Framing Coordination in Collocated Computer-Mediated Communication

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(Abstract)

This thesis explores the framing of coordinative experience in collocated computer-mediated communication. It highlights the importance of low- level coordinative properties through multifaceted examination of the transcript of the first minute of a constructed coordinative situation. In efforts to truly understand the culture we are creating and invoking by adding computers to people's activities in groups, and life in general.

A lab study was conducted using a computer program that allows one or more users to solve a Sudoku puzzle together, each on their own separate computer. This allowed for an investigation of what happens when people and technology are located in the same place. How do people construct their situation, in terms of who goes next, what do they do and what constitutes the behavior framing.

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All photographs are made by the author, N.M. Alaloula, 2010, unless otherwise indicated.

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Chapter 1

Introduction

Throughout the history of the human race, many believe that it was when humans developed the skill to communicate efficiently with each other that attainable structure was sustained, social and cultural, and gradually built upon to arrive to human civilization today. In addition, sociability is an essential part of the human nature; coordination is a key aspect to sociality(D. Tatar, Lee, & Alaloula, 2008).

Coordination is a result of successful communication while trying to achieve a common goal. Clark states, in *Using Language* (Clark, 1996) " Two people have a coordination problem whenever they have common interests, or goals, and each person's actions depend on the actions of the other" . Coordination is evident everywhere; whenever a shared goal of any sort is to be attained it is present. Some examples are, children playing a game together, a couple of students preparing an essay or employees working on a project. This leads to the possibility of examining coordination in different settings and from numerous perspectives.

Coordination

It has been perceived that a notable number of researchers in the Computer and Technology fields specifically go about describing coordinative processes and their efficacy without putting down the definition for the term "coordination "or even a nuanced mention of what coordination is, for example (Cabitza, 2007; Katzenstein & Lerch, 2000).

Since the omnipresence of coordination in normal day-to-day living and special settings e.g. (work, school) has already been established, it can be expected that there will be an array of different interpretations of this concept. For instance, (Malone & Crowston, 1994) define coordination as "the act of managing interdependencies between activities." This reflects their organizational and informational perspective, a perspective shared by several other thinkers concerned with influencing workplace processes (Bowers & Churcher, 1988; Dykstra & Carasik, 1991; Fitzpatrick & Welsh, 1995; Kaplan, Tolone, Bogia, & Bignoli, 1992; Pohl, Domges, & Jarke, 1994; Winograd & Flores, 1986). Anderson (Andersen, 2006) also takes an informational perspective on coordination; however, his work emphasizes not the equivalence between or interchangeability of human and machine but the identification of differences, especially in accountability. That is, Anderson is concerned with modeling how the automatic navigation systems on large ships can take over operational details, while the underlying responsibility remains with the human. Another perspective emphasizes the relationship between coordinative elements and larger systems of action or meaning. For example, the Oxford English Dictionary says that to coordinate is "to place or arrange (things) in proper position relatively to each other and to the system of which they form parts; to bring into proper combined order as parts of a whole" (Dictionary, 1989). This is a systems approach. It is consistent with the call to stay open to interpretation (Sengers & Gaver, 2006) and is the perspective that we bring to the study of coordination.

The systems approach starts with a concern for understanding and influencing the microstructure of coordination. This perspective points out the considerable influence of microstructure on how and what gets done. This is the traditional foci of conversation and interaction analysis (Goodwin & Heritage, 1990; Jordan & Henderson, 1995; Sacks, Schegloff, & Jefferson, 1974; EA Schegloff, Jefferson, & Sacks, 1977). It is also concerned with values, not only the efficient attainment of goals, but values embodied in the process of interacting such as human control, engagement, participation and inclusion.

Background and Related work

"From a design point of view, coordination is radically under-theorized and under-explored."(D. Tatar, et al., 2008)

In today's world, more and more technological advances have been employed as mediums of communication and coordination. Considering how technology has become and is becoming even more one of the main mediums for communicating, more attention has been given to the study of coordination via technology-specifically computers- and, evidently, more is needed.

Co-located vs. Distributed

The study of coordination can be approached from many different angels. Focusing on the loci of coordinating persons it can be divided into two major sections; co-located or face-to-face (F2F) and distributed.

Distributed

Many computer scientists focused on distributed coordination. Where people are in different physical locations, all means of communication are carried out via computers. The communication, however, could be synchronous or asynchronous, and the mediation could be limited to one or more means i.e. (typed, voice, video… etc).

Co-located (F2F)

In this form of examining coordination, people are in the same physical location and usually are able to see each other's faces, hence the term Face-to-Face (F2F).

In this form more temporal human factors come into play, language, gestures and facial expressions being the most prominent. All part of humans "original" form of coordination. As Brennan explains in (S E Brennan & Lockridge, 2006b) that one of the first means of communication is language. The original use of language evolved while using it face-to-face, and the face-to-face setting is how children learn language.

Loci are merely a factor, or an angle from which coordination can be observed. Another major dividing aspect is the background of the scientist, computer mediated coordination is a subject that has been examined by cognitive scientists, anthropologists, computer scientists and engineers alike. The lens, naturally, affects the method, foci and results, which eventually adds to the richness and complexity of information we have to start, guide or ground us in our examination as well.

In the following section, some distinction is made regarding the affiliation of the scientist studying computer-mediated coordination. It is to be made clear that this affiliation is merely reflective of the scientist membership in certain departments or labs. This does not determine the researchers educational or academic background. Many scientists adopted a methodology from a perspective dissimilar to what is usually followed in their affiliations, while others opted to partner with scientists with diverse backgrounds and memberships.

Cognitive and Social

Schegloff was one of the earliest scientists studying computer-mediated communication in (E. A. Schegloff, 1980) he provided his perspective on the what he thought were the challenges facing developers of CSCW (Computer Supported Cooperative Work). In (L. A. Suchman & Trigg, 1986) Stemming from situational human activity and the appropriate technical design comes Suchman's study of collaborative research intending to capture it's central activities and present them in a way that can inform the design of CSCW tools. Also, Galegher and Kraut (Galegher & Kraut, 1990) describe the use of computer-mediated communication in the form of video conferencing, and -given the novelty of it at the time-go into depth in describing its merits and drawbacks, the participants' reflections, mostly on the difficulties, and their predictions of future use.

Then as CSCW systems were being developed, further seemingly nuanced aspects called for the attention of sociological scientists for example, how the introduction of the systems into the intended atmosphere affected *turn-taking* (Phillips, 2000) where the quantitative study conducted showed that imposing turns on participants in a collaborative

project impacted team *effectiveness*, and (Susan E. Brennan & Ohaeri, 1999) Brennan and Ohaeri emphasize the importance of sensitizing designers of a technology developed for interaction by pointing out that aspects like *politeness* do not emerge automatically when using a medium. In addition to how certain characteristics of users affected the use of the technology, most prominently in the area of *culture* and cultural differences (Diamant, Fussell, & Lo, 2008; Setlock, Fussell, & Neuwirth, 2004; Sieck & Mueller, 2009) Stelock et al. found that in cross-cultural groups, decision-making sessions collaborating via IM in distributed settings reduced but not eliminated cultural differences. Diament et al. stated that in cross-cultural dyads given a task to navigate together via technological mediums (video, audio or IM), the dyads reflected on their performance in terms of personal disposition factors as opposed to situational factors related to task or medium. And Sieck and Mueller stated that distributed collaboration through technology provides relative anonymity that benefits multicultural collaboration.

Much attention has been given to electing the best, or most suitable medium. This has been reflected in previously mentioned studies, even though it seemed like a by product of the main thesis. However many scientists made this the main argument of their study, like (Connell, Mendelsohn, Robins, & Canny, 2001) who states that the results of their study suggest that the telephone provides the optimum blend of richness and presence for natural and satisfying interactions, in their setting of work meetings. But they do not neglect to stress the importance of carefully examining the amount of richness that is appropriate to the context. In the same line of context-awareness, Grudin (Grudin, 2001) is concerned with context, and what people are conscious of picking up on or discarding. And how that influences their coordination, in relation to what ends up mediated via technology, missed or altered.

On the other hand, many would argue that the insights that influenced the study of coordination in computer-mediated communication are more in relation to communication than computers. Clarks' grounding theory in Using Language (Clark, 1996) is a fundamental approach to the study of how people communicate, and what makes a communication successful. In (Clark, 1996) Clark states that "Two people have a

coordination problem whenever they have common interests, or goals, and each person's actions depend on the actions of the other." Along the same lines he and other scientists extended their examination to the computer-mediated coordination. Recently (S E Brennan & Lockridge, 2006a) Brenan focuses on the affects of mediating communication on communication itself. Namely she asks the questions "how do people adjust when communication is mediated? "How is language processing affected?" " And how is conversation shaped by the medium in which it is conducted?" She proposed a grounding framework for task-oriented dialogues that is useful for explaining and predicting how a medium shapes communication. The grounding framework is a reiteration of Clark and Brennans' constraints on grounding. In addition, part of Clarks' examination includes embedding the role of gestures in communication. This has been further studied in (Meredyth Krych Appelbaum) where Krych emphasizes the role of gestures in coordination. Their study consists of pairs using only gestures to coordinate a physical task of putting together a Lego piece, are statistically equivalent to pairs allowed to use gesture in addition to speech, while pairs allowed to use speech only took significantly more time.

Computer and Engineering

Following is some background of the study of coordination in computer-mediated communication, most of which influenced the direction of our thinking.

Media Spaces was the inauguration of scientist exploring dimensions of compute-mediated connectivity in (Stefik, Bobrow, Foster, Lanning, & Tatar, 1987). The term WYSIWIS (What You See is What I See) was coined, its premise being a foundational abstraction for multiuser interfaces that expresses many of the characteristics of a chalkboard in face-to-face meetings. However, after devising a strict WYSIWIS principal on the design of shared tools, a revised approach was created to relax those rules and some other devices were suggested like telephoning, teleselection. Then again Smith et. al (Smith, 1992) introduced the WYSIWITYS (What You See Is What I Think You See) which is an even more relaxed constraint than WYSIWIS. There are clues in both from which users can

ascertain the stage of their collaborators and thereby facilitate working together, or coordination. And the assertion that ”Technologies that support real time interaction without attending to the subtleties of human communication risk damaging the collaboration."

Hawryszkiewycz in (Hawryszkiewycz, 1993) one of the earliest examiners of coordination, his initial effort was to quantify coordination, in a low-level technical method that informs the process of designing CSCW systems, Hawryszkiewycz goes into depth to call on coordination semantics, building small parts into larger blocks of knowledge that could be easily assembled and customized to create the system that is better qualified to support a CSCW purpose.

Many aspects of what effects coordination in a computer-mediated communication of some sort were reflected upon and examined from many thinkers in the computing and engineering world. The notion of space and place is a unique one in the computer world addressed by (Harrison & Dourish, 1996). Their distinction between space and place and how it influences collaboration in computational environments. They point out the fault in using spatial models to support interaction and show how it is a notion of “place” which frames interactive behavior; emphasizing supporting the duality of space and place.

Awareness is an important aspect that affects and is affected by coordination. Findings went from more is better, “increasing mutual awareness enables the individuals to interact effortlessly and without disruption” (DiMicco, Hollenbach, Pandolfo, & Bender, 2007) and (Kim, Gutwin, & Subramanian, 2007) to the quality of awareness, as in better awareness provides for better coordination (Cabitza, 2007). In addition to the type of awareness, passive awareness is what Dourish (Dourish & Bellotti, 1992) describes as allowing the move between close and loose coordination and collaboration.

Shared Visual Information is one of the most common characteristics of computer-mediated communication. Fussel (Fussell, Kraut, & Siegel, 2000) outline some of the benefits of shared visual information, the results of their study with dyads of workers and

helpers on collaborative repair tasks showed no advance on workers connected via audio-video over the co-located dyads, however co-located dyads were faster than pairs connected via audio. By experimentally manipulating features of a shared visual space and observing their effects on performance and communication Kraut et al. (Kraut, Gergle, & Fussell, 2002) presented a first step in understanding which features of a shared visual space are most important. "A shared visual workspace is one where multiple people can see the same objects at roughly the same time." And they show that having the shared visual space helps collaborators understand the current state of their task and enables them to communicate and ground their conversations efficiently, the shared visual space is more useful when tasks are visually complex or when actors have no simple vocabulary for describing their world. Also Gergel (Gergle, Kraut, & Fussell, 2004) confirms in an empirical study that a shared visual space makes communication and coordination between a dyad of worker-helper more effective by reducing their collaborative effort. (Irani, Hayes, & Dourish, 2008) argues that Virtual worlds are efficient for collaboration because of how they lend themselves to appropriation and not because of their simulation of everyday things.

Shared visual information is in some sort a by-product of Clarks' grounding theory. Gaze, deixis and gesture are established as the main components of communication and therefore coordination, as many thinkers examined. In (Cherubini, Nussli, & Dillenbourg, 2008) the main thesis is that in order to better distributed communication, the addition of gaze and deixis is more effective than attempting to imitate F2F interaction by increasing bandwidth. Gesture, conversely, is a pivotal component of interaction in general. Numerous studies done with worker-helper dyads affirmed the significance of gesture in communication (Gutwin & Penner, 2002; Kirk, Rodden, & Fraser, 2007; Melanie Tory, 2008) Gutwin, concerned with network delays and jitter and how to overcome the negative effect these issues have on coordination, finds that visualization and traces of telepointer in real time groupware, convey more confidence within coordinators and actually enriche communication. In an effort to further understand coordination Carstensen (Carstensen & Nielsen, 2001) believed that a better examination of everyday coordination is in need, their

main finding is deciding on dimensions for comparing F2F coordination with distributed coordination, and conclude with the call for the need for more in-depth characterization.

Many more seemingly nuanced aspects of coordination and communication were further examined and scrutinized by many thinkers, private vs. public (Ludvigsen), anonymity, control and more aspects that seem to spill over each other.

All mentioned aspects of coordination and communication seem like pieces of a puzzle, the larger picture being the construction of meaning in any type of communication. Medina and Suthers (Medina & Suthers, 2008) attending to the construction of meaning devised the use of a contingency graph, which is created by a visualization tool that analysis the transcript from the computer log to recognize patterns in use of representations and show how negotiated representational practices affect how learners collaborate with and influence each other. Suthers et al. (Suthers, Dwyer, Medina, & Vatrapu, 2006; Suthers, Dwyer, Vatrapu, & Medina, 2007; Suthers, Medina, Vatrapu, & Dwyer, 2007) based their examination on the assumption that the properties of interaction while constructing meaning hold the same value when distributed as when face-to-face or co-located, they ponders on different methods for studying the properties of online learning, and explains how a method based on a single lens either purely qualitative or quantitative is not sufficient to "*maintain the sequential and situational context of activity*" then goes on to present the devised contingency graph introduced in (Medina & Suthers, 2008) as a feature-rich analytical artifact supporting multilayered interpretation.

Coordination in Collocated Computer-Mediated Communication

One of the oldest debates in Computer Supported Collaborative Work is the relationship between plans and situated actions. The importance of situated actions has been a focus of investigation in CSCW since its inception (Trigg, Suchman, & Halasz, 1986). But the relationship between specific designs and micro-level coordination is not yet

understood to the degree that we can predict the social influence of small design changes. Clark (Clark, 1996) says that in interaction, we seek to understand the other person to the degree needed *for current purposes*. But we do not know in any detail how CSCW design changes their conception of the purpose of the interaction. In particular, while we know that people can operate in many circumstances to a degree that they find satisfactory, we do not know how they may be compromising other, deeper goals. That is, we do not yet understand the relationship between design decisions and coordination in solving interactive problems such as "who goes next"(Sacks, et al., 1974), "are we done with the last topic", and "will this conversation go on" (E Schegloff & Sacks, 1973). Furthermore, we do know precisely how people in groups come to feel authorized to act in a shared workspace. Of course, there may be a structured activity that forces them to act, but the deeper question is how they come to feel they can act at will and in a way that is coordinated with the other people.

