would make them realize that the attributes they had known were not from the same source as before?

### 3.5.1. Task 4 Stimulus

In this last task, both individuals received two sets of 6 cards each. For the first time though, instead of having exactly the same set of cards, they were given complementary cards. Person 1 cards had apples on them and Person 2 cards had cat faces on them as showed in the following Figure 20 and Figure 21.

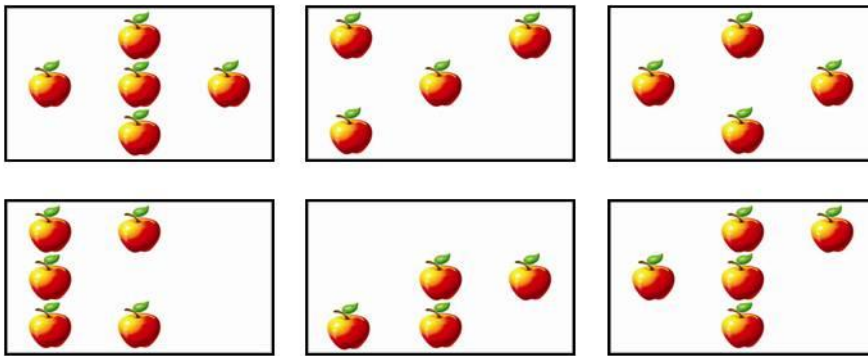


Figure 20 – Task 4 Person 1 Apples set

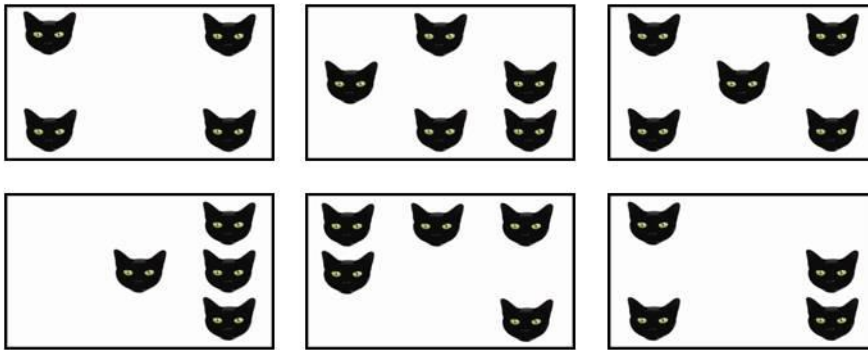
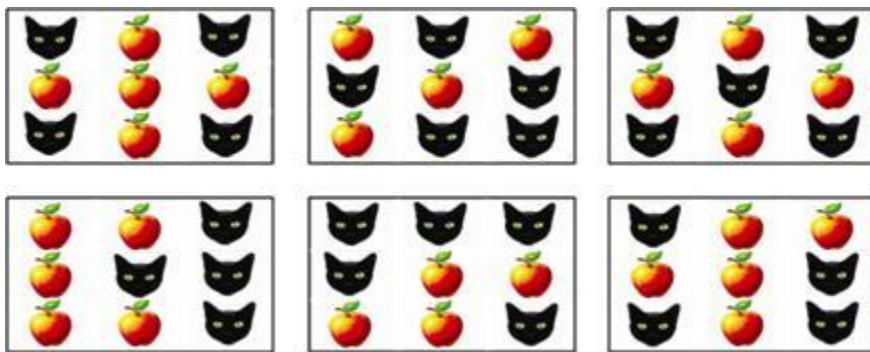


Figure 21 – Task 4 Person 2 Cat Heads set

Task 4 was designed to be performed in two different ways. In one of them, the Experimenter provided additional information (i.e., hints) in two different ways. After 5 minutes of interaction, the subjects were told that they should pay attention to not only the objects or things on their cards but also to the blank spaces. Then, if after another 5 minutes of communication the idea of complement did not come to them, Person 1 was

given a second set of cards containing the apples on it plus two of Person's 2 cards with cat faces (see Figure 23).

Conceptually, the first hint informed both participants that the structure was not complete with the figures that they could see isolated in their own cards; they had to complement that with the blank spaces that their partners had. The second hint provided information about the sequence and the correspondence between the entities (apples/cats) and cards.

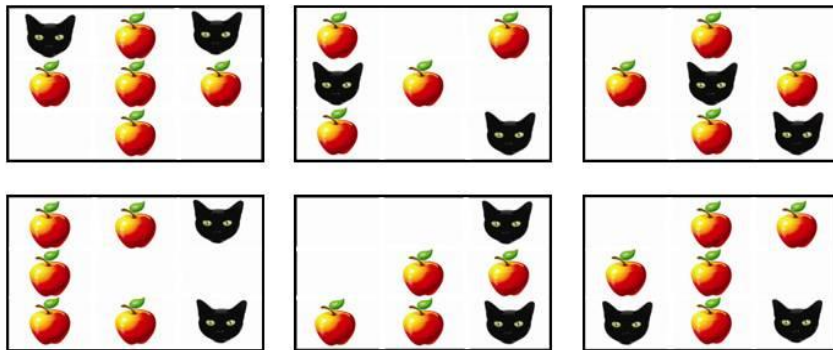


**Figure 22 – Apples and Cat Heads complimentary**

The second way to complete this task involved adding information in the form of a card itself. The researcher gave to Person 2 the first card corresponding to Person's 1 first card of the sequence (see Figure 22). Conceptually, Person 2 was getting straightforward information about the structure and its complementary nature.

How would the participants handle different sources of information? Which one would work better? Would the information provided help? In different conditions, the hints were given only to one of the individuals – either Person 1 or Person 2. Would that affect the task performance differently? How would Person 1 make use of that information? These types of questions motivated the selection of hints.

Another difference in terms of task design was that there was no time limit for the tasks before. We decided to establish a time limit for the first part of this task. After Person 1 arranged their cards in a sequence, they would have 5 minutes to communicate that sequence, or at least to figure out the complementary idea behind it. If they did not get the idea, the experimenter would interfere and give them a hint.



**Figure 23 – Task 4 Hint**

### 3.5.2. Performance

The 40 pairs were assigned to the designs randomly, i.e., a schedule was prepared with a sequence of tasks designs to be performed and pairs of subjects were assigned to available time spots. After they had finished the third task and completed the questionnaire, they were given the cards and the instructions to perform task 4. Person 1 was told to pay attention to the six cards, come up with a sequence, and then communicate that sequence to Person 2. No further instructions about the sequence or cards were given.

There was not a particular sequence that had to be made. Participants playing Person 1 role could organize the cards anyway they wanted. Any other condition was kept the same.

### 3.5.3. Observations and Preliminary Results

In this last task, as soon as the participants received their cards, they tried to find cards attributes to make their sequence. Some of them commented that they had to figure out a certain structure and make the sequence. They believed the structure would not be too complicated. Two interesting things are worth mentioning. First, they did not ask if they had received the same set of cards. Second, in general, all groups commented that task 4 should be easier than task 3, since at least now they had something tangible to start with. They said that they could count the things on the cards. The following example shows the reaction of both participants.

**P1: It should be easier right?**

**P2: Yeahh .....**

**P1: OK, this is easy, actually. Ahm .... I made two rows. Each row has three cards.**

**P2: Right.**

**P1: So the top row will have, each have five apples. So we can try to separate them that way .... and the row has four apples each.**

**P2: Four apples, so I have cats.**

**P1: Hum?**

**P2: I have cats. The face of cat.**

**P1: Cat? Oh, OK. So you have a cat. OK, so I assume that the numbers are the same. The arrangement is all the same. It's just that I have apples, you have cats.**

**P2: Right.**

**P1: Ahm, I have all apples. Do you have all cats?**

**P2: Yes, all cats.**

**P1: OK, OK, so I have five items at the top, and four items in the bottom row, each card.**

**(Part of transcript of Condition 2, Task 2, Pair 3, UW, 2010)**

Once both of them got their cards, they seemed relieved since task 4 appeared easier – they could count the apples. Person 2 would say, “oh.... cats” as soon as he or she got the cards. The interesting thing is that the other person would not hear that. Person 1 would not hear Person 2 say, “We can count the cats”, and neither Person 2

would hear Person 1 say, "We can count the number of apples on the cards".

Sometimes the words apple or cat would be mentioned three or four times before one of them would notice. The example below illustrates well this point.

