

2012

An Ecological Investigation into the Effects of Interface on Asynchronous Group Conversations

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AN ECOLOGICAL INVESTIGATION INTO THE EFFECTS OF
INTERFACE ON ASYNCHRONOUS GROUP CONVERSATIONS

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science

By

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B.S.E.E. (Electrical Engineering), Wright State University, 2003

2012
Wright State University

WRIGHT STATE UNIVERSITY
SCHOOL OF GRADUATE STUDIES

November 11, 2011

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY PETER VENERO ENTITLED AN ECOLOGICAL INVESTIGATION INTO THE EFFECTS OF INTERFACE ON ASYNCHRONOUS GROUP CONVERSATIONS BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT

Venero, Peter. M.S. Department of Psychology, Wright State University, 2012. An Ecological Investigation Into the Effects of Interface on Asynchronous Group Conversations.

Asynchronous group communication refers to the activity of multiple people communicating when they are separated by both time and space. Online groups (OG) and email are two settings that facilitate these interactions. While both of these settings accomplish this task, they do so in slightly different ways. Email organizes all of the posts by putting the new posts on the top of the display and the older posts towards the bottom. The OG interface uses a tree structure; putting the new posts in a subordinate post relationship to a previous post. How these two technologies present the posts to the user was felt by the experimenter to cause quantifiable differences. Twenty asynchronous conversations (10 from email, 10 from OG) were collected and analyzed. Significant differences were seen between the two interface conditions that would suggest that interface influences how asynchronous conversations develop.

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INTRODUCTION

The inspiration for this thesis came from trying to complete a task that most of us face every day, catching up on email. As I went through the task of trying to catch up on three days' worth of email communications I found I was overwhelmed. As I sat staring at dozens of unread emails, two questions came to mind; 1) 'How much of my feeling overwhelmed was the interfaces fault?', and 2) 'Could a better interface be developed to specifically address asynchronous group communication?'. Both of these questions are ones that I am still very interested in answering, but as I soon found out it is a complex question. With this thesis I hope to take one small step toward an answer.

Part of the problem I was facing was that I didn't have a good sense of what mattered in asynchronous group communication. After some thought I felt it was necessary to take a naturalistic look at how groups of people interact asynchronously. While I believe that the interface will have an effect on how people go about communicating asynchronously, the goal of this research is to simply get a better understanding of asynchronous group communication.

The first section of the introduction will discuss in greater detail the problem I was facing. I will also go over the email software that I was using and online groups (OG). I discuss OGs because this technology was specifically designed to address the problem of groups of people discussing the same topic asynchronously.

Background

Recently the graduate students of a psychology department in a midsize university were required to draft a program review. The goal of this document was to provide an avenue for the students to give feedback to the faculty on the state of the department and

their collective dislikes and likes of the graduate program in general, which is divided into two main areas: human factors (HF) and industrial/organizational (IO). Students were selected from the two main areas to be representatives of the student body. The representatives drafted a document (with feedback from a limited number of students) and emailed the draft to the entire student body to collect further comments and feedback.¹ This email went out to fifty-eight graduate students, myself included. I wanted to help shape this document and to provide my personal likes and dislikes, yet I was unsuccessful in ever providing my inputs.

To understand why this was difficult, the particulars of the situation must be understood. The original draft was sent out on Monday around noon. By the end of that day there were fourteen email replies to the original email. On Tuesday there were four more replies. On Wednesday there were twenty more replies to the original email. When I finally saw the original and was getting ready to respond there had been thirty-eight emails sent out in regards to the program evaluation. I did not have time to read all of these emails, but that was the only way for me to understand what the main concerns were in order to provide my own unique feedback.