In this thesis, we explore how people with separate devices initiate coordination in a co-located, collaborative activity with a general goal, but no specific process. The question is one of the framing of how people work together to jointly form the activity and their role in it. Informed by the perspective of Goffman's Frame Analysis, that:

> From an individual's particular point of view, while one thing may momentarily appear to be what is really going on, in fact what is actually happening is plainly a joke, or a dream, or an accident, or a mistake, or a misunderstanding, or a deception or a theatrical performance, and so forth. (Goffman & Berger, 1974)(p. 10)

This thesis presents humane behavior in an artificial but representative situation, focusing on the effects of the intersection of people's different sense making efforts.

Chapter 2

Computer-Mediated Coordination and TeamSudoku

The culture of technology is striving to be variable, diversified and inclusive. If there is a true and just case for that call, it will especially apply to communicative technology. It was once believed that designing technological artifacts as a computer scientist or a computer engineer with the intent of connecting people would, without doubt, create a world in which information would flow from one entity to another and people would communicate, happily and contentedly. While the attempt was not entirely a failure, it cannot be counted as a success either, because a narrow demographic mark the culture of communicative technology users, and compared to the whole world, it is a very limited one.

Embracing human beings as users with all the complexities that accompany being human, leads towards tolerance according to the authority of human scientists such as sociologists, psychologist and anthropologist among others. Guided and heavily influenced by such pillars in the world of communication as Clark (Clark, 1996) and understating human planning as Suchman (L. Suchman, 2007) and micro-sociology as Goffman (Goffman & Berger, 1974), this study is a conscious move toward examining the micro-coordinative characteristics of people from varied or unspecified demographics using a communicative technology in a co-located setting.

This chapter mainly describes the study. Study context, setting and procedure is elaborated upon, methods, data collection and participants' recruitment are discussed.

Study Rational

Purpose

This experiment was designed to examine the properties of computer-mediated coordination involving co-located people using visually segregated technologies. The chief

questions were how variations in the available methods of pointing affect coordination, participation and comprehensibility. On one hand, support for a shared reference is one of the oldest issues in the design of collaborative systems (D. G. Tatar, Foster, & Bobrow, 1991). On the other, it depends crucially on particulars of technology, application, and setting. Nonetheless, investigation has rarely been extended to include the examination of pointing in coordination between three people, much less to coordination in the context of an activity that, like so many real world activities, requires constant attention to the question of who goes next and what s/he contributes. Nonetheless investigation has been diverted to the examination of how people come to perceive the situation they are in, and how they use the provided knowledge and other collaborators to frame their situation and act upon it this is in efforts to further extend of the question of how is it that when we have people and technology all in the same place, how do people go about or construct the demands of the situation in terms of who goes next and what do they do? What constitute the behavior framing?

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Sudoku

Sudoku is a game, commonly played on paper and increasingly on small devices or online, in which the goal is to fill a 9x9 board so that all nine columns, nine rows and nine distinct 3 x 3 blocks contain exactly one instance of the digits from 1 to 9. Games are differentiated by which digits are initially provided by the game designer and where those digits are positioned. In general, games that have fewer digits provided are harder than games that have more, and numbers that have less initial representation on the board are harder to fill in than those that have more initial representation. However, there may be interactions between numbers and positions that make games with more initial digits harder than games with fewer. In general, Sudoku boards are not considered as truly constituting games unless there is exactly one solution.

TeamSudoku

TeamSudoku is a multi-player Sudoku system intended to be used in face-to-face venues. Each player has his/her own copy of the game board on his/her screen. Numbers

put on the game board during the course of play are promptly shared on every player's screen. The TeamSudoku screen is divided into three main parts, as in Figure 1

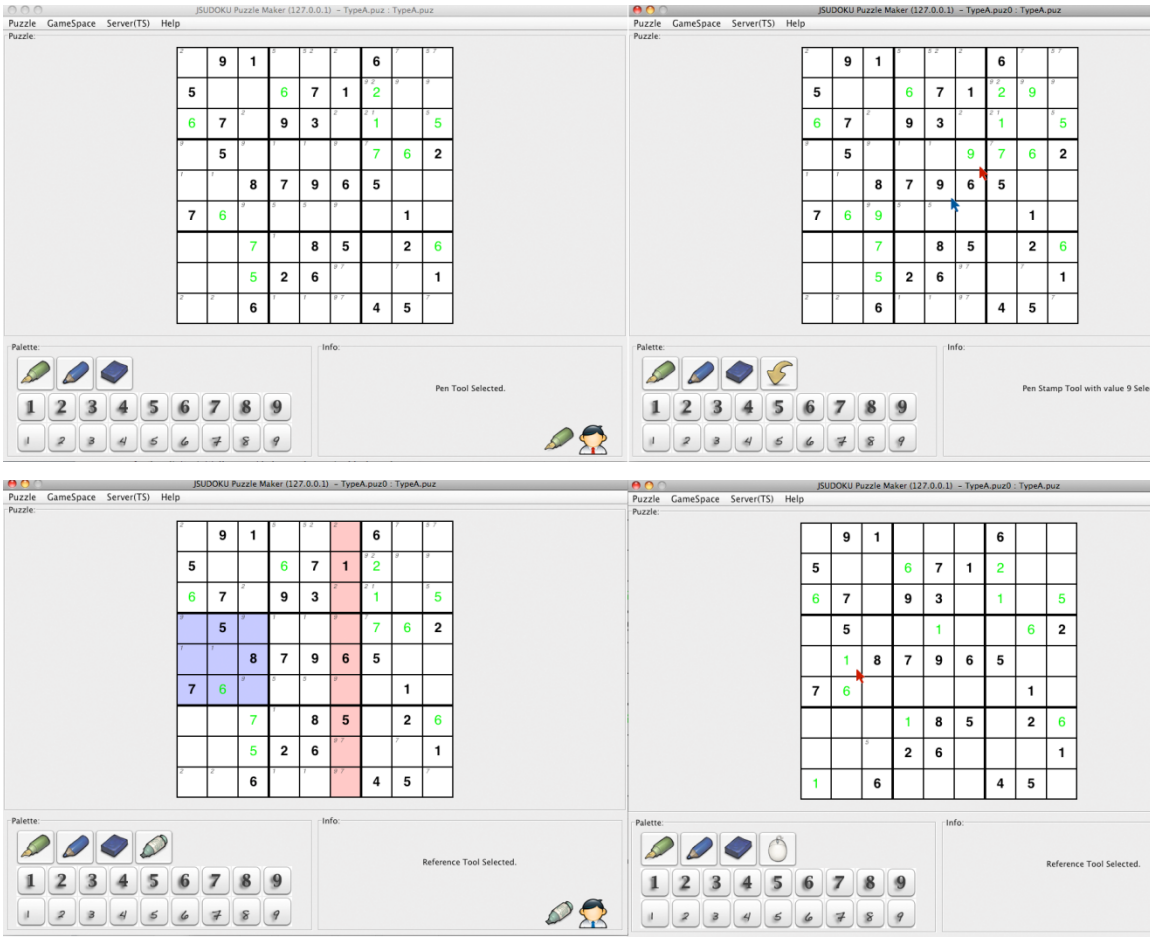

Figure 1: Screen shot of TeamSudoku, Clockwise starting from top left, Basic, Multiple pointer, Highlight and Shared Pointer. Photograph by Joonsuk Lee, used with permission, 2010.

The largest part is the *Puzzle* section, where the puzzle grid is displayed. In TeamSudoku, the numbers initially provided are shown in black. Numbers added by players are either in Green (if they are "answers") or small, italic and grey (if they are "notes").

The *Palette* is used to manage the tools for choosing numbers, putting in notes, erasing, and managing shared pointing (when available). Numbers are entered into the grid by clicking on an icon found in this area, and then clicking on a cell in the grid. To enter a note, users click on the note icon and then on a cell. Numbers replace one another, but multiple notes may be entered into a cell.

The *Info* section provides feedback to the user about the state of the system. It shows what tool is currently selected, and, if a reference tool is provided, the little person's tie shows the color that signifies the player.

When referencing is provided, an icon representing it is added to the Palette section. In the case of Shared Pointer/ Icon, each player has an opportunity to draw the other players' attention to a certain section of the puzzle by clicking on the icon that is a picture of a mouse, and then clicking anywhere on the puzzle grid. Doing this would leave a pointer stamp, in addition, the same person that put the pointer stamp, or any other player who has selected the reference tool can move it around by clicking and dragging on the puzzle grid. This motion is visible to other players, however, that one reference tool is the only one available to all players. Two players trying to manipulate the Shared Pointer would result in a flickering non-functional pointer. This would be made clear to the group at the beginning of the session by having it demonstrated during the walkthrough. The color of the pointer changes in order to correspond with the color distinctive to each player. The Shared pointer can be removed from the grid by dragging it outside of the puzzle grid square.

The Multiple Pointer gives each player the opportunity to manipulate a pointer that is their own. After clicking on the reference tool button and then clicking anywhere on the puzzle grid, a pointer stamp is left on the grid, that stamp can be moved around with the motion visible to other players by clicking on it and dragging it on the puzzle grid. All the players' pointers can be visible on the grid at the same time; they are distinguished by their color, which represents each player throughout the session. Players can remove a pointer by dragging it outside the grid's scope.

The Content-based reference mechanism allows players to highlight specific content-based sections related to Sudoku. Each player can highlight a cell, 3 x 3 box, row, or column by clicking on the highlight tool in the Palette and clicking on the content the player desires to draw the team's attention to. Clicking on a cell to highlight it, or clicking and dragging over two or more adjacent cells in a row or column to highlight it and click and drag over four adjacent cells or more in one of the 9 distinct 3 x 3 blocks. The highlight color is distinctive to each player and consistent throughout the session. Two or more players can use their highlight pointing at the same time. Whenever highlights overlap a

mix of the two colors results with an overlap of the most recent highlight. To remove the highlight, the reference tool button should be selected, and then the Escape key from the keyboard should be pushed. Finally, each player can manipulate only his or her own highlighting tool.

Pilot Study

In Spring 2008 a pilot study was carried out. 57 sessions were conducted in which 30 were 3-person sessions while the rest were 2-person sessions.

Participants: Participants were recruited from the Psychology Participant pool at Virginia Tech University (N >1200) and received extra credit for participation.

Tool: An earlier version of TeamSudoku was used. That version, while similar to the current one in the sense of allowing participants to play Sudoku and work at solving the same Sudoku grid at the same time, had a different interface and offered only two kinds of support for coordination. While each participant had a sustained color for reference (when available) throughout the game, there was no indication for the person on the screen of what the color is, the color was revealed in the beginning of the session, and the participants were told that it would stay the same.

Conditions: The conditions available were Highlight (Content Specific Pointing), Pointer (Content Free Pointing) and Basic (no support for coordination).

Procedure: The study procedure was similar to the main study. Participants were greeted by the researcher, handed consent forms and asked to read through them and sign them. Before starting, a pre-questionnaire was handed out, and then TeamSudoku was demonstrated by the researcher. Participants had 15 minutes for each game and post-questionnaires where handed out after each game.

Data collection: Pre-questionnaires and 2 Post-questionnaires were collected in addition to video recordings of the session and computer logs.

Modifications in the program TeamSudoku were devised, and slight changes to the procedure of the study were made. One camera was added in the process of video recording the session to capture facial expressions and gestures of all participants in addition to microphones for audio quality. All questionnaires were revised and necessary

alterations were made in order to reflect more accurately on the main questions of the study. In addition a larger room was allocated for conducting the study.

The Final Study

Implementation of TeamSudoku Study

The study consisted of a lab-based, between subjects experiment, in which groups of one, two or three participants, located in the same room and on the same table, were attempting to solve a Sudoku puzzle each on their own laptop, using TeamSudoku as the tool.

The groups of two or three people were working on the same puzzle at the same time. TeamSudoku is a game in which the actions taken by one person affects the others because actions are very difficult to undo. Even when there is an automated "undo" function (something we did not provide), it is difficult to know the root source of a conflict. Therefore, there is a high premium on coordination.

Each group solved the puzzles using one of four variants of the tool. The first variant (Basic) provided no shared support for pointing. That is, each person had their own mouse, but could not see the other persons'. The second (Shared Pointer/Icon) supported turn-taking between participants who shared a single "telepointer" by holding and dragging the shared pointer, which then left an icon stamped on the screen. The third (Multiple Pointer) gave each person their own shared pointer, continually visible on other people's screens and the fourth (Content-based) highlighted particular, content-based referents tied to the Sudoku game, that is, cells, blocks, rows or columns. In all shared pointer conditions, each person had a color associated with their pointing, and more recent pointing selections erased earlier ones. That is, if a player stamped a mark on the screen in the Shared Pointer/Icon or selected the same kind of item in the Content-based scheme, the old mark or item would be replaced when that person made a new mark or item.

The variations in numbers of players and in pointing schemes changed the need to describe actions and the indexical properties of the system. Thus, the Content-free pointing required the user to plan out exactly what the intended referent was, while the receiver had to do less to interpret the referent. The Shared Pointer/Icon allowed

participants to move the icon while speaking and/or settle on a point, which meant that the speaker had to pay less attention to whether listeners were in fact listening, but that the listeners were under more pressure to start attending to the speech at the beginning of an utterance.

The actual use of the reference tool differed significantly between groups and less significantly between participants in a team where it seemed that one user would set the scene and most of the time the rest would follow through. That part raised different questions regarding to group behavior in relation to technology as well.

The concept of ownership verses effectiveness or efficiency was an issue that came into focus, where while participants that played the Shared Pointer/ Icon version of TeamSudoku rarely complained about the fact that it was shared, participants playing the Multiple Pointer version unanimously did not accept the suggestion of a shared pointer in the semi-structured conducted interview at the end of the session.

An eye tracking system was used in approximately half of the groups that consisted of two-persons on each participant throughout the study, all of the one-person groups, and three of the three-person groups to trace attention. The distribution of conditions and eye tracking systems implemented is displayed in Table 1: Distribution of Conditions Among Groups.