**P1 – Ahm ... a apples... OK, so you... so you have five apples... you have three cards with five apples?**

**P2 – Yeah...**

**P1 – And three cards with four apples, right?**

**P2 – Yeah ...**

**P1 – So let's start with the five apples first... uh, the first one on your right uh the one that goes on the right is the one that uh it's a plus sign ... five apples card that makes a plus sign... something that's similar to a plus sign ...**

**P2 – Plus sign?**

**P1 – Yeah, add sign? Like when you add... add, subtract, multiply and divide, there's a plus sign... a card that makes a plus sign**

**P2 – For me, you know, in the three of them, one of them is uh symmetric one of them is symmetric and one of them is in the middle... the cat ...**

**P1 – Yeah, so ...**

**P2 – In the middle, the two cat are about uh... on the middle line? The two head are about oh...**

**P1 – Which one are you looking at? Like are you...**

**P2 – The five**

**P1 – The five card, yea**

**P2 – OK, so, one of them, the... the head of the cat is in the middle and it's symmetric.**

**P1 – One of them what?**

**P2 – If the shape is symmetric, the head of the cat is exactly...**

**P1 – You have a cat?**

**P2 – Is a cat**

**P1 – I have an apple...**

**P2 – Apple? haha**

**P1 – Haha ... OK... so ... hahaha ... OK ... No problem, so let's see, so uh the cats that you have umm ...mmm the five cats, right? You have five cats... so... if we look at the five cats, umm there should be... there should be three... let's see if uh...**

**P2 – Can I explain for you the ones that I have?**

**P1 – Sure.**

**(Part of Transcript Condition 1, Task 1, Pair 7, UW, 2010)**

In one specific case, Person 2, even though she realized that she had cat faces and Person 1 had apples, carried out the task until the end talking about her face cats in terms of apples not letting Person 1 know that they had different figures on their cards.

When asked why she did that, she said that if the other person knew that they had

different figures, she would be more confused. Person 2 then defended herself and said that Person 1 was wrong because not knowing was even worse since the hint did not make sense, and she did not get the idea of complementary cards even when they ended the task. She felt betrayed.

That was an exception though. In general, during the first 60 or 90 seconds, the participants would realize that they had different figures on their cards. However, 96% of the times, all groups except one (see part of the Transcript of Design1G8), ignored the difference and said, "They are different, but who cares, we still can count them and say where they are". Then they called them "stuff", "things", "items", and separated the cards in two different sets: the set with 5 items on each one of the cards, and the set with 4 items on each card.

**P1 – Uhhh, OK, there are two lines, three cards in each line? The first one is uhm only one apple in the middle, they are all...**

**P2 – Apple? ... I have a cat.**

**P1 – You have a cat?**

**P2 – Yea ... excuse me... (to the Experimenter) She has apple, I have cat**  
(Experimenter: "Yes, you're right!")

**P1 – Ha... OK... So uhm... If we say like... Is your cat like uhm... Three lines, in each column, do you have three lines of cat? And...**

**P2 – So uhm, first need to divide into two group, like total is four, and total is five.**

**P1 – Yeah, that's how I do it.**

**P2 – OK , so uhm, first one**

**P1 – So the first one is four cat, the first line is three cards with four cat, right?**

**(Part of Transcript Condition 1, Task 1, Pair 8, UW, 2010)**

Sometimes, as required, Person 1 would already prearrange a sequence. The idea behind the prearrangement was frequently the same, separating cards into two groups of three cards each – the five items cards and four items cards. However, if for

some reason it was not, Person 1 asked to reorganize the cards or just did it without even being asked to do so.

When researcher asked why they would choose to ignore the difference between cats and apples, the participants said that since their cards were equal in all previous tasks, it seemed logical to them to ignore the figures and only count the spots where they were. They thought they were being tricked by the change of figures. They did not expect another modification.

Once the assumption was made, participants divided their cards into two sets of three cards each, one with four apple or cat illustrations and one set with illustrations. The participants would then set aside one of the sets and start working with the other one. Suppose Person 1 started their sequence with cards with four illustrations. She would ask Person 2 to take her three cards with four illustrations and put the other cards aside. Person 2 would do exactly that. Sometimes Person 2 would still have two different sets in front of her but clearly pay all attention to cards with four illustrations.

To be able to match the cards without the hints, at least one of the two participants had to look at the entire set of the cards and realize that the card been described in the set would be the wrong one to put together. In other words, if Person 1 was describing a card with five illustrations, initially Person 2 started to look at cards with five illustrations; hence to be able to get the idea of the task, Person 2 had to look at the set with four illustrations. The example below shows how it happened in practice.

**P1: Cause it seems like a ... none of my cards have that ... hummm... I think... well... it feels like it's messing with us, but I wanna, I wanna make sure ... move on to the second column, the one with fives ... Here's what I have, I have one apple top left, one apple middle left, one apple bottom left ...**



**P2: top left, middle left ...**

**P1: bottom left, so three on the left side.**

**P2: Three on the left side.** (Repeats and turns back to his first column of cards, the ones with four cat heads on them, not five.)

**P1: Yeah, one on the top center, one on the bottom center, and it looks like a "C".**

**P2: OK, I'm... OK, So ... I'm got put this one at the first...**

**P1: Oh, yeah?**

**P2: This is one that matches it to the first one I guess, do you wanna do that instead? Cause I'm guessing the blank spaces that are supposed to fit with your apples, right? ... It would make sense, wouldn't it?**

**P1: Yes.**

**(Part of Transcript Condition 1, Task 1, Pair 5, UW, 2010)**

Next move would involve the agreement about the best way to describe the way these illustrations were situated on a card. Some of them would try geometrical shapes. For example, "I have a diamond" or "I have a cross" – if dealing with five items on each card. Others would suggest the idea of a 3X3 matrix, assigning 1 to a thing/item and 0 to blank space. Yet others would say, "I have a 'thing' on the left top and bottom, and another 'thing' on the right bottom and top".

**P1 – OK, are you ready? Alright ... umm ... basically, uhm. I did these in two rows, three cards... some of the cards have four apples, and some have five... so the first row has the four apples, and apples... so basically the stem is at the top right, so they're upright.**

**P2 – OK.**

**P1 – And OK, so if you have the apples on the card divided into three rows and four columns... so the first row has two apples, actually that's the only card with two apples in there, which would be the .... first column sorry, so the first column has two apples with the apple being in the first row and the third row, right? You see that card? It's one of the cards with four apples on it ...**

**P2 – Okay, which, which, row are they in?**

**P1 – Oh, you're talking about row?**

**P2 – OK, which column?**

**P1 – So column, if you're looking at the column lines, the first column has two apples.**

**P2 – OK.**

**P1 – Yeah, that's the only card actually that has two apples in the first column... you see it?**

**P2 – No ...**

**P1 – First column, column is up and down, right?**

**P2 – Yeah.**

**P1 – Yeah, so... has two apples in that 1 column.**

P2 – In column one?  
P1 – In column one... column one, row one and row three, you see that one?  
P2 – Mmm... I have... I have a card with that, but then, there is two others...  
P1 – Yeah Yeah, there's two others, there's one in the middle, and one in the top right... in column two there's one apple, and in column three there's one apple...  
P2 – OK, say that again.  
P1 – OK, column one, two apples column two, one apple, and column three, one apple ... you have that one?  
P2 – I don't think so.  
P1 – Yeah, you do.  
P2 – I don't think so, I have cats ...  
P1 – Oh ... you have cats?  
P2 – I have cats.  
P1 – OK, well it's the same thing ... So you have one with.. Okay, you have cats on all your cards?  
P2 – Yup ... hehe  
P1 – OK, well it should be the same thing then, there's cards with four cats, right? And cards with five cats, right?  
(Part of Transcript Condition 1, Task 1, Pair 3, UW, 2010)

The language would or would not stay the same, depending on how efficient it was, i.e., on whether Person 1 and Person 2 understood each other and made progress. For example, Person 1 started talking about bottom left, middle right, bottom right, and Person 2 got lost. The language was not effective at all. Person 2 would either ask to be the one describing her cards or suggest another way of talking about them.

The interaction was very intense during the task performance. There was no main communicator anymore. Person 1 did not mind whether Person 2 led the conversation or not. The only thing that seemed to matter to both of them was getting the task done. They took turns, discussed the method, stayed silent, stared at each other, and looked at the cards.

If during task 1 they were so meticulous with the position of the cards, difference among the stars, pointing of the edges of the triangles and so on, here acceptance

seemed to be the primary order. If one of them has no pattern that would resemble a diamond, they would “try the most symmetric”. “I do not have a cross or a plus sign, but I have an ex or a multiplication sign”. Increasing the tolerance level, they would “match” two out of six pairs of cards. There would be only two cards left. “Now there is one left, and nothing is going on”. “Maybe that is the idea”. “They are the last ones, they should pair up!” Both Person 1 and Person 2 considered the task finished, even though it did not make any sense.

#### **3.5.4. Discussion**

Task 4 had a unique design compared to the previous ones. The participants worked with six cards each but this time, their cards were not exactly the same anymore. The idea behind the task was to observe how people would work if each one of them were given part of the structure. Essentially, what we were doing is giving them partial knowledge of the same situation. First, how would they identify that they were sharing complementary features of the same structure? What kind of information would they need to notice that?

It was a one-round task, but it was designed to be performed in two different ways. After five minutes of trying to figure out the sequence, if the participants did not get the idea of complementary cards, the experimenter would provide a hint. Two different stimuli were created. One – used in conditions 3 and 4 – provided two hints, one after the first five minutes and the second one after additional five minutes. The first hint provided verbal information, and the second one provided visual information. The second stimulus used in conditions 1 and 2 added visual information only.