My first questions when dealing with this problem were; ‘Why wasn’t I able to contribute in a more efficient manner?’ and “Why was I uncomfortable with just replying?’ I felt that the answer was that I lacked the understanding of the conversation, or in Clark’s (1996) term I didn’t have the common ground. I wondered if there was a way that I could have gained that common ground quicker. At this point, I printed off all of the emails, numbered them in chronological order, and determined the relationships

¹ Not all of the students are on campus regularly, so it would be hard for the representatives to get the necessary feedback from face-to-face contact only.

between them. From there I laid them out spatially with the goal of trying to get a better understanding of what was going on. The Flow Chart shown in Figure 1 is the result of that effort. The horizontal dimension shows the time the message came in with the earliest on the left and the vertical dimension shows who sent the message. Each numbered box represents a message. The arrows represent which message was being referred to from a contextual point of view

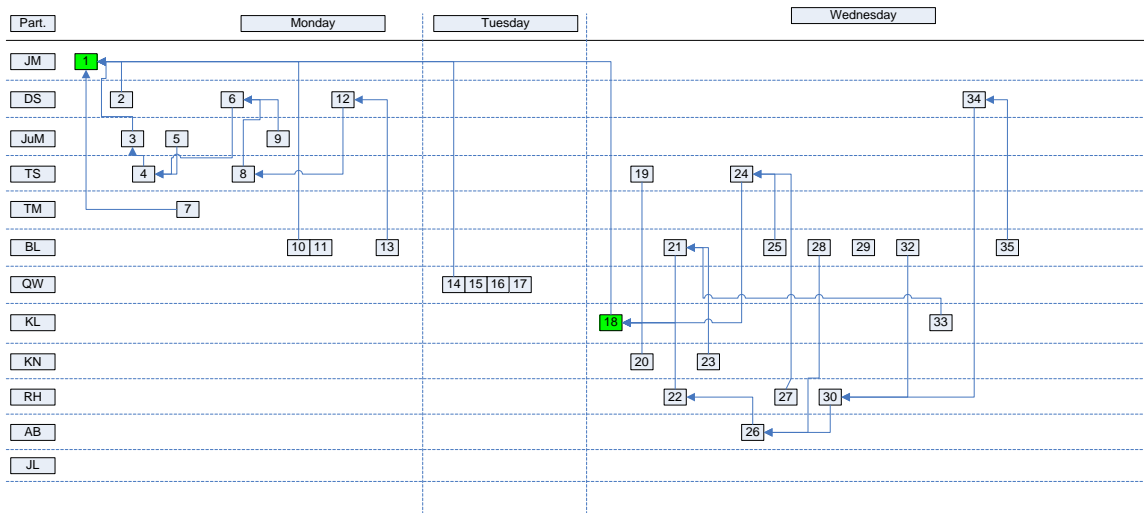


Figure 1. Flow chart of email generated conversation.

I also started looking at other technology that supported asynchronous communication and came across the online group (OG). I wondered what a conversation that was generated from an OG would look like in the Flow Chart format. With that goal in mind I took a random OG conversation and performed the same transformation as in Figure 1 the result of that effort is shown in Figure 2.

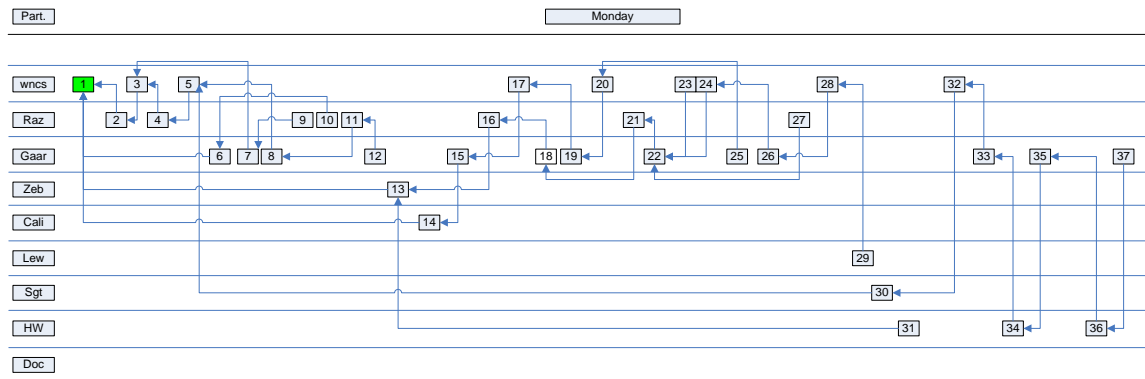


Figure 2. Flow chart of OG generated conversation.