Table 1: Distribution of Conditions Among Groups

Number of Participants per group	Number of Groups With Eye tracking system applied				Number of Groups Without Eye tracking			
Type of Reference Support provided	None	Highlighting	Pointing	Multi-Pointer	None	Highlighting	Pointing	Multi-Pointer
1	10	0	0	0	0	0	0	0
2	5	5	5	5	6	6	6	6
3	0	3	0	0	10	10	10	10

Study Design

Procedure

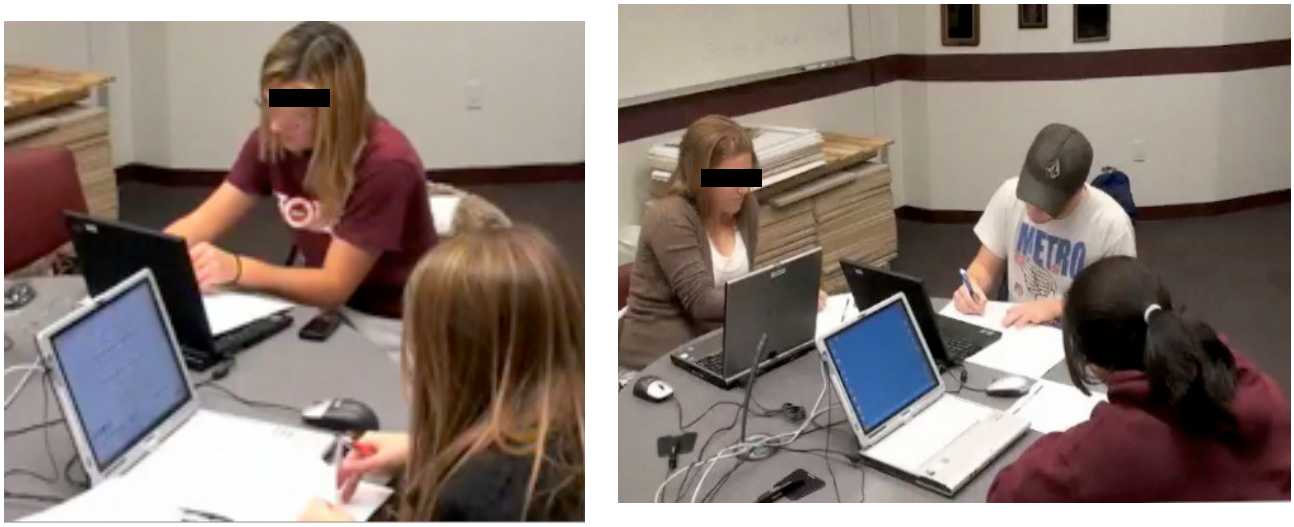

Figure 2: Setting for dyads and triads

The study was conducted in a large room with participants seated on one round table in proximity to one another but unable to view one another's screens Figure 2. After the informed consent process, participants were asked to fill out pre-questionnaires about prior experiences with Sudoku, with teammates (if any).

Study Protocol

A session would start with distribution of consent forms and briefing would-be participants about the contents of it. The goal of the study was discussed as being to play Sudoku together; subtle emphasis was put on the "playing together" element by repeating the phrase during review of the consent form. Pre-study questionnaires are distributed after collecting consent forms and verbal confirmation; pre-study questionnaires inquired about demographic information and previous experience Sudoku. Then a detailed introduction to TeamSudoku is presented by performing a walkthrough, with participants performing basic tasks one-by-one. Basic tasks include; adding a number to the grid,

deleting a number, exchanging a number, also adding note numbers and deleting them as well, and in the cases where support for coordination is provided trying them out, one-by-one and together is carried out before the work on the actual Sudoku grid starts, participants are encouraged to explore the tool at that time, any questions regarding functionality are addressed.

In sessions where eyetracking is used, it is set up after the walkthrough. The process of setting up eyetracking include setting the equipment as appropriate as possible on the participant's head, calibrating the eye tracking software, by asking the participant to follow a sign that moves around in different parts of the participant's view, and starting the record process for the eyetracking tape. After the session is over, the last process of calibrating eyetracking is done manually for each participant.

The first puzzle would then be launched on TeamSudoku and the participants would have 15 minutes to try to work on it together. After Puzzle 1, a round of post-study questionnaires is distributed. Next comes Puzzle 2 for another 15 minutes and another post-study questionnaire. A short semi-structured interview is conducted before the session is completed.

Recruitment

Players were recruited from the Psychology Participant pool at Virginia Tech University (N >1200) and received extra credit for participation. The advertisement specified that participants would play a collaborative game and asked for people who had played Sudoku before and are familiar with Sudoku rules. Groups were formed by who signed up at the same time and consisted of both same-gender groups and mix-gender groups. Each group was randomly assigned to a variant of the game. The study was run over the course of a semester, with chances to participate offered at many times of day and on all weekdays.

Participants

Our initial goal was to conduct the study with mostly groups that consist of three participants; however, we ended up with a large number of two-participants per group and three-participants per group and some one-person groups. See Table 1.

In total, this study involved 248 participants, 115 Female, and the average age of all participants was at 19. The majority of students were freshman (43%), a minority of students in their senior year (7%), and an almost equal percentage of students in sophomore and junior years (26% and 23%), See Figure 3.

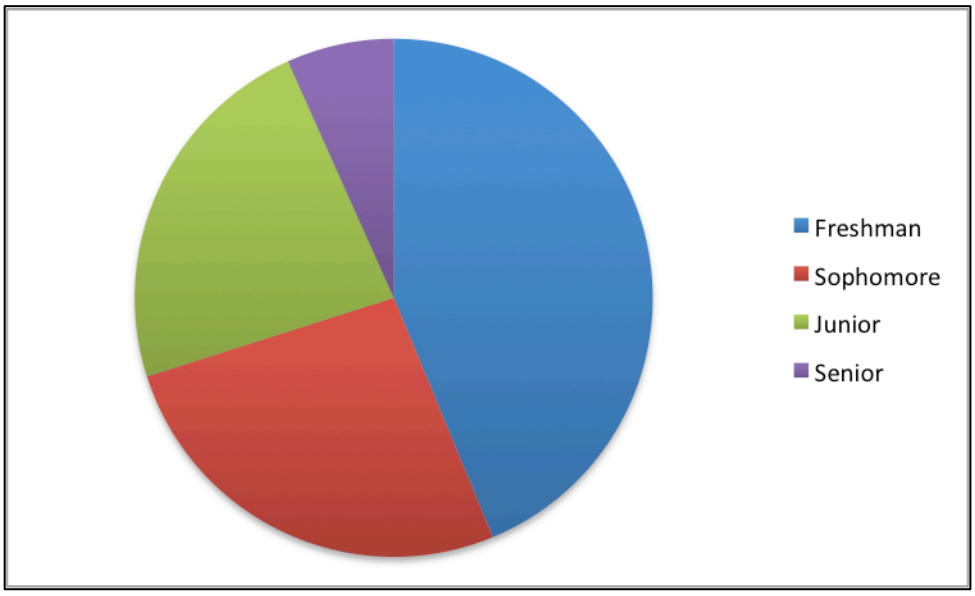

Figure 3: Participants School Year

11 people worked alone; 44 groups consisted of two participants trying to solve the puzzles together; and 43 groups consisted of three participants.

Twenty-four groups played the Content-Specific (Highlight) reference version of TeamSudoku, of which 11 were groups consisting of two persons and 13 were groups consisting of three persons. In the case of the Shared Pointer (Icon) 21 groups played

TeamSudoku, of which 11 were groups consisting of two persons and 10 three persons group. Twenty-one groups used the Multiple Pointer (Icon) as the reference tool to play Sudoku as a team, of which 11 were two persons groups and 10 were three persons group. In the Basic TeamSudoku version where no particular tool was dedicated to referencing a total of 31 groups played the puzzle, 10 persons played alone, 11 groups consisted of two persons and 10 groups were three persons groups. Thirty-three groups performed the study with the eye tracking system attached to each person's head while the rest of the groups (65) did not.

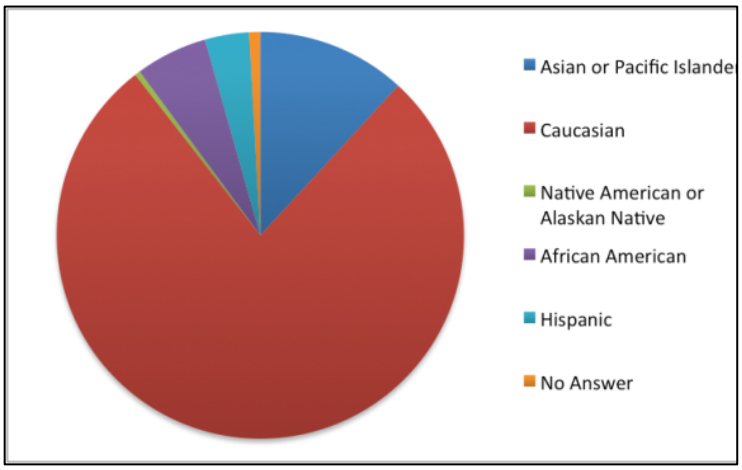

Figure 4: Demographics of Participants

Participant demographics, see Figure 4, were in more than one way representative of the university's undergraduate demographic, consisting primarily of Caucasian American (78%) some Asian American (12%) and African American (6%), and a small percentage of international students (3%) enrolled to participate in the study. Few of the participants (10%) reported that their first language was not English but none appeared to have difficulty because of this.

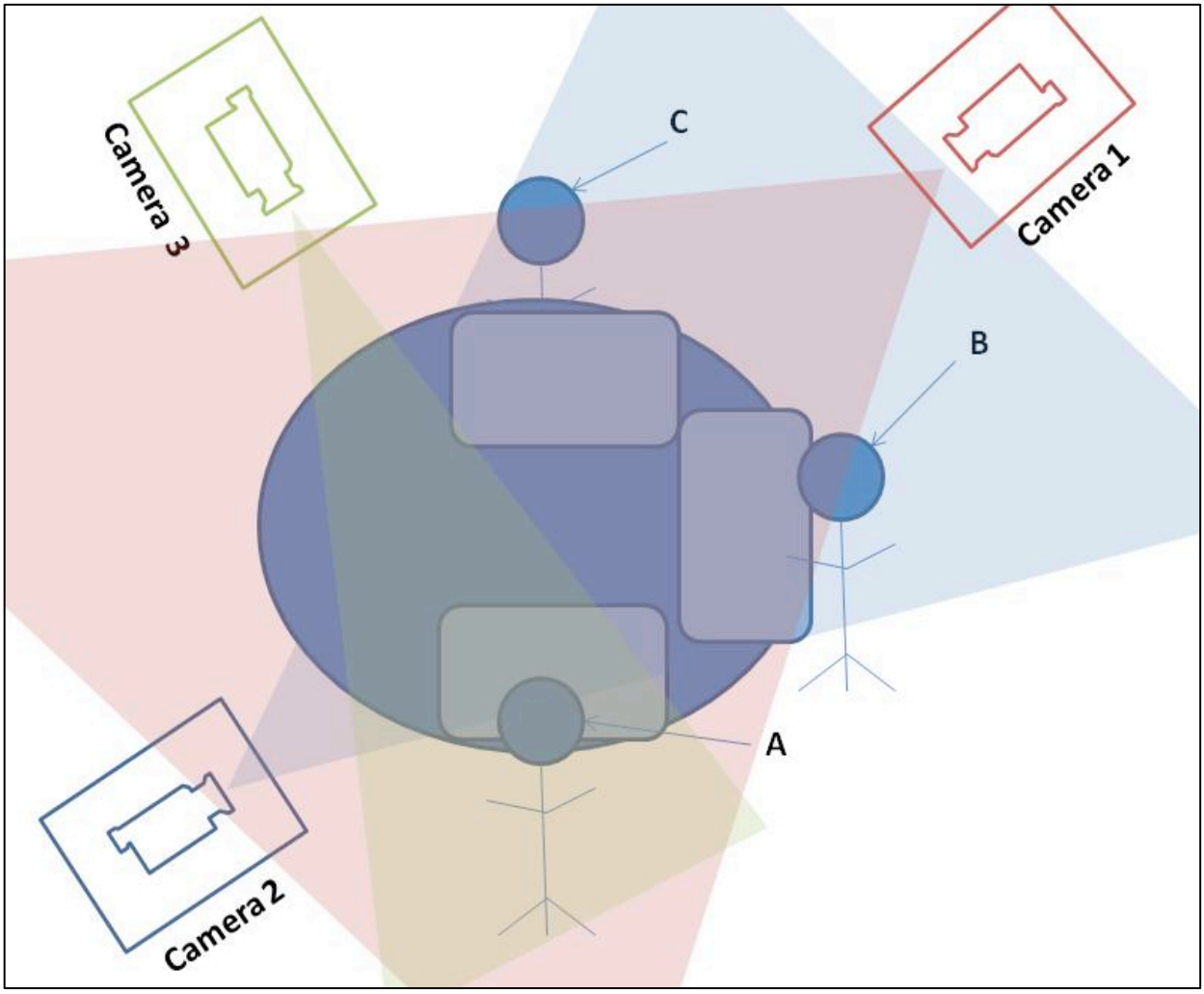

Figure 5: Camera Positions

Data Collection

Quantitative data were collected using a pre-study questionnaire that gathered demographic facts in Section I, and in, Section II, information regarding prior experience and familiarity with Sudoku, and general attitudes and experiences with other puzzles on paper and/or computers. Participants were asked what they thought about Sudoku and how they went about playing it. Two identical post-study questionnaires were distributed after each puzzle was played. These tend to the participants reflections on how the group functioned, their experience, and their opinion regarding the puzzle, the software (TeamSudoku) and the reference tool when applicable. Also, a set of questions in the post questionnaire was devoted to collecting reflections of participants on the group experience

in Section III. Section II, collected participants thoughts regarding their enjoyment and what they felt the level of puzzle difficulty was to them. Some questions about the software were included as well. The same post-questionnaire is presented to each participant twice throughout the session, once after each game, that is intended to detect learning effects and may even allow for identifying other un-anticipated effects (for example, groups' taxonomy, puzzle order, puzzle differences).

Qualitative data was collected via observations, a semi-structured interview at the end of each session, the interview was performed initially to elicit the participants thoughts about the experience in general, open ended questions were used, and sufficient time was given to participants to reflect, the main focus was to record for the participants prior experience with Sudoku collectively, and for participants to share their thoughts together, in that direction some of the same questions that were asked in the questionnaires were asked again in a group setting, and participants were asked to elaborate, silent participants were encouraged to share their thoughts in a non invasive manner (i.e. after Mark finishes his comment regarding a certain tool functionality the interviewer might turn to Lucy, who is silent, and ask if she thinks the same). In addition to three video cameras that were used. The cameras capture how participants were seated, their gestures and their facial expressions (see Figure 5) and even though 2 microphones were used to ensure voice recording quality, the multiple clicking, typing affected and the plentiful equipment on the table affected the voice recording quality to some extent. Also, a screen capture video recording of the puzzle being solved with consistent distinctive colors for each number were entered depending on the player. A Clapper was used to synchronize video recordings; the clapper was labeled with the session and puzzle numbers as well. Additionally, a log for each game is collected, marking contributions to the board, erasures, and use of any shared reference tool.

Chapter 3

The Analysis

Much HCI research on the organization of behavior has been conducted in a teleological fashion in that action is described as furthering the ends of larger goals. In our work the fact that the artifacts' organization of behavior in the small scale was not particularly well specified by the larger goals feeds into the main concern, which is pointing out precursors of coordinative behavior.

In this thesis, the focus is on the kind of communicative work that different openings are doing, and how each individual frames the communicative task when given the option of talking and, or doing.

This chapter contains a detailed description of our analytic process. Participants' responses to the questionnaires are listed. The qualitative data processing forming the core of this thesis is showcased.

Questionnaires

As mentioned earlier participants were handed two types of questionnaires, one pre-questionnaire before they started playing and two post questionnaires one after each game. The pre-questionnaire collected demographic data in addition to information related to the participants perspective of puzzles, Sudoku and computers.

Pre-Questionnaires

One pre-questionnaire was filled before the beginning of the session. This was intended to collect information about participants' previous experience with gaming, computers, and puzzles in general and Sudoku. Almost all participants reported that they

know how to play Sudoku (98%), 4 said they did not know how to play Sudoku (3%), however only one person mentioned that he was not familiar with the game in the first minute, that person was a part of a mixed gendered 3-people group. When participants were asked what do they associate with solving a Sudoku (89%) checked the personal challenge box, See Figure 6.