The hints provided information about the entire structure. We wanted to see how participants would use that information, and which type of information would be the most effective.

Task 4 is somehow unique due to the type of stimulus used. Thus trying to draw direct comparisons with tasks 1, 2, and 3 would perhaps not be worthy. However, the study of this task by itself brings insight to worthy questions, such as, “How people deal with uncertainty in a real figure and ground gestalt situation? How do they use information to create knowledge systems? What happens if the categories are ambiguous?”

Observing the subjects’ performance during this last part of the study was astonishing. It was amazing, for example, to observe how 96% of the participants initially ignored the difference between the cats and the apples. Their first assumption was that the last task should be easier than the previous one as soon as they looked at their cards and saw familiar illustrations that they could count.

Why something as important as the difference between a cat face and an apple suddenly disappears and counting items appears to be so imperative in that situation? Important information is given when two particular categorical sets – cats and apples – do not match any more and participants, instead of paying attention to the new feature, chose to ignore it. Unexpectedly, everything else, except counting the number of items on the cards, made no difference.

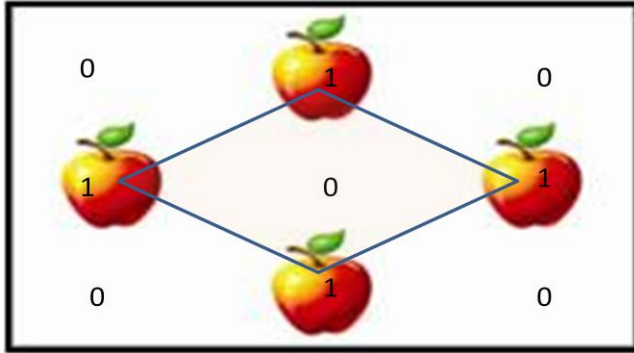
Most participants divided their cards into two sets: the cards with five items on them and the cards with four items on them. Once the cards were divided, participants

would start working with one set of cards and literally put the other set aside. That seemed to be the main cause of their problems. With their attention focused on the wrong sets, they could not see the matching cards. Only when one of the participants for some reason shifted the attention towards the other set of their cards, they both could realize that their very first assumption was wrong.

The second assumption that many groups made was that perhaps not only the items but also orientation changed. After trying to find their cards by counting the items and matching their positions on the cards, they would see that it was not possible and they would try to move their cards around to see whether the orientation of the cards – being placed horizontally or vertically on the table – would make difference. Soon they concluded that they still did not find the key.

In general, the subjects noticed that there were actually nine spots on the cards. Some of the cards had illustrations in five spots while others had illustration only in four spots filled. Part of the participants used matrix language to talk about the spots. The spots that contained items were labeled as 1 and blank spaces as 0. Thus, a card as the “cross” or “plus sign” would be described as 0,1,0 – 1,1,1 – and 0,1,0. The matching or corresponding card would be the “diamond” – 1,0,1 – 0,0,0 – and 1,0,1 (see Figure 25).

Similar to what happened in task 3, there was good interaction between the two participants. The interaction was very democratic. Participants took turn smoothly and cooperation and teamwork emerged naturally. It does not mean that individual contribution was not observed though.



**Figure 24 – Binary understanding of Apples and Cat Heads**

Sometimes, the individual who noticed the complementary idea, either because of a good understanding of the hints or due to a card description received from the other person that worked well, did not tell their partner what was going on. On the contrary, he or she started describing their partner cards and communicating the sequence of that card. In this case, there was no interaction; instead, one person directed while the other completed. The following partial transcription provides an example.

(Experimenter – asks P2 “did you get the idea?”)

**P2 – I did not get it.**

**P1 – Okay, the thing is you have ... Our cards are inverted kind of, so where you don't have ... where you have cats, I have blanks, and where you have blanks, I have apples.**

**P2 – Okay.**

**P1 – So we have to basically make one card**

**P2 – Okay, I was so confused in the beginning, and then all of a sudden you got it, and I couldn't figure it out and you stopped describing your cards, and I just...was like, what did I miss? Hahaha ...**

**(Part of Transcript Condition 1, Task 1, Pair 3, UW, 2010)**

In this case, Person 1 gave the explanation to Person 2 at the end of the task. The experimenter asked Person 2 whether he understood the task. He said that he did not. He realized that Person 1 stopped describing the cards and got confused. Person 1 felt he had missed something. For all cases where one individual found the key behind

the task – the complimentary idea – and instead of discussing it, started making the cards sequence by describing the cards of their partners, their partners did not get the idea of complementary structure.

The degree of ambiguity was also high in this task. However, different from task number 3, the ambiguity here is not based on the absence of features or attributes. The cards in this task comprised clearly identifiable attributes; however, instead of providing helpful information, these attributes mislead the subjects. The features seem to emphasize something that is not useful at all in accomplishing the task – matching the number of items on it and their position on each card. In fact, it is quite the opposite, as participants were required to match different figures by complementing one card with the other, as in the *TIC TAC TOE* game.

Imagination and creativity were still used to help them communicate the cards. Even when thinking that they had figured out the way the cards were structured, they still had to discriminate the cards and communicate them. To talk about the cards, participants developed some languages. For example, some participants tried to compare what they could see on their cards with something familiar to them, for example, a letter “C”, a “diamond”, a “plus sign”, a “cross”, an “x”, a “Z”, “a triangle”, “square”, a “parallelepipeds”, and so on.

The existing ambiguity made the subjects ignore the difference between cats' heads and apples. This first big categorical distinction would have been made in normal circumstance. Important theoretical questions emerge from this situation. Why do people seem to develop “tolerance” to the unusual in certain circumstances? To what

extent is ambiguity responsible for this tolerance? Is there a degree or a scale of tolerance allowable? What role does information play in this context? Does information decrease the degree of tolerance? How does it work? What is the relationship between information, knowledge, and the level of ambiguity of a situation?

### **3.5.4.1. One odd example**

The following example is an interesting one. The participants understood the complementary idea almost immediately, roughly 60 seconds after they had started the task. However, the language they developed to describe the cards was still not working very well and they got lost during the task. Although they did not need the hint after the five minutes, the experimenter felt that it was necessary to inform them that the sequence was wrong even with the right idea.

**P1: Ok we have three cards that have a... four apples.**  
**P2: Yeah...**  
**P1: And we have a...**  
**P2: Apples?**  
**P1: Yeah, apples.**  
**P2: Ok, apples. I see. I guess we have the same a... the same number but not the same ...**  
**P1: Yours are not apples.**  
**P2: Picture.**  
**P1: Ok, we also have a... four cards with five apples, right?**  
**P2: Ok.**  
**P1: A... Ok, let's divide them into two groups.**  
**P2: Yeah.**  
**P1: And the, Ok, let's divide them into two groups, we first we first sequence the one with four apples.**  
**P2: OK**  
**P1: OK. The first one are four apples, each one of the four apples are placed, we are dividing to a... four quadrants.**  
**P2: Four what?**  
**P1: Four quadrants, let's say north, south, east and west.**  
**P2: Ok.**  
**P1: Ok each apple is exactly is on the four sides of the card, Ok**  
**P2: Four sides of the card?**  
**P1: Upper one apple, lower one apple, left one apple, and right one apple.**



P2: Aham, ahm. But actually... I don't have that kind of card. I have four... have cats but four cats are on each corner of the card.

P1: Each corner?

P2: Yeah.

P1: Mine, are not each corner? But they a... the apples is in the middle of the upper side of the card

P2: No, none of my cards has any a... cat at the middle of a...

P1: Ok. None of the cats is in the middle. OK. But ok do we have a card which a... none of your cats is in the middle of yours cards?

P2: Very middle.

P1: Very middle, which is the geometrical center of the card.

P2: Geometric center, a... I have three cards, yeah I have two cards without any cat in the geometrical center.

P1: Ok, so you have two cards that has ... Oh my God! Ok, I think I got the idea maybe the spaces in your card is referencing to apples in my cards, and the space in my cards are referring to cats in yours cards.

P2: Maybe. I think.

P1: Maybe, let's do this way. Ok, a... I can see you have only one card with cats that is at the geometric center of the card, right?

P2: Yes.

P1: Ok, place that one first.

P2: Ok my cat in the geometric center that corresp, that, ahm, corresponding to you card with no apple in the geometrical center.

P1: Ok, now we got the next two. The next one is the easier to identify if we divide the card in three area horizontally, oh, no, no, vertically.

P2: Vertically.

P1: A Upper part , middle part, lower part.

P2: huhum

P1: This one I have two apples as middle part, two apples as lower part, none of them at the upper part.

P2: None of them, a... upper part.

P1: The other card I got in hand has no, a..., it has apples in all the three parts, which upper part has two apples, lower part, middle part has one apple, and lower part have one apple.

P2: A... are you placing the card vertically?

P1: No, horizontally.

P2: Horizontally, OK. And then, pardon me. Describe more.