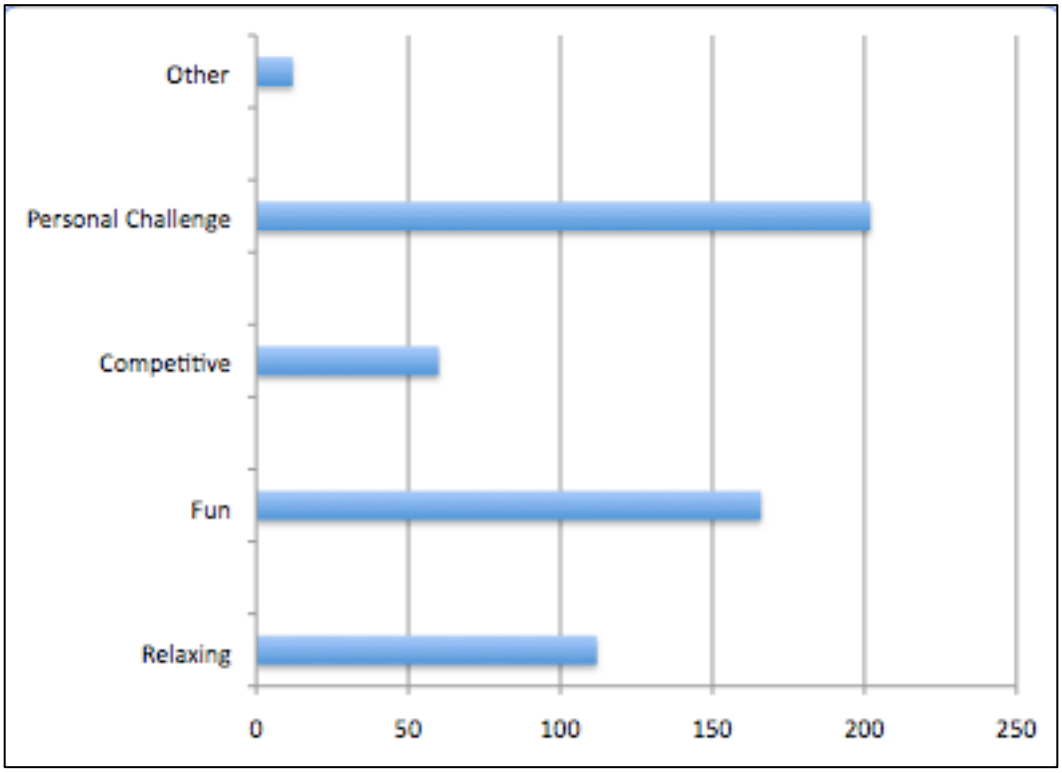

Figure 6: Answers to what do you think about solving puzzles or Sudoku? (Check all that apply)

Using a Likert Scale that is numbered from 1 to 7, with 1 meaning rarely and 7 meaning several times a day, when participants were asked how often they play computer games: 1% chose "several times a day" and 35% chose "rarely". When asked how often they play non-computer games with friends 0% chose "several times" a day, while 18% chose "rarely", the majority 32% chose number "3". When asked how often they tried puzzles again 0% chose "several times a day" and 17% chose "rarely" and the majority 27% chose number "2". However, when asked the same question in regards to playing puzzles but with friends an overwhelming majority 64% chose "rarely" and 0% chose "6" and "several times a day" See Figure 7.

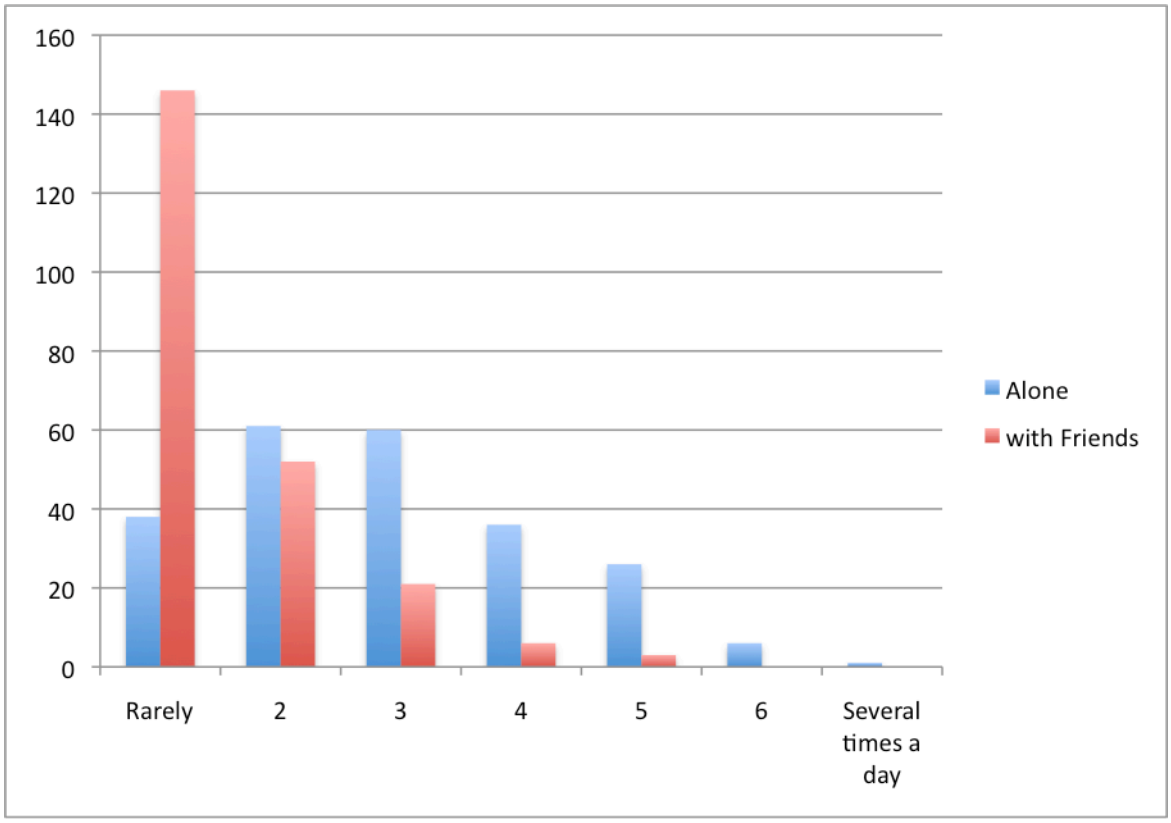

Figure 7: Participants answers to Likert scale question, how often do you try puzzles?

When participants were asked how often they play Sudoku 0% chose "several times a day" and the majority 32% chose "rarely". When asked how often they try Sudoku on computers, or gadgets the overwhelming majority 71% chose "rarely" and 0% chose "several times a day". And when asked how often they try Sudoku on paper and pencil or pen the majority 39% chose "rarely" and 0% chose "several times a day". See Figure 8 for a closer look at the difference.

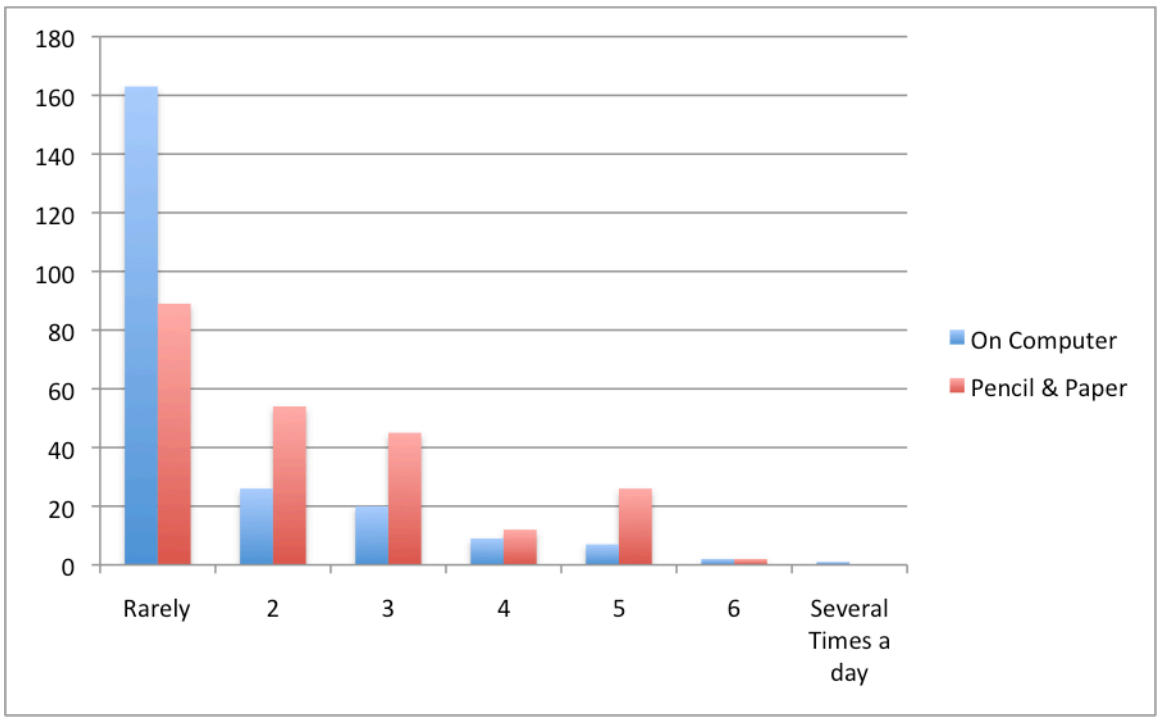

Figure 8: Participants answers to Likert scale question about how often they try Sudoku on computers and another question about how often they try Sudoku on Paper and Pencil

In a different set of questions that are Likert scale questions as well, but where asking about how the participants rates their enjoyment from 1 which equals "not at all" to 7 which is "very much". The question how much do you enjoy puzzles 2% chose" not at all", 7% "very much" and the majority 30% chose "5". While when asked about how much they enjoy Sudoku puzzle 2% chose "not at all" and 11% chose "very much" and the majority 29% chose 5. See Figure 9.

When asked how much participants enjoy playing Sudoku on a computer 8% chose "not at all", 4% chose "very much" and the majority 29% chose "4". When asked how much they enjoy playing Sudoku with Pencil and Paper 2% chose "not at all", 11% chose "very much" and the majority 27% chose "5". See Figure 10.

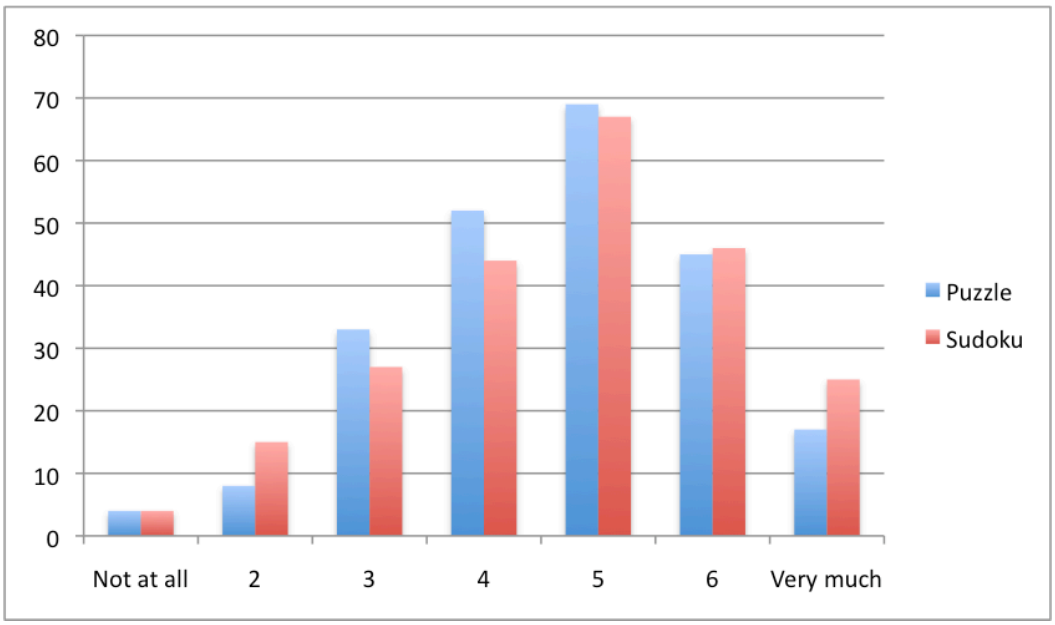

Figure 9: Participants answers to Likert scale question rating their enjoyment of Puzzles and another question rating their enjoyment of Sudoku

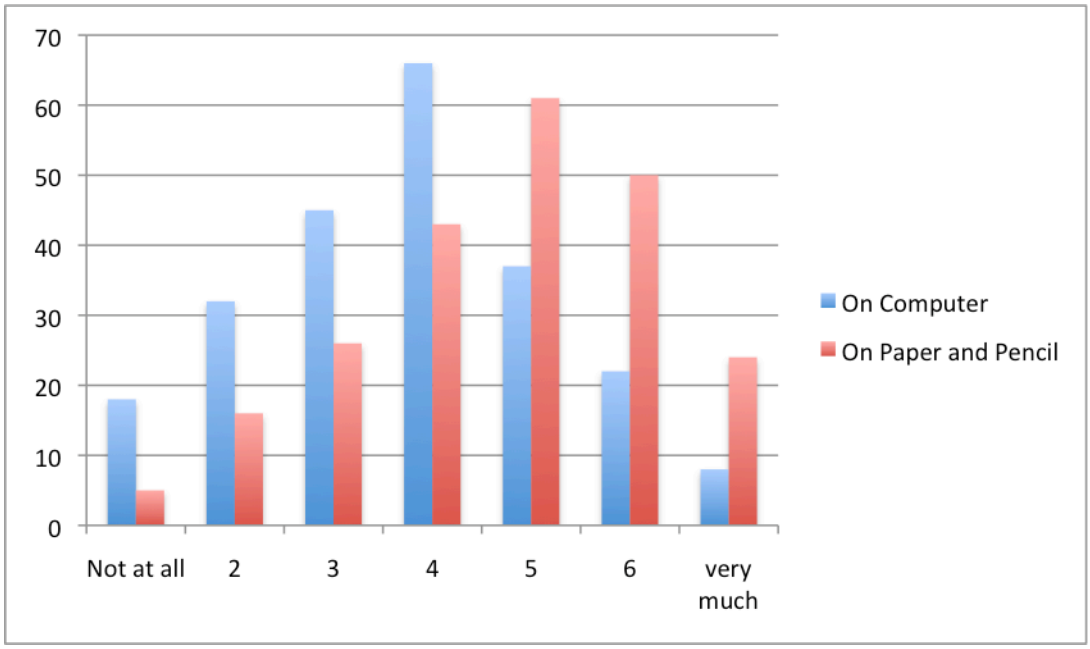

Figure 10:Participants answers to Likert scale question rating their enjoyment of Sudoku on computers and another question their enjoyment of Sudoku on pencil and paper

What does that tell us?

All participants know how to play Sudoku, and Sudoku is generally associated with positive things, mostly "personal challenge" that hints to the pre thought of challenge and

hard. Also playing Sudoku with friends is a rarity so they are not used to it. Another interesting aspect is that in spite of the popularity of Sudoku Gadgets and computer games to play it, the overwhelming majority rated pencil and paper is more enjoyable.

Post-Questionnaires

Two identical post questionnaires were administered one after each puzzle. This was to collect information about participants' reflections regarding their experience with the tool, the group and in general. In the interest of our thesis we will focus on the first one.

When asked a Likert scale question about their enjoyment where 1 was "did not enjoy at all" and 7 was "enjoyed it very much", 1% reported that they "did not enjoy at all", 7% chose" enjoyed it very much" and the majority 37% chose "5". When asked how much did they enjoy playing with their team members 0% chose "not at all", 18% chose" enjoyed it very much" and 5% did not supply an answer while the majority 29% chose "4".

Asking about the difficulty of the puzzle the 1 in the likert scale was " very easy" and 7 was "very hard', 0% of participants chose "very easy", 19% chose "very hard" while the majority 37% chose "6".

In the question about how they prefer to play Sudoku they were offered two answers to choose from 61% chose "Alone", 35% chose "With a Team" while 4% did not supply an answer. When asked if they would play Sudoku with others again. 81% said "Yes", 14% said "No" while 5% did not answer.

In questioning more about how they felt about their team, one likert question asked how much were they satisfied with the team and how it worked together, with 1 being "not at all satisfied" and 7 "very satisfied". 1% chose "not at all satisfied", 16% chose "very satisfied", 5% did not answer and the majority 28% chose "5". Another one asked about how much did they enjoy working with other people 0% chose "not at all", 14% chose "enjoyed it very much", 4% did not answer and two equal percentages formed two majorities were 24% chose "6" in addition to another 24% choosing "4".

When asked how much confidence did you have that other people understood what you were talking about with 1 being "not at all confident" and 7 being "very confident", 3% chose "not at all confident", 18% were "very confident", 4% did not answer and the

majority 30% chose “6”. While when asked how well they understood what other people were explaining, with 1 being “not at all” and 7 being “completely”, 4% chose “not at all”, the majority 27% chose “completely” while 7% did not answer. For a comparison of how participants in general perceived of the situation in terms of understanding and being understood See Figure 11.

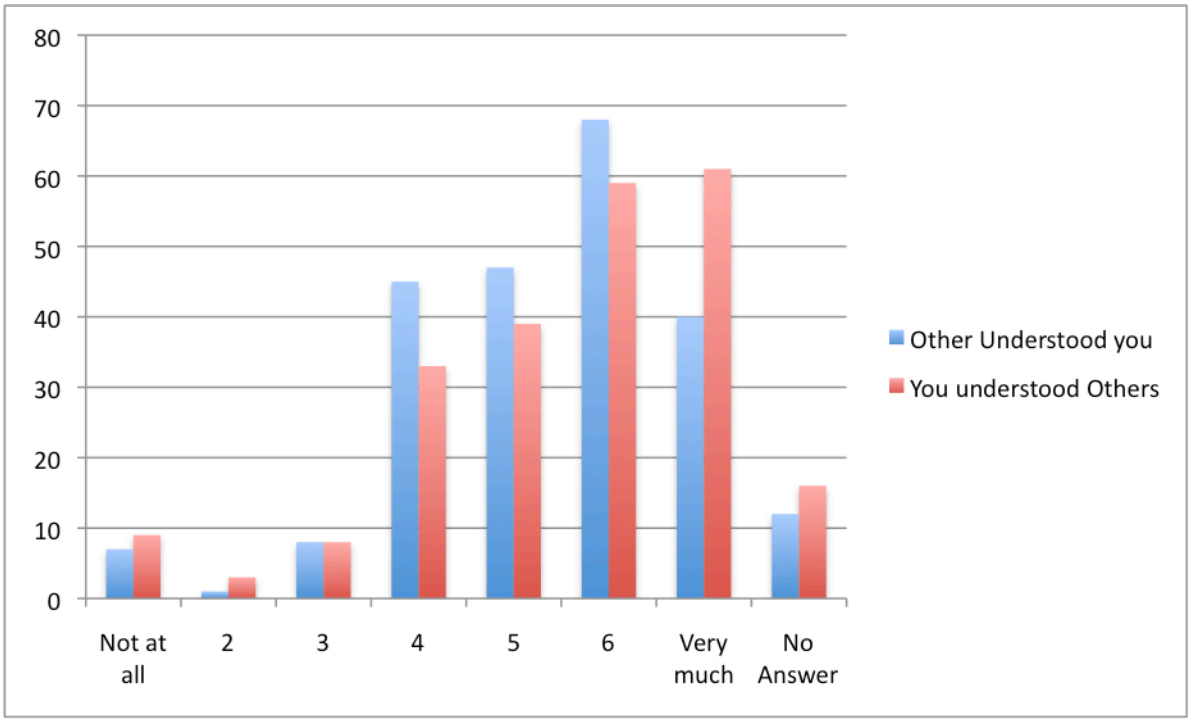

Figure 11: How participants in general perceived of the situation in terms of understanding and being understood. Answers to two Likert scale questions.

Qualitative Analysis

Qualitative analysis constitutes the core of our focus, specifically, the first minute of the first game played by participants. Following is a description our process.

The Iterative Cycle

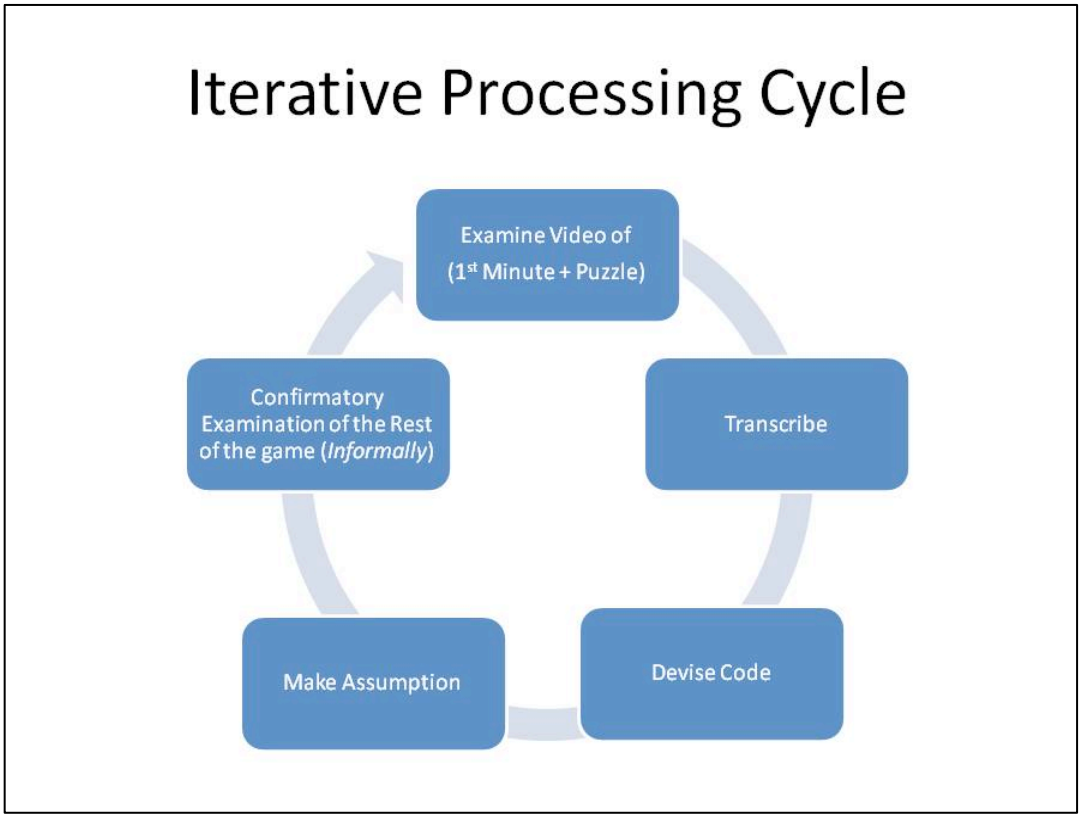

Figure 12: Iterative Processing Cycle

Analysis consisted of several steps constituting an iterative cycle. First we conducted a verbatim transcription of the verbal utterances of the first minute of video, then examined the video recordings and transcripts of the first minute in sync with the screen capture of the puzzle. We also considered any information about activities before the session began officially. Finally, we commenced a more formal process of code development, using a Grounded Theory approach. Each transcript was examined for patterns or codes (Strauss & Corbin, 1990) . After locating each tentative code, we developed a preliminary assumption related to how the group was coordinating to frame the activity. Each code was studied as it occurred in the rest of the first minute. Finally, we examined the rest of the video of the first game (un-transcribed part) informally with respect to the codes we had developed. See diagram Figure 12.

The Process of Analysis: Transcription

The examination consisted of transcribing and analyzing the first minute of the first game for all groups. All groups 87 groups consisting of 44 dyads and 43 triads. The rules we formed and followed in our transcription of each session are listed in Table 2.

In addition, transcription included noting all verbal utterances in a format derived from (Du Bois, Schuetze-Coburn, Cumming, & Paolino, 1993), supplemented by gestural notations, when participants use their hands to gesture on their screen or to another participant, and the use of reference tools and grid related action the details of those transcriptions are that: all reference tool actions have been transcribed. All other action on the grid (inserting numbers, inserting notes, deleting numbers, deleting notes) was not with the exception of the following:

1- Right before and right after a participant says

a. "I was gonna do that"
b. "What are you doing?" or "did you just erase mine?"
c. "This is wrong"
d. "Oops" every immediate gird action right before the "oops" utterance and right after it is transcribed
e. "See that one"

2- When participants have agreed on a final plan. This is to check if they conform to it.

3- When one participant is teaching the other/s or thinking her process out loud while performing actions on grid.

4- When no talking occurs: only the use of reference tools and the first immediate subsequent action is transcribed.

Table 2: Rules of Transcription

Rule	Explanation
Heading	1. Session number 2. Tool Reference type as (Basic, Highlight, MultiPointer, or SharedPointer) 3. Session participant designation by number, gender and seating arrangement 4. Notes Example: Session 53 Multipointer 2 Male (B,C) / 1 Female (A)
Beginning	Time stamp, beginning of game Example: [00:00:07.24] Game 1 starts
Participant Turn Marker	A,B or C, followed by a colon. (Example A:) The letters references fixed seating positions counter clockwise from Camera2 See Figure 5: Camera Positions
Investigator Turn Marker	I followed by a colon Example I:
Gesture or Sounds	Enclosed between double brackets and in capital letters Example B: ((MUFFLED LAUGH))
Action on Game Grid	Enclosed between double brackets and in capital letters. Cells are referred by position on grid Example ((B PUTS IN NUMBER 1 IN CELL 8,8))
Notes before game starts	Anything observed before the game starts is written down between square brackets before beginning of game annotation. Example []
Partly undistinguishable words	Sounds of letters that can be made out are written down. Stars in the place of unknown letters or sounds Example h**er*
Completely undistinguishable words	When an utterance is completely undistinguishable, the word Inaudible is in its place enclosed in double brackets Example ((INAUDIBLE))

Table 2: Rules of Transcription

Rule	Explanation
Overlapping utterances	Overlapping is marked at the utterances level. Overlaps are marked ((Over lapping with)) then letter of participant overlapped is included. The same is appended to other participants' utterance. Example: B: kinda have to use them all that's the problem ((OVER LAPPING WITH A)) A: yeah ((OVER LAPPING WITH B))
Interrupted utterance	Interruption is marked at the utterances level. Interruptions are marked ((Interrupted by)) then letter of participant interrupting is included. The interrupting utterance follows in the next line. Example: A: so that ought ((LOW VOICE)) ((INTURRUPTED BY B)) B: so that oughta be a 6 as well
Thinking out loud	When participant seem to be talking to herself, by not guiding her utterance in a noticeable direction, and not waiting for a reply, that is noted on the utterance level by adding a TO SELF tag embraced by double brackets. Example: A: okay ((TO SELF))
Change in voice volume	If participants voice is noticeably lower that is noted at the utterance level by appending a low voice tag embraced in double brackets. Example ((LOWER VOICE))
Stuttered utterance	When stuttering is present in an utterance the stuttered letter is repeated once with a hyphen. Also, a comment at the end of the utterance is included between double brackets. Example: A: alright so you guys wanna work on the same square or wanna **s-**split up and work d-different different areas ((STUTTERS))

In the mentioned conditions the actions on the grid were an integral part of the utterance, all parties related to the utterance (speaker and addressed) acknowledged it. Not transcribing the grid action when the previous conditions applied prevented a key understanding of the nuances of an utterance.

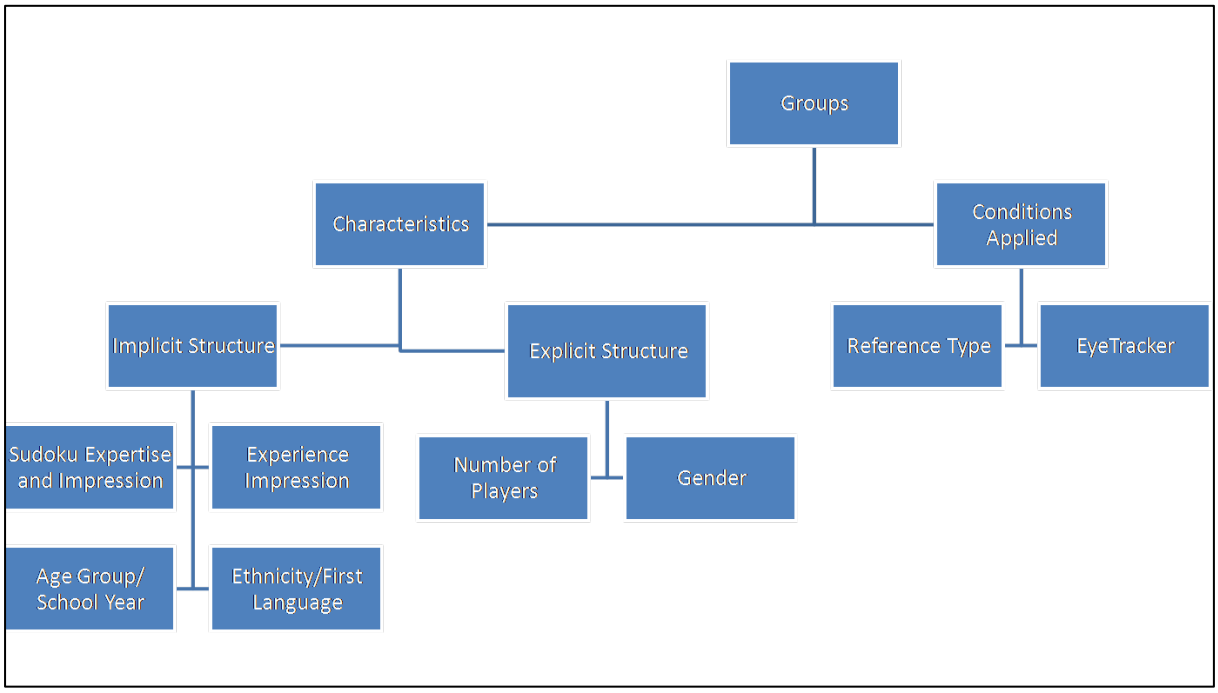

Figure 13: ***A Priori*** **Potentially Important Group Conditions and Characteristics**

Groups

In recruiting participants, the only stipulation we gave in the call for participation is that they would be familiar with Sudoku rules. Nonetheless, the purpose of Sudoku as a puzzle is explained at the beginning of the walk-through. Given that no other conditions were placed on participants, we ended up with a diversity of group types that could provide a basis for categorization. This diversity could be in terms of group characteristics, by conditions applied or by certain types of behavior. Groups' categorization is present in the graph Figure 13. Following is their discussions in detail.