P1: OK when you place your card horizontally you can divide your cards in two, into three area.

(5 min: Since they had the right idea the Experimenter only said that the first card was still wrong)

P1: Do you have, after you placed all your cat, all your cards ahm, after, ahm do you have a card with three cats either in the bottom, at the upper part or the lower part?

P2: Upper part?

P1: Three cats.

P2: Three cats? Yeah.

P1: So place that one is the second card.

P2: OK. I have three, OK, I have one card that has a... three cats on my right-hand side, and it level have one cat.

P1: OK.

P2: And a cat in the middle.  
P1: OK.  
P2: In the centre.  
P1: OK.  
P2: Do you? Do you have one?  
P1: Yeah that's the second one.  
P2: That's the second one? OK.  
P1: OK. What's the third one?  
P2: Third one, OK I tell you I have a card that have a four cats in each corner of the card. So I guess that corresponding to the card that you have each apple at the middle of the side.  
P1: Wait. If, if, I, I ahm . Ok let's make it this way, Ok, ahm, if we treat the, if we treat the space as  
P2: Humhum  
P1: Cats in your cards.  
P2: Humhum.  
P1: So the first three we need to sequence are actually those cards with five cats.  
P2: Ok, I see.  
P1: Ok, OK, the first card is the one with four cats in the corners and four cats in the middle.  
P2: Four cats as each corner.  
P1: Yes. Ok? Ok the second card will be three cats in the upper part of your card, one cat in the middle, and one cat as the lower right corner of your card.  
P2: Lower right, yes.  
P1: Ok. The third one will be the one cat in the upper part.  
P2: Humhum.  
P1: Two cats as the middle part, but the two cats, none of the two cats as the geometric center of the card.  
P2: Humhum  
P1: And two cats in the lower part, which is on, the, the, right hand side of the lower side.  
P2: Humhum  
P1: Ok the next one you need to sequence is the one with four cats.  
P2: Yeah  
P1: OK? Ok the first should have four cats, each of them on the four corners of the card.  
P2: OK Yeah.  
P1: Ok, the second one will be ahm, there is one cat at the geometric center of the card.  
P2: OK.  
P1: And the other three cats are all on the right-hand side of the card.  
P2: Humhum.  
P1: Oh left-hand side of the card, depend of how you place them.  
P2: Humhum  
P1: Ok, the very, the very last card, the very last one is if you, no cats in the geometric center of the cards.  
P2: Humhum  
P1: Ok one cat ahm there is one cat in the middle part of the card, two cats as the lower part of the card, but the two cats are, ahm... each corner, left corner

and the right corner and one cat is on the upper left part of the card, is that correct?

P2: Humhum. You mean only one corner doesn't have a cat?

P1: Yeah. Only one corner does not have a cat.

P2: Ok.

P1: Ok, let's double check, the first one you have five cats.

(Part of Transcript Condition 2, Task 2, Pair 2, UW, 2010)

The conversation does not end here though. The participants confirmed the sequence of all cards once more. As mentioned before, Person 1 comprehended what was happening with their cards almost immediately. Watching the videotape we observed that in the beginning, Person 1 tried to separate the cards into the two sets – five item and four item cards – but did not separate them physically. After Person 1 described one of their cards to Person 2 (one apple on each side of the card: **north, south, east, and west**), Person 2 said that he did not had a card like that and told him what he had (cats in all four corners), perhaps one of the most similar cards.

Person 1 was astonished that he has an apple in the middle of the card. Person 2 gives him another piece of information saying that he has no cards with cats in the middle of the card (**I have two cards without any cat in the geometrical center**). In terms of information, it was enough for Person 1 to realize that they both had “matching” cards (**maybe the spaces in your card are referencing to apples in my cards, and the spaces in my cards are referring to cats in yours cards**).

However, Person 2 did not get the idea. The language developed by Person 1 to describe the cards in terms of lower part, upper part, geometrical center, and by dividing the cards in quadrants did not seem to work very well for Person 2. Suddenly, the only thing that seemed important to both of them was whether the center spot was occupied

or not. With attention towards the center, they started working out their sequence, but it was wrong.

After five minutes of interaction, the experimenter interfered and said that they had the right idea but the sequence was wrong. They went back to the beginning to figure out what was wrong. Person 2 was still keeping the idea of matching five items with five items and four items with four items. For him, the entire logic was only behind the figure (apple or cat) positioned in the center of the card. He was not observing the other cats or apples at all.

It seems that ambiguity is everywhere in the communication process. The categorical knowledge people have are often ambiguous. The information generated and interpreted by those categorical systems is naturally very ambiguous. The language we use to communicate the selected messages adds more ambiguity to that. How do people handle that amount of ambiguity? How can we still communicate with and understand each other? How can we quantitatively measure the role of information as a helpful tool for handling different information? Those are important empirical questions.

### **3.6. General Discussion**

Comparing observations between previous tasks performances 1 and 2 and the latest 3 and 4, it is possible to draw some conclusions. The same stimulus was used to design Tasks 1 and 2 cards. Two different known categorical attributes were used in each one of the tasks that had to be communicated from one person to another one. The intent was to study whether communication would be affected in the context of

known attributes. Using similar stimulus but different attributes not only validated the study but also allowed to compare task performances.

On the other hand, task 3 was designed to observe how the absence of known structure would affect the interaction between people. Participants had to rank cards with random lines and then communicate the sequence to each other. In the context of unknown categorical attributes, communication was influenced by task motivation.

Compared to the preceding tasks, task 4 had a different and unique stimulus. The cards that each member of the dyad received were complementary to each other rather than the same. The objective was to observe how people with only partial knowledge of the situation would communicate with each other. Perhaps this could be the best scenario to study what happens to both systems at the same time – the categorical set and the information system – and their relationships with the communication process.

Some comparisons could be made among the four tasks. Hence, four experimental conditions with five rounds of tasks were designed for this purpose. This thesis reports only qualitative comparisons between random prearranged sequence task 1 given by the experimenter and non-random sequence made by Person 1, and between random prearranged sequence task 2 given by the experimenter and non-random sequence made by Person 1.

We also compare different tasks to understand what happens between people when communicating known attributes (tasks 1 and 2) and unknown attributes (task 3); people communicating known attributes (tasks 1 and 2) and complementary attributes

(task 4); people communicating unknown attributes (task 3) and complementary attributes (task 4).

### **3.6.1. Task Coordination**

Compared to tasks 3 and 4, tasks 1 and 2 were in simpler. The stimuli used in the third and fourth cards made the scope of the task complex. Due to the task's difficulty and complexity, mutual adjustment coordinated the relationship between Person 1 and Person 2. A mutual effort to understand each other and finish the task lasted throughout the tasks performance.

It does not mean that there were conflicts while performing tasks 1 and 2. All that it means is that sender and receiver of the message are mutually dependent of each other. In fact, the role exchange happened so regularly and so effortlessly that it felt almost as only one role or one character existed.

Constant communication was required between the parts to make sure that coordination requests and expectations were met and that activities were performed with maximum effectiveness and minimum confusion. The nature of the stimuli present in tasks 3 and 4 required dynamism and collaborative behavior on the part of participants in order to prevent them from coordinating their activities with mechanisms other than mutual adjustment.

Tasks 1 and 2, on the contrary, allowed individuals playing Person 1 role to speak most part of the time of the experiment performance. Person 2 could just nod while listening to Person's 1 commands or keep saying "OK", repeating key words, or murmuring something inaudible. Questioning was rare since almost no uncertainty or

ambiguity was present. Sometimes real difficulties occurred and had to be dealt with; however, these were insignificant compared to those that occurred in tasks 3 and 4.

The amount of ambiguity generated by tasks 3 and 4 was much higher than the amount generated by tasks 1 and 2.

### **3.6.2. Task Ambiguity**

The fact that the subjects demonstrated almost no difficulties communicating sequences when working within two different contexts under the same stimuli conditions indicates that structural knowledge reduces ambiguity in the communication process. In other words, if the amount of ambiguity, which is structurally shared by the sender and the receiver of the message, is small, it is easier for both of them to select and interpret information.

On the other hand, as the amount of ambiguity increases, as in tasks 3 and 4, adjustments are needed to make the information come through. As the tasks became more complex, the categorical sets of the communicators did not match anymore. Thus, participants had to interact and communicate more.

As observed, differences among stars, among the grayish colors in task 2, between male shirt and the sweater in task 2, and the hierarchy among categories and subcategories in tasks 1 and 2, all of which have different attributes, increase the amount of ambiguity in the communication process, causing misunderstandings and miscommunications.

### **3.6.3. Categorical Set Hierarchy**

Observations seem to indicate a hierarchy among certain categorical attributes. Tasks 1 and 2 performances showed not only that people rely highly on known attributes to communicate to each other, but also how they use these attributes in two different contexts – when dealing with categorical sets as geometrical shapes and sizes as well as clothing items and shades of blue. The experiment pointed out to the existence of a hierarchy among categorical knowledge, i.e., some categories seems to be more salient, such as shape compared to size, for example.