Group Characteristics Description

This is representative of all the given facts related to the composition of the group. Some facts are obvious to the naked eye, like the gender of the players, the number of players involved and whether the players knew each other before coming into this experience. That's the explicit section. Acknowledging the fact that the later two conditions might not be entirely explicit in all situations. In our sessions, the investigator introduced participants to each other and any comments regarding prior acquaintance was noted 3 groups 2 dyads and 1 triad involved participants that knew each other.

In relation to number of players per groups, a total of 87 groups were examined. 43 3-people groups or triads and 44 2-people groups or dyads. In terms of gender per group we had 31 same-gender groups and 36 mixed-gender groups amongst dyads and triads, See Figure 14.

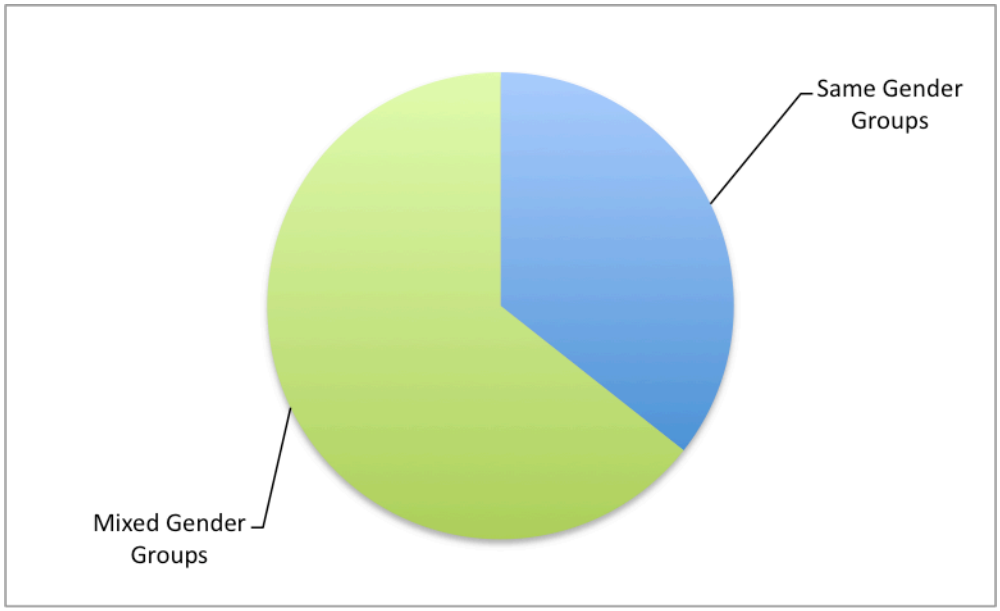

Figure 14: Distribution of Same Gender Groups and Mixed Gender Groups in Relation to All Groups

Throughout the sessions most participants sought out the implicit or unseen part of the group characteristics, such as Sudoku expertise, Sudoku impressions, experience impression, age and class standing, ethnicity and first language.

It is worth noting that while these are *generally* hidden characteristics of the individual and group, the degree of their ambiguity varies depending on the person and

situation. Some information *could* be construed within the first few seconds of exchanging utterances (i.e. first language), at the same time, that same information (first language) might never be apparent. The same applies to all categories that come under the implicit structure.

Some methods participants used to elicit this information were direct questions and a form of self-announcement then waiting for others to follow.

Experimental Conditions

This was discussed in the previous chapter. In TeamSudoku there are four different variations for reference support: Basic, no specific tool was allocated for the sole purpose of referencing; Highlight, tool used for content-specific referencing; and Pointing, shared pointer which allows for multiple content-free referencing. We used an equal number of groups for each condition. See Table 1.

The eye-tracking system was applied to half the dyads and 10 of the triads. The use of this tool created its own specific challenges, such as the inconvenience of having a device mounted on one's face, and the fact that it actually hindered the vision of participants who use eyeglasses because it did not mount comfortably over eyeglasses. While no participant voiced a complaint in regards to not being able to see, including participants who needed to take off their glasses, in consideration of the particular nature of our situation, the effect is worth noting.

Observed Behavior

When looking into the first minute of interaction between two or three people in a group, every choice each person makes holds implications for the framing process. These choices are one of the very subtle visible evidence of how individuals come to conceive of the situation at hand.

From examining the first minute of play for 87 groups, one distinctive difference was whether or not the members in the group chose to talk. Each group was asked to play and solve a Sudoku puzzle together, and it was made clear that participants were allowed to talk. Additionally, groups were given a challenging puzzle to solve in a limited time

frame. The fact that some groups went through the whole first minute without talking is intriguing.

Most groups (63) started by establishing verbal contact, that is, by talking with one another. Of these *talking* groups 32 were dyads and 31 were triads.

The rest of the groups (24) said nothing in the first minute, of these *non-talking* groups 12 were dyads and 12 were triads. Instead they focused on their screens and entered numbers. For an extended look at how talking and non-talking groups were distributed amongst their gender and number of players see Figure 15 and Figure 16 for dyads and triads respectfully.

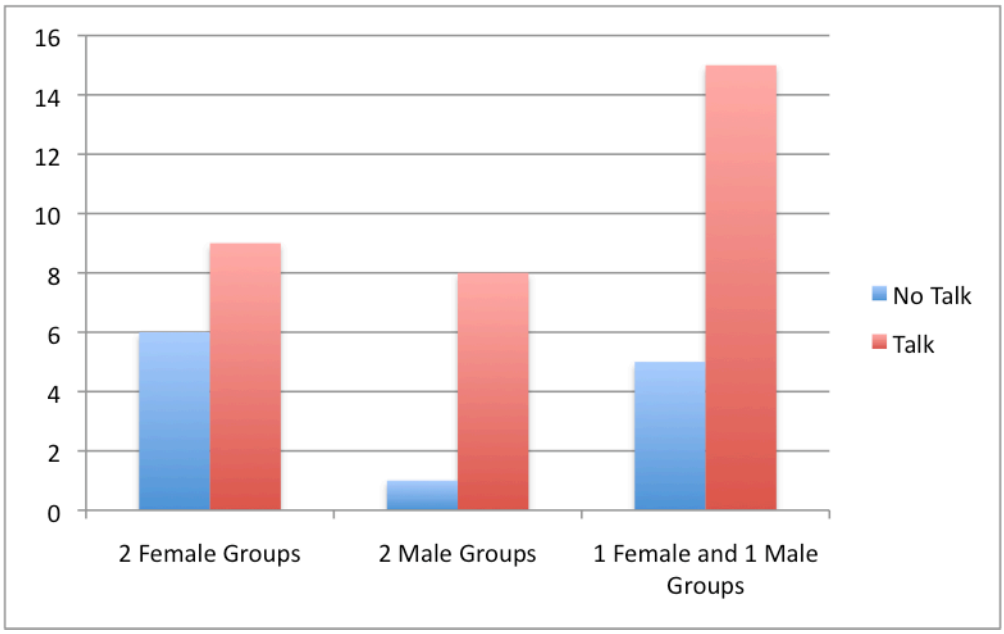

Figure 15: Distribution of Gender Amongst Dyads

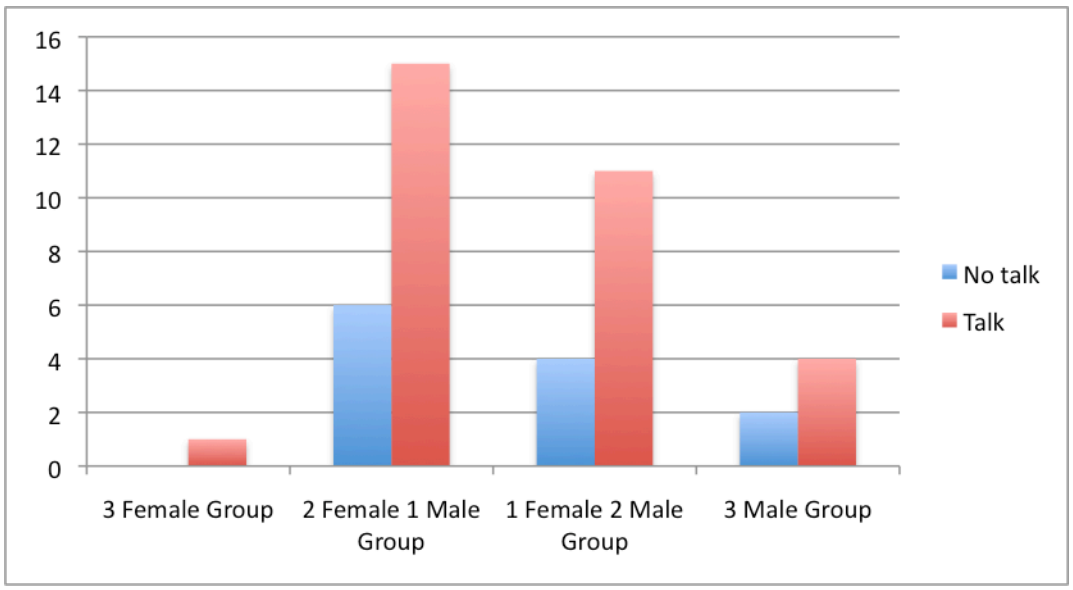

Figure 16: Distribution of Gender Amongst Triads

For groups who chose not to exchange utterances, on some occasions, without talking, players even changed numbers that someone else had entered into the grid. This behavior raises the question of whether, when and to what extent these groups were coordinating verses just acting.

The Case Of "Oops!"

Out of 87 groups, 24 groups did not exchange utterances throughout the first minute, and 12 of these groups continued throughout the whole 15 minutes with little or no talking. 9 of these groups started to talk during the last 5 minutes of the game, while 2 groups changed their behavior before half the duration of the game was over. Then there were the rest of the groups whose members communicated readily through words, sounds and gestures throughout the experience.

What Is Talk?

While distinguishing who talked and who didn't seemed obvious in the beginning, the question of what constitutes talk arose. Would a single utterance of "Oops!" and only that word, with no verbal response from other players throughout the first minute, be

considered talking? What about just making sounds (i.e. “tisshhhtisshhh”)? In addition, the same question can be asked about talking in a very low voice as if to oneself. While this has been studied in the field of linguistics, it was not entirely clear how to deal with it in our situation.

The *transitive* meaning of the word talk from Merriam Webster is:

1: to deliver or express in speech: Utter

2: to make the subject of conversation or discourse: Discuss

3: to influence, affect, or cause by talking

4: to use (a language) for conversing or communicating: Speak

This information sheds more light on our uncertainty. Although *talk* is synonymous with *to utter*, it has connotation with a response. In other words, “talk” is not dichotomous, but should be looked at as a functional spectrum. We decided, in the interest of our study to consider utterances talk if they were words, and semi-talk if they were just a sound or a non-direct comment like “Oops”. We called groups that did not exchange any utterance through the first minute no-talk groups.

There were a few groups (6) who did not exchange talk but fell under the semi-talk category. That would make the final numbers: 18 groups that did not talk at all, 6 groups that semi-talked and 63 that talked all related to the first minute of play.

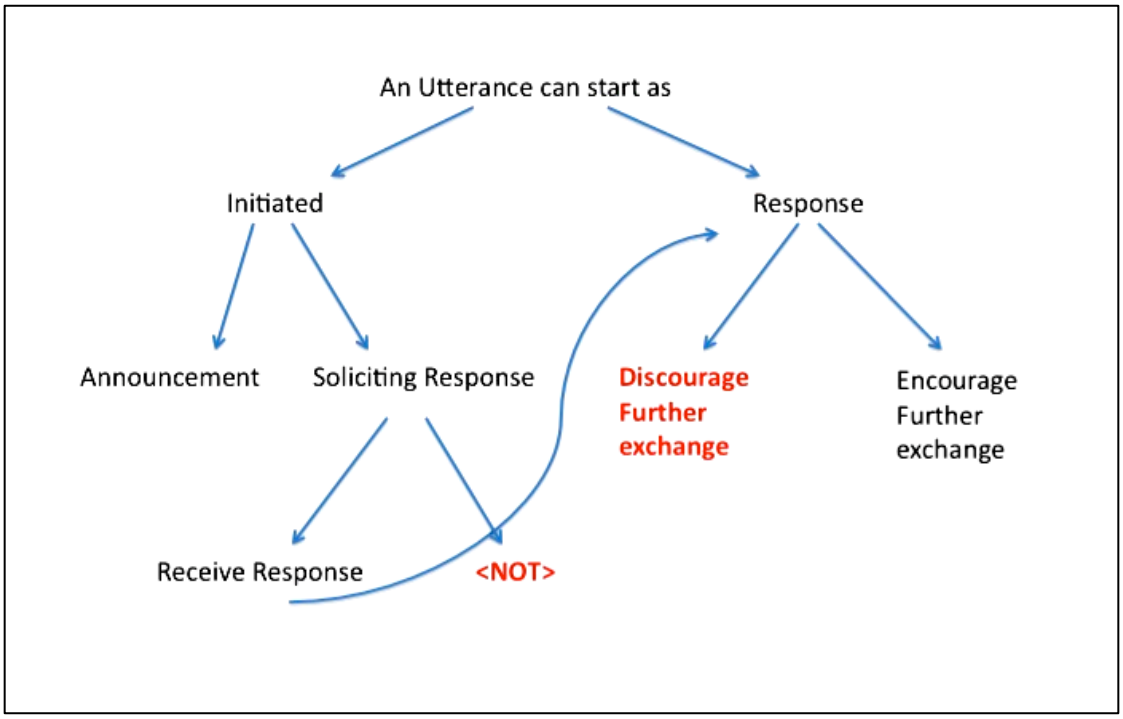

Figure 17: Observable Flow of Utterances

When Participants Talked

When groups did talk in the first minute, the first minute was defined as everything the participants did or said after the researcher used the film clapper to synchronize multiple recording media. After transcribing the first minute of the first game, we analyzed the interactions iteratively using a combination of interaction analysis (Jordan & Henderson, 1995) and grounded theory (Strauss & Corbin, 1990) . It was noted that an utterance a person makes could be categorized as either initiating, or responding. When an utterance was initiated, it could either be an announcement, a thought spoken aloud, or a question explicitly soliciting response. When soliciting a response, that utterance could receive a response that either encouraged further exchange or discouraged it. However, utterances might not receive responses even if they seemed to ask them. See diagram Figure 17.

Codes

Licensing Code

Table 3: Categories of Initial Utterance

No-Talk	No verbal exchanges occur.
Disclaimer:	An announcement of inability to play adequately
Notification	Is a narration of the process a person is engaged, usually characterized by being softer in volume and less distinct than other communication
Negotiation	Initiate a response to the verbal presentation of a problem

Table 4: Types of Negotiation

Territorial	Claiming or ceding authority over either a feature in the tool (mostly the reference tool) or a region (area) on the grid.
Planning	Planning Proposing and asking how to proceed with solving the puzzle, usually encompasses other negotiations including negotiation style (implicitly or explicitly).
Devise Code	Proposing and accepting an assignment of specific meaning to the use of a tool or accumulate use of tools (notes, reference tool).
Query	A question, directed to the other person in regard to a change to the condition of the grid, that mostly the other person is responsible for a reply to such a query.
Reference Resolve	An exchange of pointing turns that resolve in one person guiding the others attention to a preset destination on the grid.