On the other hand, there are categories that can work both ways, not only as main categories but also as subcategories, depending on the focus of attention given to them. For example, blue shades could be considered as a category itself or a subcategory, depending on the degree of ambiguity brought to the task by the person playing Person 2 role or by the situation itself. As discussed in section 3.3, if Person 2 had demonstrated a big problem dealing with the blue shades, Person 1 would rank their cards first in terms of color rather than clothing pieces.

As discussed before, among the geometrical shapes and sizes used as stimuli in task 1, size was never used as the main structural set. None of the participants playing Person 1 role ranked their cards first in terms of size and then in terms of shapes. All of them prioritized the shapes. Within each shape, size appeared as the next hierarchical identifier.

In contrast, the hierarchy was less prominent when performing task 2. Although the amount of participants ranking their cards using pieces of clothing was considerably



higher than was the amount of participants who ranked cards based on blue shades, both categorical sets belonged to the same level.

Figure 15 shows the way this hierarchy worked for the two categorical sets in tasks 1 and 2. It also illustrates that clothing and blue shade can both be used as the salient categorical set regardless of shape and size. Shape rather than size seems to be more salient to people. Perhaps because more complicated measurements are involved regarding size.

Grouping the cards in terms of size first and then distinguishing them by their geometrical shape would mean calculating the areas of the geometrical shapes printed on the cards. Since this measurement is not easily accessible in comparison to the alternative, that is, the difference between the geometrical shapes themselves, it seems reasonable shape, as a categorical set, appears more salient than size.

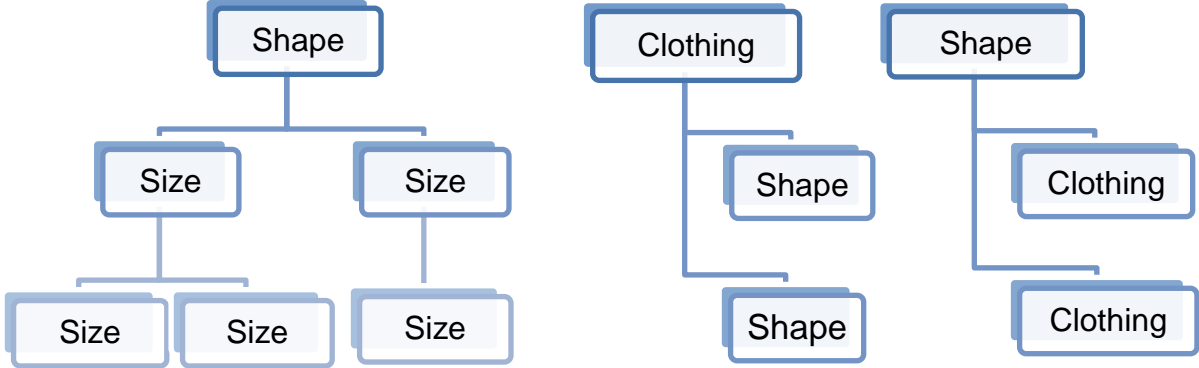
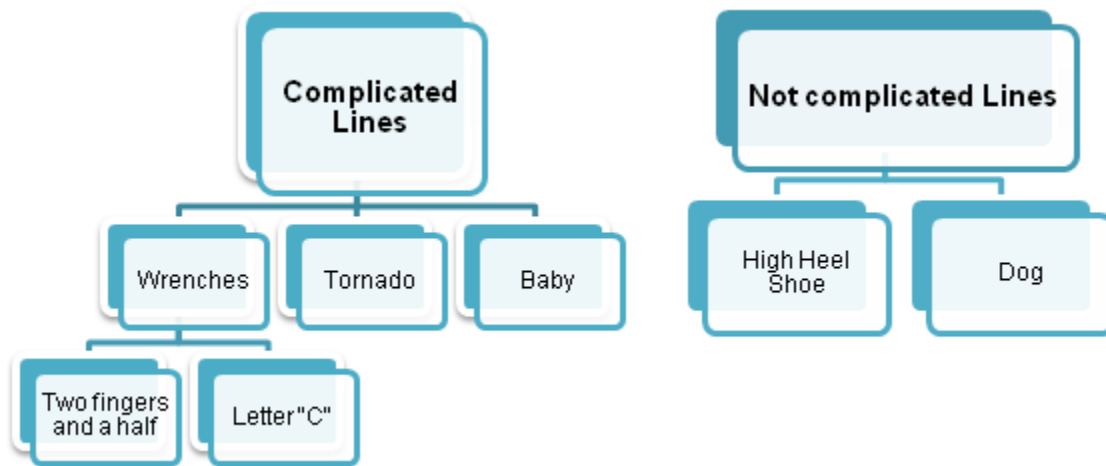


Figure 25 - Task 2 Hierarchy

A similar thing could also be happening in the third task. During the task performance, participants chose two similar strategies to communicate the “things”

printed on the cards. The lines and the use of mental representations, i.e., comparing the lines on the cards with known animals, tools, or objects to make the distinction among them easier to both participants, were the most used means.

Although rigorous analysis and credible measurement had yet to be developed, observations point out that both categorical sets are interchangeable as grouping sets. In other words, either the outline or drawing of the lines or the visual images formed by the participants while looking at them were used as a starting pointing of distinction between the cards. The following figure (Figure 26) provides an example of how this kind of hierarchy works during the third task.



**Figure 26 – Task 3 Hierarchy**

In the fourth experiment, someone could argue that participants should have made the categorical distinction between apples and cats' heads first. However, it did not happen. The first distinction made by all of them, except one pair, concerned the number of contents printed on every card. They separated the cards in two sets, the set of cards with four items and the set of cards with five items.

Hence, it looks that the amount of illustrations is more salient than the difference between those things, at least in the context of the experiment. Perhaps the participants were influenced by the previous tasks where the content cards were the same. Since they could not match the images printed on the cards, the next reasonable alternative was to make the number and the position of the items the same. Further studies are still necessary to confirm the proposition though.

Further studies have to focus on the role of information in the communication process, how it simultaneously, selects an item from a person categorical set to be communicated, and creates and expands that person's categorical set. In other words, how the grouping of items affect communication but at the same time communication can also affect the grouping of items. What is the influence of known attributes in that process?

This part of the study did not focus on the measurements. A good method for measuring accurately the effectiveness of the communication process needs to be developed. Future research should focus on quantitative measurements. All further comparisons, including participants' performance when manipulating random and non-random sequences, need to be investigated in the future.

## Chapter 4

### Conclusion

Three main questions were considered in this study. How do people communicate to each other in the context of known categorical attributes? How do they communicate in the context of unknown categorical attributes? What happens during the communication process when structural attributes mislead attention?

We have suggested that information and knowledge are intimately connected to each other, as in a duality, in the communication process. The selection of the message to be informed is dependent on the structural set in which that one item is embedded for the informer. On the other hand, the interpretation of the message received is dependent on the structural set of the person informed. Due to the information and categorical knowledge duality, communication effectiveness depends on the degree of match between sender and receiver's structural sets.

As shown in experiment 1 and 2, people rely on known attributes to communicate. The presence of those characteristics helps people to group or classify things easier, eliminating uncertainty. Once uncertainty is reduced, the need of information is also reduced, thus communication happens smoothly. Experiment 3 suggested the same. In the absence of known attributes, people tend to develop some.

When dealing with lines randomly drawn on 6 cards, individuals performing the third experimental task perceived distinctive attributes on the cards by looking at the endpoint of the lines or at the number of curves. Some of them identified and associated

the cards with certain objects (e.g. tools, animals etc) in the real world. By drawing such distinctions, they were able to group the cards into smaller sets and reduce the number of potential outcomes.

Experiment 3 also showed that when no clear attributes exist, communication becomes more complicated. Although uncertainty tends to decrease as the number of outcomes decreases, the level of ambiguity is very high from the beginning of the task until the end – both people are still in doubt if they are talking about the same thing until the end of the task. The necessary mechanism to coordinate interaction is mutual adjustment, which implies a higher amount of role exchanges between speaker and listener.

A practical implication of experiments 1, 2, and 3 can be easily observed in the communication process. Misunderstandings are less likely to happen when the individuals are communicating based on attributes which are available to both of them in their categorical sets. For example, electrical engineers are unlikely to misunderstand each other while talking about Ohm's Law.

However, the same does not apply if they are talking about how to decorate their houses, or how to raise their children. Rather than on technical knowledge, decoration or children education are activities highly dependent on individual perception, thus it should not be a surprise that engineers would have different tasks performance. Even psychologists would differ from each other in those matters.

Experiment 4 brought to attention how important individual perception is to the communication process. In a cross-functional situation, two different individuals

perceive the same entity according to their different capability of dividing the world. To communicate to each other, they have to be able to find a common ground from where both of them can build their understanding. Finding that common ground, sometimes, can be a real challenge.