First, we created a rough categorization of behaviors and then refined our analysis to describe more particular similarities and differences across groups. Building on Brereton and her colleagues, we argued that, although these categories are not entirely mutually exclusive, the ambiguity is (a) inherent in the activity, and therefore, (b) does not distort our vision, and (c) still allows useful insight into the coordination behavior of co-located groups of individuals who are using technology together(Brereton, Cannon, Mabogunje, & Leifer, 1996). High-level categorizations of framing behavior are shown in Table 3: no verbal, disclaimers, notifications and negotiation. Negotiations were further broken down into five types as in Table 4.

Disclaimers included a potential tacit apology for the inability to play or perform adequately in the situation. Disclaimers appeared in 27 groups, 10 of these groups were triads and only in one group as the only topic, 17 of the 27 groups were dyads and again only one of the dyads used Disclaimer as the only initial topic.

For example, in Excerpt 1, Annie starts out "This one is hard" and when Bob agrees, she subsequently asks him "do you play very often?" This interaction results in a mutual assertion of a relationship to the problem at hand. Disclaimers were extremely common. All disclaimers except one, shown in Excerpt 2, referred to playing the game. Excerpt 2 shows Carrie talking about how to communicate in the game: "I don't really know how to talk about this!" Interestingly, the issue that concludes the interaction is an important one in computer-mediated communication--trust. Carrie says, "I trust you!" What, precisely, is this trust in or for? Conversation analysts would probably argue that the trust is that her partner will do the work that has to be done to achieve adequate understanding of the task.

Excerpt-1: A Disclaimer

Annie: this one is hard
Bob: yeah
Annie: do you play very often?
Bob: no, not a lot

Excerpt-2: A Disclaimer about Process

Carrie: I don't really know how to talk about this! ((LOOKS AT BECCA))
Becca: I know ((LOOKS AT CARRIE)) ((SMILES))
Carrie: ((LAUGHS))
Carrie: I trust you

Notification acts are announcements of a concurrent action or reasoning process that the speaker appears to be engaged in. Notifications appeared in 52 groups, 25 of these groups were triads, and 27 were dyads. Of the 25 triads that included Notifications in their initial topics only 1 triad mentioned it as the only topic, and none of the dyads initial topics included Notifications only.

They are often uttered in lowered tones, as if they are not full bids for attention. At first, we interpreted these as an effort towards coordination in grounding, towards letting the other person know what the speaker was doing. However, we noticed that notifications occurred most often in situations in which the speaker appeared to be in trouble. Excerpt 3 starts just after Tom had put two numbers on the grid. It shows him making a notification ("Ummmm, that's all I got"). When this receives only a backchannel acknowledgement from Cindy ("alright"), he repeats the notification "Ummm… Yeeaaah" and then adds a disclaimer. Notifications may do more than alert the partner to problems; they may be part of opening up a bid for help. Their role in asking for help is reinforced by the fact that most notification utterances are followed with either a disclaimer or a direct negotiation.

Excerpt-3: Notification Acts followed by a Disclaimer

Tom: Uummmthats all I got ((MUFFELED LAUGH))
Cindy: alright
Tom: Ummm… Yeeaaah
Tom: Should practice a little more I haven't done this in a while
Cindy: It'll be fine
Tom: Hmm
Tom: Alrighty

In Excerpt 4, Terry has successfully engaged Susan in the activity of solving the puzzle together. He engages in a sequence of notification acts in a lowered voice, until

finally she participates actively by asking "Why?" The reduced volume of notifications appears to give the speaker a kind of deniability. Until the utterances are treated as communicative by the other(s), the speaker can say he is just talking to himself.

Most of the initial interactions, 56 groups, in our sessions were *negotiations,* that is explicit discussions between two people about how to proceed. Of these 56 groups 27 groups were triads and 29 groups were dyads. Of the 27 triads that included *negotiations* in their initial topics only 3 were triads and 2 were dyads. *Negotiations* focused on five different issues.

Territorial negotiations had to do with claiming or ceding authority over a feature in the tool or the grid, as in "Please don't move the [shared] pointer while I'm…." or "I'll look in the middle row, it's got a lot of numbers."

Planning utterances focus on the discussion of a process, and *Devising a Code* indicates a proposal about how to use the tool. Planning is usually laid out as a proposition, as in Excerpt 5. As in Excerpt 6, sometimes it starts with the assertion "I always start by…." These differed in tone, with Excerpt-7 being a very directive plan and Excerpt-8 being tentative.

Excerpt-4: A Series of Notifications followed by the Partner's Entry into the Activity

Terry: Ok Terry: This first one it can't be a 1 ((LOOKING AT SCREEN)) Terry: It has to be a 2 ((puts a 2 note in a cell)) it cant be a 3 or a 4 it could be a 5 ((PUTS A 5 NOTE IN THE SAME CELL)) it could be a 9 ((PUTS A 9 NOTE IN THE SAME CELL)) Susan: why? Terry: ((INADUBILE)) Terry: Soo... look at the lower right hand, see it cant be a 1 or 2 3 or 4

Excerpt-5: Brian Discussion of Planning

Brian: Can we just fill'em in and then switch on along the way or somethin ((LOOKING AT ALE))
Alex: Ummm…
Alex: Yeah we can try that ((LOOKING AT BRIAN))

Excerpt-6: Julie proposes and explains a plan to Michael

Julie: ((POINTING AT SCREEN WITH FINGER)) I always start by trying to find the numbers that are... in the puzzle the most, and like ((STOPS POINTING WITH FINGER AND PICKS UP REFERENCE TOOL))
Michael: like nines
Julie: yeah
Julie: see theirs two nines right there ((POINTING WITH REFERENCE TOOL)) it can't go in any of these two boxes so it has to be right here ((CONTINUING POINTING WITH REFERENCE TOOL)) see theirs a nine right there
Julie: ((PUTS IN A 9))Yaayi

Excerpt-7:

Ashley: ((LOOKING AT SCREEN)) first thing I'm looking at right now is ((CLEARS THROAT))like the middle three boxes... like horizontally ((GESTURES WITH HAND))
Karen:((LOOKING AT SCREEN))
Karen: ((NODES LOOKING AT SCREEN))
Ashley: You see lets use the clicker ((USES REFERENCE TOOL TO POINT)) Umm you see that 3 ((POINTS USING REFERENCE TOOL))
Karen: Uh-hm ((NODES LOOKING AT SCREEN))
Ashley: And you see that 3
Karen: ((LOOKS PUZZLED AT SCREEN))
Ashley: That 3 ((POINTS USING REFERENCE TOOL))
Ashley: so you have one that 3 ((POINTS USING REFERENCE TOOL))
Karen: ((LOOKS UNDERSTANDINGLY AND NODES LOOKING AT SCREEN))

Excerpt-8: Devising a Code in a Tentative Way

Rob:Umm... if you see something just like highlight it for me and then umm
Jeannie: OK

Discussion of Licensing Code

On the one hand, each of these examples and categories shows quite different ways of framing the interaction needs of the situation. The difference between the people who say nothing and those who give disclaimers or notifications are at once different in stance

toward the game and toward defining the mutual endeavor with the other player. The different types of negotiations call out what is seen as problematic or important by the players. In the future, we will examine how this initial framing effects subsequent coordination and reported outcomes.

When focusing on the kinds of work different openings do, at first all licensing code categories seemed to be omnipresent, however counting the occurrences of each category within the first minute (from clapper to the completion of 60 seconds) showed that not all categories appear in all groups, however a distinctive mark is that very rarely would one category appear by itself (3 groups and less in triads) and (2 groups and less in dyads) in both cases the highest occupancy for a category by itself was for Negotiation, which involved all its sub division, the insight we can get from this is that when one goal is to be discussed it would most likely be Negotiation related to the grid and puzzle, how our participants conceived of the situation in that regard.

Another matter to note is that Negotiation and Notification went mostly hand in hand as the highest occurring category together (17 of 31 *talking* triads) and (13 of 32 *talking* dyads). For those two topics to appear in that frequency makes indication for figuring promptly in framing coordination together to constitute the situation See Figure 18 and Figure 19.

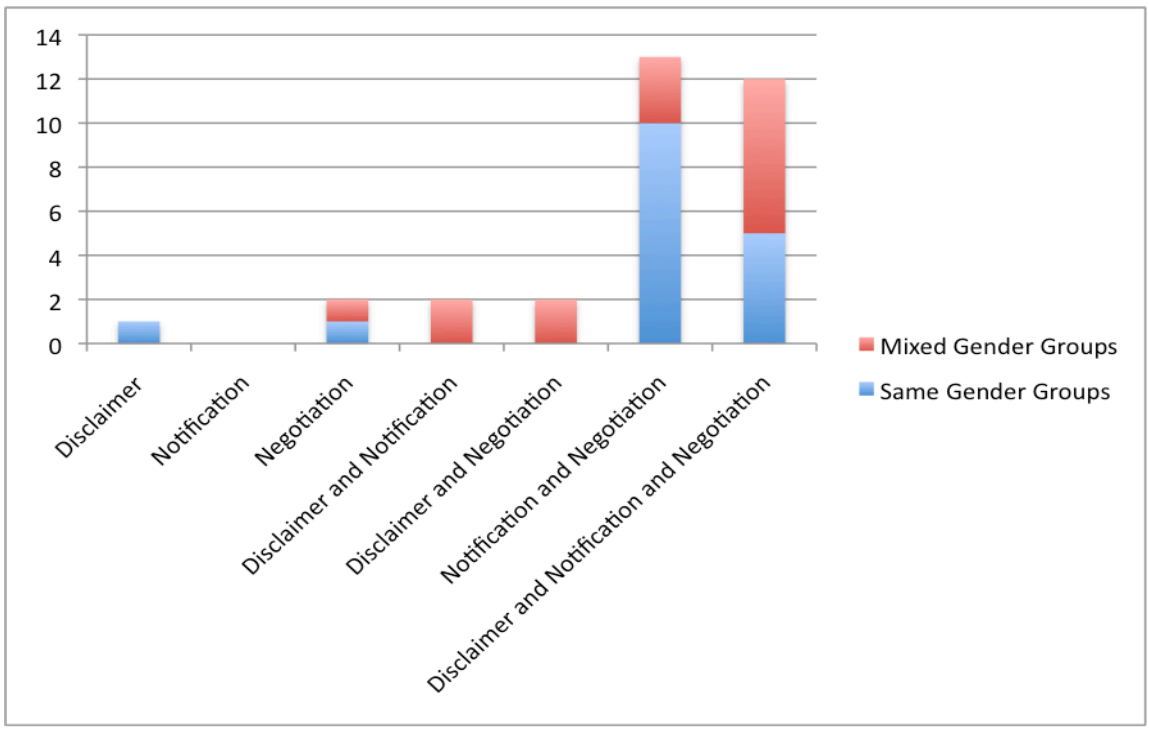

Figure 18: The Occurrences of Each Code in Dyads with Gender Distribution Distinction

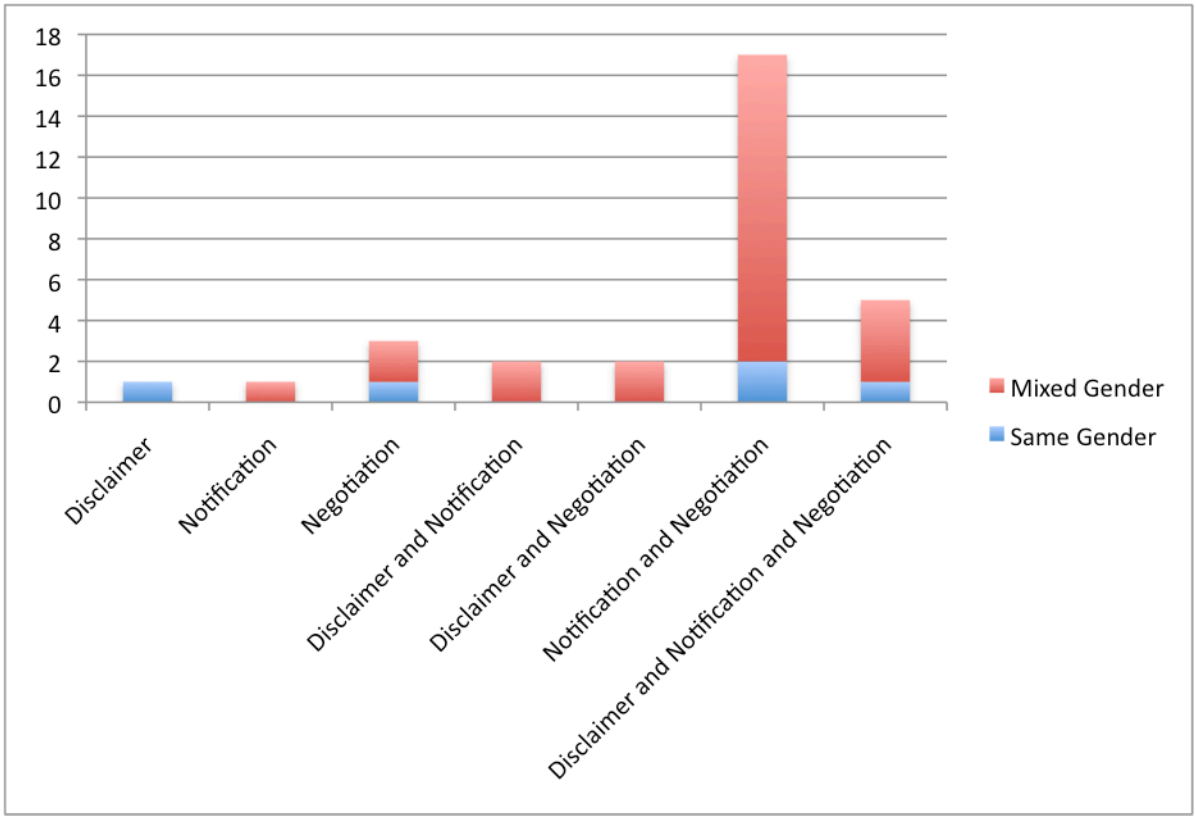

Figure 19: The Occurrences of Each Code in Triads with Gender Distribution Distinction

Relational Code

Goffman explains; the framing of a situation is "built up in accordance with principles of organization which governs events & our subjective involvement in them." Hence, how a user defines his or her role in the situation is paramount.

Studying what the groups did and said in the first minute lends itself to an examination from a different approach, this approach, while still focusing on the kinds of communicative work different openings do, is also paying special attention to the effect of the presence of the computer itself, and how this is reflected in the way participants perceive their role, other's role and the computer's role and the role of each relationship.

- **Getting Attention**

Excerpt- A: First Minute of Triad of Mixed Gender

A: Kay... How is it... do you wan do you want to start... any idea? I mean do you wanna just go for it?...
B: I'm looking at the bottom right corner ((LOOKING AT SCREEN))
A: I got 9 right there
A: 9 right there ((IN LOWER VOICE))
A: ((PUTS 9 IN CELL 9,9))
A: yeah ((WHISPERS))
A: Thats a 3 ((LOOKING AT SCREEN))
C: ((SNIFFS))

- **Respecting attention**
  - In Excerpt- A we might say that A is respecting others' attention to the board, by using his low voice, and not actively demanding their attention while still making himself heard.
- **Waiting for attention**
  - We notice that in Excerpt- A it is a session for a group of 3 people but only 2 people are narrating, we might say C is waiting for attention in being quite and not participating in general form of talk.