Observations showed that since both people involved in the interaction are dealing with individual partial knowledge, they are often misled by false information. Once a false lead is taken, much time and information are wasted until the process is restarted. As in task 3, ambiguity is very high and mutual adjustment necessary to coordinate the interaction between speaker and listener.

The practical implications of the above findings can be realized in terms of typical communication scenarios. In a work situation, for instance, one individual from marketing may wish to communicate to another individual from engineering. Experiment 4 suggests that due to different perception capabilities and interests, it is expected that both individuals perceives the same entity differently and misunderstandings will happen. Hence, some measures should be adopted to facilitate communication between them, perhaps a “translator” – a third person who knows both of their fields (Tabatabai, 2009).

### **Limitations of the Study and Future Research**

The foremost limitation of this thesis is that this is a twofold study – this part is qualitative, mainly the report of the task performances; ongoing studies are dedicated to the quantitative part, all the measurements and comparisons missing here. An accurate

method to capture the dual relationship between information and knowledge is still needed.

Additional attention has been given to the data collected to see how the description of items changes over time and how people adjust their descriptions when communication fails.

The number of cards used by the participants to perform the third task restricted the activity performance. Tasks 1 and 2 were designed with 16 cards each. Originally, task 3 had 9 cards on it. However, during the pilot trials we observed that it would not be reasonable to invite the subjects to perform five rounds of task, around two hours and thirty minutes, of such a difficult activity.

The small number of cards, however, causes important drawbacks. The amount of time spent during the performance cannot be accurately compared with the amount spent during the tasks with larger amount of cards, for example. More important though, since the finite set is reduced, the number of possible choices is smaller too, thus the need of explicitly organizing or structuring the cards to minimize ambiguity decreases.

In other words, if the number of cards in the third task was as high as the 16 existent cards in the previous tasks, the participants would probably feel much more necessary to separate cards in small sets to facilitate the work. Perhaps they would try to categorize by similarity – similar shapes, or clothing items – and then subcategorize by dissimilarity – size, or colour – as they had done before.

Setting 5 minutes to give the hints to the participants in the last task was a source of limitation too. By doing that we were not able to observe how the participants

would be able to solve the question on their own without any hint. As other participants figured that out, those that did not during the initial 5 minutes may have done so eventually. It would be very interesting to observe the evolving process of that achievement.

Repetition and redundancy are definitely some of means used in the communication process to emphasize, clarify or even explain the message being informed. However, in a reward context, or in a “test” situation many people tend to overuse those means. The experiments could be considered one of those situations. The incentive offered to them, although not much significant, and the fact that their images and voices would be used for a scientific study, could alter their behaviour.



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Sons Inc.

## Appendix A – Instructions

I'd like to welcome you both and thank you for your time.

You will work in pairs and I might refer to you as Person 1 and Person 2. I will give you some cards to work with. Person 1 will be always the main communicator although Person 2 can talk even asking questions. There are no constraints about what you talk but you cannot see each other cards until I say so. The experiment has 4 parts, and I will be given you instructions to each one of them.

**Round 1:** For the first round, I am giving 16 cards to both of you. Person 1 is getting those prearranged some way. I'd like her/him to take some time, look at the cards, and communicate to Person 2 what s/he got. Both of you should have the same formation in the end. When you are done, please let me know. Make good use of communicative interaction to accomplish the task. Try to make the interaction effective by giving feedback of what you have accomplished.

Remember, you are not allowed in any hypothesis to show cards to each other. At the end of each round I will be asking you some questions. For example, what kind of difficulties you experienced to get the task done. You might start now.

**Round 2:** I am giving to you another set of cards. This time though there is no previous arrangement. Person 1 will figure out how to line them up, and then describe it to Person 2. Same rules still apply – interact and do not show the cards to each other.

**Round 3:** Now you are receiving the third set of cards. This task is very similar to the second one. Person 1 will arrange the cards in some way and then describe that to Person 2.

**Round 4:** Nothing has changed too much, same rules, same activity.

(They will work for 10 min with the first set of cards)

Ok, I will give you some extra cards. I am not taking the first set out. Working with both sets might make easier to understand what is going on.

(They will work for other 10 min. If they figure out what is happening and start working toward the goal, I will give them more time until they finish. If it doesn't happen I give them the third set.)

How about I give you extra help? Here I have an additional set of cards. I guess you can finish the task now.

## Appendix B – Invitation

### 1. Undergraduate Students

#### University of Waterloo – Department of Management Sciences

#### Participants needed for research on Structure and Information

You are invited to participate in an experimental study of structure and information. The objective of the research is to examine the relationship between information and structure.

As a participant in this study, you will be asked to:

Communicate to another student a prearranged sequence of cards; come up with your own sequence of cards, and then communicate that sequence. To reach the goal, it will be necessary attention to the sequence, and information sharing.

The whole experiment takes from 1-2 hours to complete.

You will receive **up to 3 bonus marks** for MSCI 311 depending on your performance.

This study will be hold between March 17<sup>th</sup>, 2010 and March 30<sup>th</sup>, 2010.

To sign up for the study, please select at least 3 of the timeslots that fit your schedule from the list below and email your timeslots to:

Student Investigator: Geovania Pimenta, Department of Management Sciences

Office: 3642, Tel: 519-888-4567 Ext. 38634

Email: [gdpiment@uwaterloo.ca](mailto:gdpiment@uwaterloo.ca)

This study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. There are no anticipated risks associated to participation in this study. Your group will be video-recorded during the experiment for data collection purposes only. All personal information collected will be kept confidential and no individual will ever be identified in the final results.

Thank you for helping us out in our research.

Principal Investigator: Prof. Rob Duimering, Department of Management Sciences

Tel.: 519-888-4567 ext. 32831

Email: [rduimering@uwaterloo.ca](mailto:rduimering@uwaterloo.ca)

## 2. Graduate Students

### University of Waterloo – Department of Management Sciences

#### Participants needed for research on Structure and Information

You are invited to participate in an experimental study of structure and information. The objective of the research is to examine the relationship between information and structure.

As a participant in this study, you will be asked to:

Communicate to another student a prearranged sequence of cards; come up with your own sequence of cards, and then communicate that sequence. To reach the goal, it will be necessary attention to the sequence, and information sharing.

The whole experiment takes from 1-1:30 hour to complete.

You will receive **up to \$15.00** for your participation depending on your performance.

This study will be hold between March 20<sup>th</sup>, 2010 and April 6<sup>th</sup>, 2010.

To sign up for the study, please select at least 3 of the timeslots that fit your schedule from the list below and email your timeslots to:

Student Investigator: Geovania Pimenta, Department of Management Sciences

Office: 3642, Tel: 519-888-4567 Ext. 38634

Email: [gdpiment@uwaterloo.ca](mailto:gdpiment@uwaterloo.ca)

This study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. There are no anticipated risks associated to participation in this study. Your group will be video-recorded during the experiment for data collection purposes only. All personal information collected will be kept confidential and no individual will ever be identified in the final results.

Thank you for helping us out in our research.

Principal Investigator: Prof. Rob Duimering, Department of Management Sciences

Tel.: 519-888-4567 ext. 32831

Email: [rduimering@uwaterloo.ca](mailto:rduimering@uwaterloo.ca)



## Appendix C – Assignment of tasks to pairs

	Condition 1	Condition 2	Condition 3	Condition 4
Pair 1	X			
Pair 2		X		
Pair 3			X	
Pair 4				X
Pair 5	X			
Pair 6		X		
Pair 7			X	
Pair 8				X
Pair 9	X			
Pair 10		X		
Pair 11			X	
Pair 12				X
Pair 13	X			
Pair 14		X		
Pair 15			X	
Pair 16				X
Pair 17	X			
Pair 18		X		
Pair 19			X	
Pair 20				X
Pair 21	X			
Pair 22		X		
Pair 23			X	
Pair 24				X
Pair 25	X			
Pair 26		X		
Pair 27			X	
Pair 28				X
Pair 29	X			
Pair 30		X		
Pair 31			X	
Pair 32				X
Pair 33	X			
Pair 34		X		
Pair 35			X	
Pair 36				X
Pair 37	X			
Pair 38		X		
Pair 39			X	
Pair 40				X

## Appendix D – Pilot Test Cards

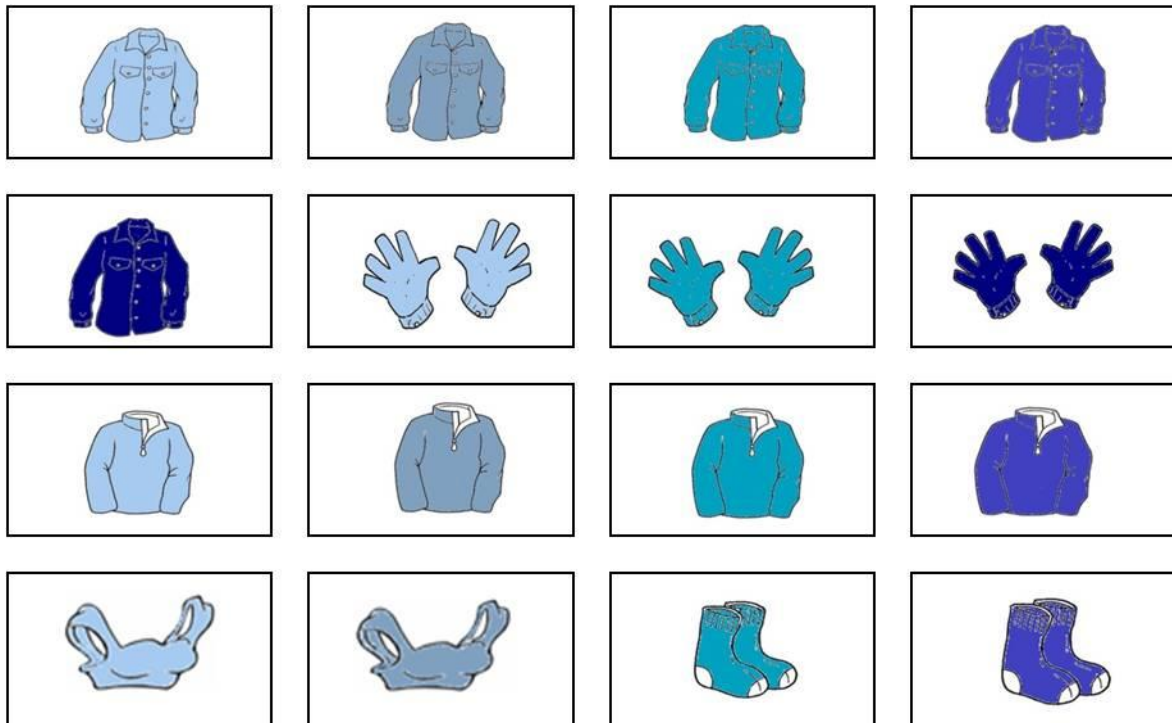


Figure 27 – Task 2 Pilot Test Cards

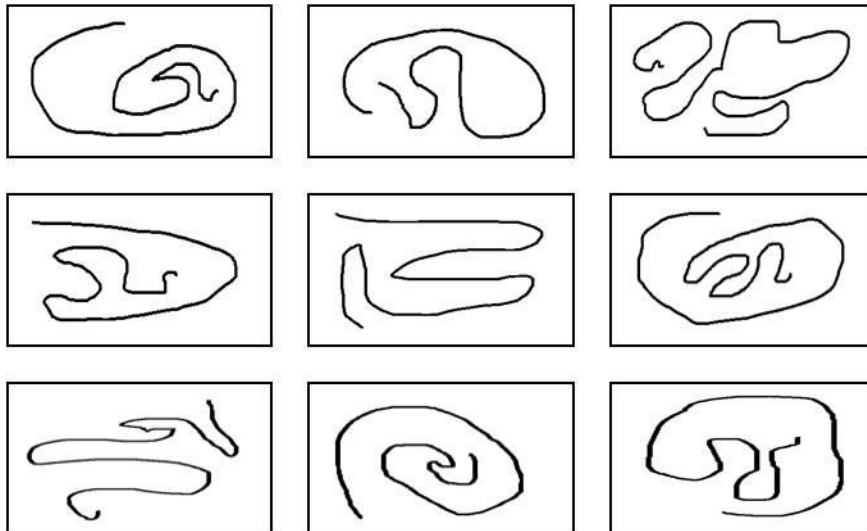


Figure 28 – Task 3 Pilot Test Cards

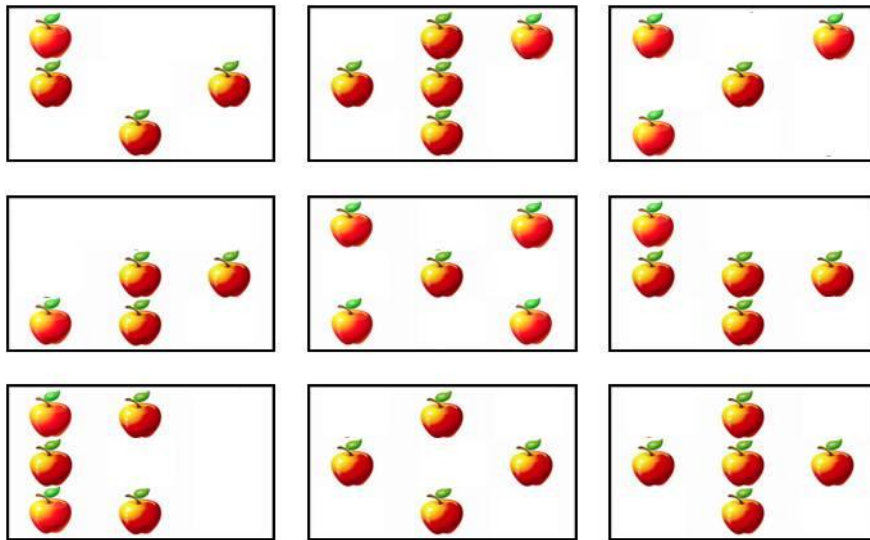


Figure 29 – Task 4 Pilot Test Person 1 Cards

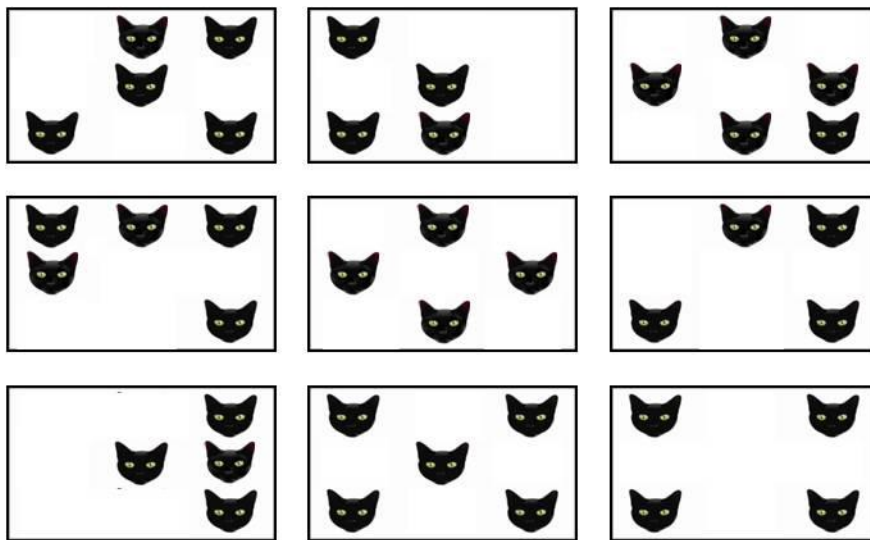


Figure 30 – Task 4 Pilot Test Person 2 Cards

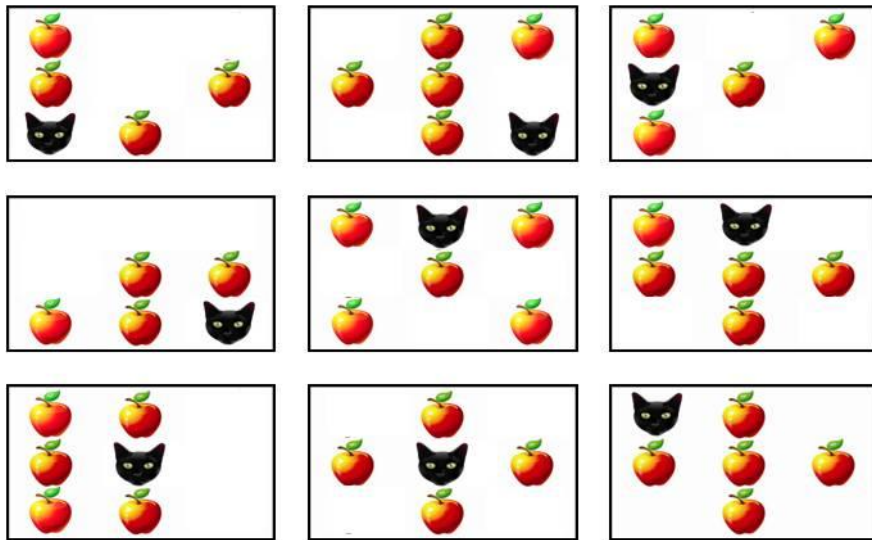


Figure 31 – Pilot Hint 1 given to Person 1

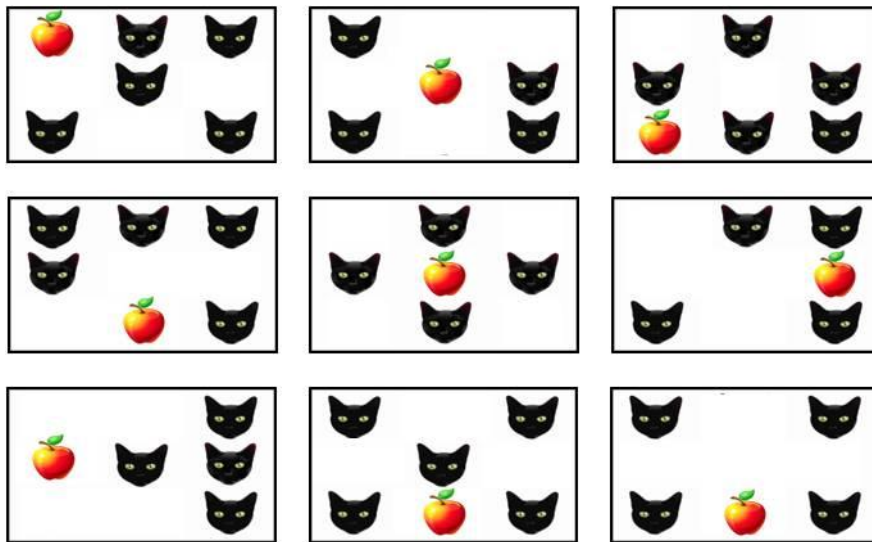


Figure 32 – Pilot Hint 1 given to Person 2

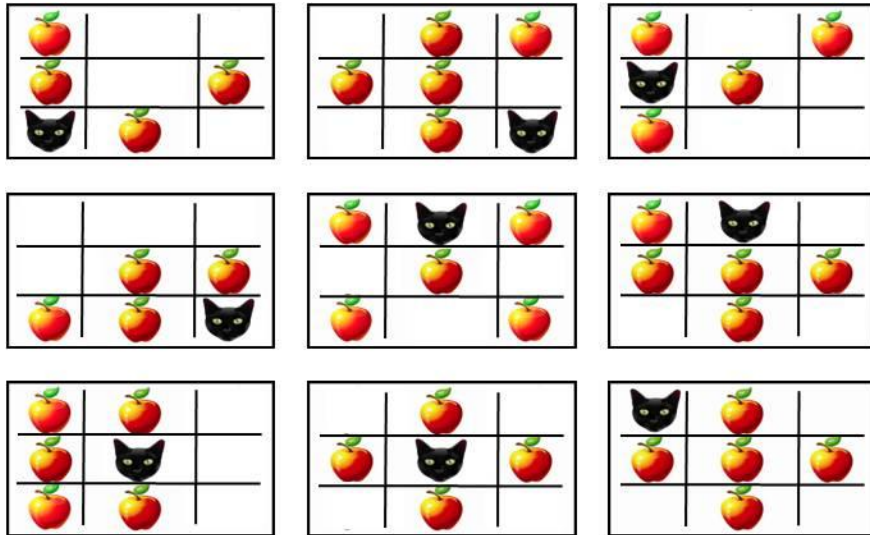


Figure 33 – Pilot Hint 2 given to Person 1

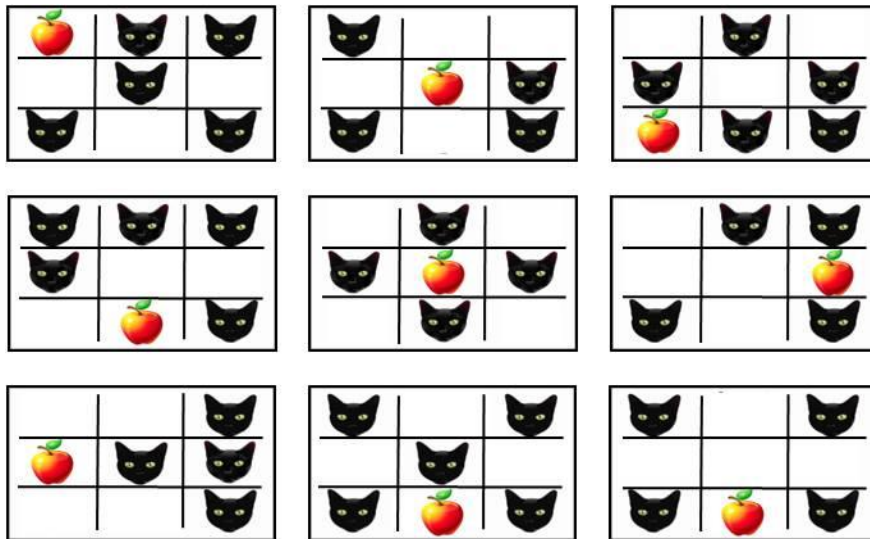


Figure 34 – Pilot Hint 2 given to Person 2

## Appendix E – Questionnaires

### 1. Condition 1

#### 1.1. Random Pre-defined Sequence Task 1a

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 1a:**

1. Can you describe how the cards were sequenced?
2. What difficulties did experience trying to communicate your sequence to Person 2?
3. What did Person 2 do that was helpful in the communication?
4. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 1a:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

## 1.2. Non prearranged Sequence Task 1b

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 1b:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 1b:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

### 1.3. Non prearranged Sequence Task 2a

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?



### 1.4. Task 3

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 3:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 3:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

## 1.5. Task 4 Two Hints

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 4:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?
6. Did the **hint(s)** and/or the **second set of cards** (if applicable) help you? How?
7. Was (were) there anything about the **hint(s)** and/or the **second set of cards** that you found confusing? If yes, what was confusion?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 4:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not helpful in the communication?
5. Did the **hint(s)** and/or the **second set of cards** (that Person 1 got) help you? How?
6. Was (were) there anything about the **hint(s)** that you found confusing? If so, what was confusing?

## **2. Condition 2**

### **2.1. Non prearranged Sequence Task 1**

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 1:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 1:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

## 2.2. Random Pre-defined Sequence Task 2a)

**Please answer those questions based on the round you finished.**

**Questions Round 2a:**

**Person 1:** \_\_\_\_\_

1. Can you describe how the cards were sequenced?
2. What difficulties did experience trying to communicate your sequence to Person 2?
3. What did Person 2 do that was helpful in the communication?
4. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

**Questions Round 2a**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

### 2.3. Non prearranged Sequence Task 2b

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2b:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2b:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
5. What did Person 1 do that was not so helpful?

## 2.4. Task 3

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 3:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 3:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

## 2.5. Task 4a - Two Hints

Person 1: \_\_\_\_\_

Please answer those questions based on the round you finished.

### Questions Round 4:

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?
6. Did the **hint(s)** and/or the **second set of cards** (if applicable) help you? How?
7. Was (were) there anything about the **hint(s)** and/or the **second set of cards** that you found confusing? If yes, what was confusion?

Person 2: \_\_\_\_\_

Please answer those questions based on the round you finished.