- **Meaning**: in relation to the meaning of the situation mostly in concern with the puzzle's grid.

Excerpt- B Dyad of Same Gender

B: Ok B: this first one it can't be a 1 ((LOOKING AT SCREEN)) B: it has to be a 2 ((PUTS A 2 NOTE IN A CELL)) it cant be a 3 or a 4 it could be a 5((PUTS A 5 NOTE IN THE SAME CELL>)) it could be a 9 ((PUTS A 9 NOTE IN THE SAME CELL)) A: why? B:((INAUDIBLE)) B: Soo... look at the lower right hand, see it cant be a 1 or 2 3 or 4 A: which one? B: the lower right hand ((PUTS IN A 5 NOTE)) A: oh OK B: it can be a 5 but it can't be a 6 or a 7 B: so it has to be an 8 or a 9((PUTS IN 8 AND 9 NOTES)) A: yeah

- **Grid or action**

In Excerpt- B participant B is walking her teammate through her thought process by talking out while changing the state of the grid with explanations of her actions. A follows B's train of thought by inquiring about the explanation.

- **Meta**

Excerpt- C : Triad of Mixed Gender

~ First minute starts ~
B: ((CLEARS THROAT))
B:O.. E.. how do you guys think we should do this?... just do it
C: yeah ((OVERLAPS WITH A))
A: yup ((OVERLAPS WITH C))
A: Lets hope we..
A: ((PUTS A 7 IN CELL 7,6))
B: Awwh I was gonna do that ((LOOKING AT SCREEN))
A: ((LOOKS AT B AND SMILES)) I guess thats where we'rgonna have all the trouble
B: I'm really not good at this ((SMILES LOOKING AT SCEEN))
((MUFFLED LAUGH))
((A and C are filling in the 7s))
C: tochchchhh ((MAKING SOUND))
B: too many 7s
C: Heh ((SMILE))
A: I think they're all good though
~ First minute ends ~

- **How shall we proceed?**

In Excerpt- C Participant B starts by clearing his throat then explicitly asks his teammates how they wish to proceed. The plan seems to be "Just do it" while implicitly he might be inviting a certain technique or more precise plan but the worm welcome his suggestion receives from both teammates end plans talk.

- **Human connection**

All form of human interaction has a human connection element embedded in it. Examples of forms of talk that embodied a certain human connection form are:

- **Bossy or Pushy**

Excerpt- D: Triad Same Gender

B: if you are already just guessing you should probably just use pencil A: Okay

In Excerpt- D B is informing A of what he thinks A should do. A agrees.

- **Indifference to Others**
-

Excerpt- E: Dyad of Mixed Gender

A: Just pluggin and chuggin? ((LOOKING AT SCREEN)) B: Me? ((LOOKING AT PARTICIPANT A)) A: Yeah ((LOOKING AT SCREEN)) B: No I just figured out all the 6s ((LOOKING AT SCREEN)) A: Oh jee thats fast ((LOOKING AT SCREEN)) B: ((PUTS IN A 5)) ((LOOKING AT SCREEN)) A: Do I put a 2 up here? B: Ehihm

-

In Excerpt- E participant A asks a question, and B answers by questioning him if he was asking her, there are only 2 players, one can argue that some effort is given to avoid connecting, that is further confirmed by B's attitude towards A continues attempts to seek connection.

Discussion of Relational Code

While this code provides a different perspective of the progression of an ongoing situation, it also allows for interesting insights into how participants choose to manage their resources, attention being one of the most important resources in a situation with high premium on coordination, not unlike the situation we chose for our participants. By allowing the groups to solve the Sudoku puzzle in various installments with no detailed

description of specific rules other than the Sudoku rules themselves, we created a situation in which the group members had to form their own rules of coordination and make their own choices about how to manage resources. This draws a more detailed picture of *what is really going on* as Goffman puts it. However, that picture by itself is not completely inclusive of all that could be derived from what happens in the first minute.

All Possible Topics of Conversation

After examining different plausible forms of codes that provide insight into the framing process and exploring how people come to perceive the situation, in different yet sometimes overlapping ways, we saw that the possibility of revealing even more codes, or ways of examining what people said and did is very likely. In that sense, additional rigorous iterations are needed to further elaborate on current analysis, and to refine it.

Every thing participants said was *segmented* in detailed in so that that it encompasses every possible topic that could have come up during the first minute of the first game.

The following is a layout using basic labeling, when appropriate, of everything participants said within the first minute, See Table 5.

Table 5: Topics of Discourse

Topics	Explanation	Example
Comments on puzzle	Referring to the grid in a general matter, with no specific outcome.	"This one is hard"
Comments on experience	Referring to the situation in general with no specific income	"This is like stressful"
" I was a bout to do that!"	In reference of an action done on the grid (putting in a number, deleting a number)	" I was a bout to do that!"
Sudoku Skills	Enquire about others skills	"B: you play these before or not A: yeah((NODES)) B: you good A: descent "
	Share own ability, or skill level: usually happens before beginning of the game	"And I can't do hard pretty good, medium is a little easy for me ((LOOKING AT PARTICIPANT A))"
Why did you do that?	Action on grid (numbers, Notes, Reference tool)	B: why do you have one highlighted
	Performance: usually occurs after an action is done in the grid	"Your good at this"
Informing of wrong move	Stating	"The one down at the bottom is wrong too"
	Questioning	"Was that correct that one you just put down?"
Looking	You?	"Are you looking at the 9s or the 6s?"
Narration	I am..	"First thing I'm looking at right now is ((CLEARS THROAT)) like the middle three boxes... like horizontally ((GESTURES WITH HAND))"
Justification	Starts with because..	"Yeah cause if you look its got like the... you got 9 on ((PICKS UP SHARED POINTER))... "

Table 5: Topics of Discourse

Topics	Explanation	Example
Request/demand		"Can you not move the mouse when I…"
Planning	Propose a method	" I usually
	Solicit a method	"So how do you want to do this?"

Table 6: Proposals for process

Type		Example
Geographic	Corners	"A: so yeah do you wanna like start from one corner I'll start from other or just like. B: yeah"
	Horizontal and rows	"A: Do you wanna look at things one like horizontally and I'll look at like actual cubes or something like that? ((THEN LOOKS AT PARTICIPANT B)) you know what I mean? B: Okay ((LOOKING AT SCREEN))"
	Rectangles and columns	"A: Uuu you guys wanna divide them like into columns or something like that?"
	Boxes, cubes or square	"Do you want to start with the… The box that's more filled?"
By Content	Numbers	"((LOOKING AT SCREEN)) I was thinking like one of us could do 1 through 4 and the other one could do 6 to 9 ((LOOKING AT OTHER PARTICIPANT))"

Method Behind the Unfolding of Action

Albeit having a very specific task at hand, the situation as unfolded was not at all simple. There were various complexities in regards to how participants dealt with the situation, what they brought with them to the session (i.e. tired, excited, confused) how they framed their experience and how their singular framings juxtaposed to form a joint experience, even if the joint-experience was just how their framings contrasted, overlapped or just developed in parallel. Any attempt to originate a code that transforms all observable swirly lines into a straight one or two sets of rules deprives the data of its richness and would surely distort the final vision.

The jointly visible developed frame is what could be called the tone or mode of the game. This is the result of combining all the observable, subjective framings of all participants, gathered by observing 5 more minutes into the game. It is not unusual for most (80% of the groups) to maintain that joint frame or tone throughout the end of the game.

The observed disorder, or chaos is not uncommon for normal human behavior, this actually corroborates with our "alternative understanding of the nature of intentions and their relation to actions- one that views the every day business of identifying intent as an always *contingent, practical and interactional accomplishment" (L. Suchman, 1987).*In that way, breaking down the interaction into the smallest components possible and examining them closely as we have done is sufficient as a first step in understanding the properties of framing and how framing comes into play in coordination.

Summary

As presented, various sets of conventions could be derived from the data at hand. And the information we obtain from these sets of conventions or codes is highly influenced by them, maybe even biased. That, however, is not necessarily a bad thing if we are precise in regards to what we are looking for. In this thesis, we are looking for signs of framing and how the first minute influences the act of coordinating via a medium. In our study, we defined the work we wanted the participants to do: solve a Sudoku puzzle together. We

made sure they were capable of dealing with the medium, and then we examined how they chose to navigate the situation as a whole by micro-analyzing the first minute.

The underlying complexity of a seemingly simple setting allowed for a diverse range of situations to develop, and provided a rich set of data for examination. While, as explained, uniqueness's and signs of different framings were present, these were not necessarily meant as predictors of future action, but rather as precursors of coordinative behavior. In that sense, they shed light on the current moment instead of foretelling what would come next.

In the same sense, we believe that having more than one code is not only a necessity, but also helps us to fully appreciate the value of the whole picture. Framing coordination is a valid precursor and worthy of attention.

Chapter 4

Conclusion and Future Work

Review

Groups consisting of 3-people and 2-people were asked to solve a Sudoku puzzle together while located in the same place. The puzzle was available on each person's personal computer and all changes made to the puzzle were reflected in all members' puzzles in a timely fashion. The first minute of this process was thoroughly examined, transcribed and reexamined. The rest of the session was informally examined as well.

During the examination the focus was on the kind of communicative work different openings are doing. This was done mostly by going through iterations of transcribing, observing video recording of the process and the puzzle being worked on in addition to studying the transcription for patterns or codes. Two codes have been devised each approaching the process of framing the coordinative experience from a unique perspective, in addition to summation of all topics that came up in the first minute, in each code we did not feel the need to categories codes in more than 5 categories for all 87 groups.

Future Work

On Current Data

A continuation of transcribing and examining the whole session is required to further understand the complexity of framing. In addition, the basic frameworks of understanding people utilizes in order to make sense of situations as Goffman mention in (Goffman & Berger, 1974) can be broken down to primary and secondary. Points of the interaction could be identified as keys and keyings for framework changing.

Additionally, more codes and patterns can be derived from the current data. As explained in the end of chapter 3 the code and or pattern lend its self to the researchers lens of examination.

Examining participants questionnaire data alongside their transcription in a manner that focuses on what participants expressed after the fact comply with what they did and said beforehand can prove beneficial in shedding more light on the internal process of framing in addition to the collective one of all participants in one group.

Elaborate on Study

Coordination is one of the human behaviors that omnipresent across settings, cultures and situations. Culture has an evident effect on the process of coordination, and much research has focused on cross-cultural coordination, that is coordination between people from different cultures and, or cultural back grounds examples (Diamant, et al., 2008; Setlock, et al., 2004). Our view is that examining the coordination of different cultures in the same settings, via technology, is sure to shed much needed light into the nuances of differences and similarities in low level coordinative processes of humans in general.

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Appendix A – IRB Letter of Approval

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

Institutional Review Board

Dr. David M. Moore
IRB (Human Subjects)Chair
Assistant Vice President for Research Compliance
CVM Phase II- Duckpond Dr., Blacksburg, VA 24061-0442
Office: 540/231-4991; FAX: 540/231-6033
email: moored@vt.edu

DATE: January 18, 2005

MEMORANDUM

TO: Deborah Tatar Computer Science 0106

FROM: David Moore

SUBJECT: **IRB Expedited Approval:** " Tuple-Space Project" IRB # 05-023

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective January 18, 2005.

Virginia Tech has an approved Federal Wide Assurance (FWA00000572, exp. 7/20/07) on file with OHRP, and its IRB Registration Number is IRB00000667.

cc: File

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An Equal Opportunity/Affirmative Action Institution

Appendix B- Consent Form

Informed Consent for Participant of Investigative Project
Virginia Polytechnic Institute and State University

Title of Project: Evaluation of the Efficiency of Content Specific Pointing in a Collaborative Software Game

Investigator(s): Dr. Deborah Tatar, Joon Suk Lee, Nouf Alaloula

I. THE PURPOSE OF THIS RESEARCH/PROJECT

You are invited to participate in a study that aims at evaluating the efficiency of pointing techniques while solving software games in a collaborative environment.

II. PROCEDURES

You will be asked to collaborate with other participants in solving Sudoku puzzles. Minimum experience using computers and solving Sudoku is required. Each collaborative session between participants will take at most two hours and the study will be video and audio recorded, for later analysis. In addition, during the game play, you will be asked to wear a special goggle designed to track your eye gaze.

According to the product manual, the eye tracking device is safe and complies with criteria in "Safety with Laser and Other Optical Sources."

- Quoted from ASL MobileEye User Manual. (p.8)

1.2 Statement on Safe Levels of Infrared Illumination

One of the most comprehensive and authoritative sources on the subject of light source safety is a handbook entitled Safety with Lasers and Other Optical Sources, by David Sliney and Myron Wolbarsht, first published in 1980 by Plenum Press. Quoting from page 147 of this book, " However, safe chronic ocular exposure values, particularly to IR-A, probably are of the order of 10 mW/cm² or below". "IR-A" refers to the spectral band between 760 and 1400 nanometers, the range in which the ASL Mobile Eye Optics Modules operate.

We are aware of no data, made available since the book was published, that would challenge this conclusion. Most people might wish to be more conservative than the figure cited above, and the Mobile Eye Optics Modules operate at least an order of magnitude below this level. The power of the LED's used varies somewhat from sample to sample. The largest irradiance value that will be produced with the ASL Mobile Eye Optics is 0.50 - 0.60 mW/cm² (@ 880nm Wavelength), at the plane of the eye.

The Mobile Eye uses non-coherent illumination. There are no lasers in the system.

III. RISKS

The risks associated with participation in this study are minimal. However, whenever audio and video recordings are made, there exists the possibility that such recordings might be heard and seen, resulting in your identity being recognized by someone. However, the recording will not be seen or heard by people outside the research team.

IV. BENEFITS

Your participation in this study will provide information that will help us contribute to the Computer Supported Collaborative Work (CSCW) knowledge-base by providing valuable insights on what features are essential and useful in collaborative software. This will improve collaborative activities through the use of technology. If you are part of the Psych-1 pool, you will be rewarded with 2 credit points.

V. EXTENT OF ANONYMITY AND CONFIDENTIALITY

The results of this study will be kept strictly anonymous and confidential. Your written consent is required for the researchers to release any data identified with you as an individual to anyone other than personnel working on the project. The information you provide will have your name removed and only a subject number will identify you during analyses and any written reports of the research. Audio and video recordings will be stored in a locked and secure place in Dr. Tatar's research laboratory.

VI. COMPENSATION

Your participation is voluntary and unpaid. If you are part of the Psych-1 pool, you will be rewarded with 2 credit points.

VII. FREEDOM TO WITHDRAW

You are free to withdraw from this study at any time for any reason.

VIII. APPROVAL OF RESEARCH

This research has been approved, as required, by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic Institute and State University, and by the Department of Computer Science.

IX. SUBJECT'S RESPONSIBILITIES AND PERMISSION

I voluntarily agree to participate in this study, and I know of no reason I cannot participate. I have read and understood the informed consent and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

07-568
Virginia Tech Institutional Review Board: Project No. 07-568
Approved November 8, 2008 to November 7, 2009

_____ _____
Signature Date

_____ _____
Name (Please Print) Email

Should I have any pertinent questions about this research or its conduct, I may contact:

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