### Questions Round 4:

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not helpful in the communication?
5. Did the **hint(s)** and/or the **second set of cards** (that Person 1 got) help you? How?
6. Was (were) there anything about the **hint(s)** that you found confusing? If so, what was confusing?

### 3. Condition 3

#### 3.1. Random sequence Task 1

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 1a:**

1. Can you describe how the cards were sequenced?
2. What difficulties did experience trying to communicate your sequence to Person 2?
3. What did Person 2 do that was helpful in the communication?
4. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 1a:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?



### 3.2. Non-random sequence Task 2)

Person 1: \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 1b:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

Person 2: \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 1b:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

### 3.3. Non-random sequence - Task 2

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

### 3.4. Random sequence - Task 3

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 3:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 3:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

### 3.5. Task 4 - 1 Hint

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 4:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?
6. Did the **hint** help you? How?
7. Was (were) there anything about the **hint** that you found confusing? If yes, what was confusion?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 4:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not helpful in the communication?
5. Did the **hint** help you? How?
6. Was (were) there anything about the **hint** that you found confusing? If so, what was confusing?

#### 4. Condition 4

##### 4.1. Random sequence Task 1

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 1:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 1:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

## 4.2. Random sequence - Task 2

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 2a:**

1. Can you describe how the cards were sequenced?
2. What difficulties did experience trying to communicate your sequence to Person 2?
3. What did Person 2 do that was helpful in the communication?
4. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

### **Questions Round 2a:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

### 4.3. Non-random sequence - Task 2

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2b:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

#### **Questions Round 2b:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?

#### 4.4. Task 3

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 3:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 3:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not so helpful?



#### 4.5. Task 4 - 1 Hint)

**Person 1:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 4:**

1. Please describe how you arranged your card sequence.
2. Did you experience any difficulties putting these cards in a sequence?
3. What difficulties did you experience trying to communicate your sequence to Person 2?
4. What did Person 2 do that was helpful in the communication?
5. What did Person 2 do that was not so helpful?
6. Did the **hint** help you? How?
7. Was (were) there anything about the **hint** that you found confusing? If yes, what was confusion?

**Person 2:** \_\_\_\_\_

**Please answer those questions based on the round you finished.**

##### **Questions Round 4:**

1. Can you describe how the cards were sequenced?
2. What difficulties did you experience trying to understand Person's 1 sequence?
3. What did Person 1 do that was helpful in the communication?
4. What did Person 1 do that was not helpful in the communication?
5. Did the **hint** help you? How?
6. Was (were) there anything about the **hint** that you found confusing? If so, what was confusing?