When comparing the data from an email conversation to the data from an OG conversation I started to notice differences that will be discussed below. The interesting thing was that OG's and email provide the same information. They both provide who sent the message, what they said, when they sent it, and (if applicable) who they were addressing. Even though the information provided between each was the same, there are several potential reasons for seeing a difference in conversation structure, such as;

- Different people took part in the conversations
- The speakers from one conversation may have been under different deadline pressures than the speakers from the other
- The content of the conversation was different (program review vs. political discussion)
- The relationships between the authors was different
- The intent of the conversations is different (paper collaboration vs. discussion)
- The interface used to carry out the conversations is different (email vs. OG)

The initial motivation for this thesis was the last question, to understand the impact of different interfaces on asynchronous group communication. When trying to design an experiment to investigate this more it became apparent I was having a hard time understanding what matters in these conversations. I wasn't sure what to vary and what

to keep constant; I was still interested in the effects of interface. The next section dives deeper into the details of the email interface and the online group interface.

Email

The email system that I was using when the messages began arriving was Microsoft Office Outlook 2003. The way that Outlook can be configured is described below. A generic representation of Outlook that has the essential parts is used for the figures.

| From | Subject | Received | Size |
|---------------|----------------------|--------------------|--------------|
| Amanda | Re: Re: Paper | Sat 1:00 P | 17 KB |
| Amanda | Re: Re: Paper | Sat 12:30 P | 14 KB |
| Amanda | Re: Paper | Sat 11:00 A | 13 KB |
| David | Re: Re: Paper | Sat 12:45 P | 3 MB |
| David | Paper | Fri 2:00 P | 10 KB |

All,
 I don't think we should use the pie analogy.
 Amanda

On Fri, at 2:00 pm, David wrote:

Figure 3. Sample email interface with email orgnaized by authors.

The inbox is where new messages are located. Unread emails are bolded and read emails are not. To read a message the user has to click on the email and the contents of the message will be shown in the message preview area.² Once the users have viewed a message the email turns from bolded to un-bolded. The user is able to organize the

² Not all email programs have a message preview box, but it is felt by the experimenter it is not a critical part of the interface.

contents of the inbox by any of the categories listed at the top. For example, one way is to organize it by who the email is from, which is what is shown in Figure 3. For the particular problem at hand it seems most appropriate to organize the emails by the date and time received shown in Figure 4.

| From | Subject | Received | Size |
|---------------|----------------------|--------------------|--------------|
| Amanda | Re: Re: Paper | Sat 1:00 P | 17 KB |
| David | Re: Re: Paper | Sat 12:45 P | 3 MB |
| Amanda | Re: Re: Paper | Sat 12:30 P | 14 KB |
| Amanda | Re: Paper | Sat 11:00 A | 13 KB |
| David | Paper | Fri 2:00 P | 10 KB |

All,
 I don't think we should use the pie analogy.
 Amanda

 On Fri, at 2:00 pm, David wrote:

Figure 4. The email interface with messages organized by when they were received. As can be seen in Figure 4 organizing the emails in this way is somewhat helpful, at the very least the user now knows what order they came in. Even though email does a good job of showing the temporal order of the messages it does not do a good job of showing the conversational order of the emails, it is not immediately obvious which email(s) a person is responding to. This opaqueness is partly the fault of the 'reply to all' button. When a user presses the 'reply to all' all the users in the group get the message. What is misleading about it is that it gives the impression that the new message is replying to all the messages that came before it temporally speaking, that may or may not be the case. The authors assume that everyone has read everything that precedes in the thread, and

therefore has common ground. Put another way; as an asynchronous email conversation develops it appears that the messages are treated as one big thread. As will be seen below this is not necessarily true of the OG.

Online Groups

In OG's (and email) everybody can read what each other is saying and at anytime a participant is able to make a contribution. Figure 5 shows a typical structure of an OG. The first entry into the OG is shown at the top left corner as A₁. The responses are organized temporally with the first responses being at the top. For example, responses to A₁ are shown below and to the right. In the example shown these would be B₁, C₁, and D₁. Any tertiary responses follow the same basic pattern.

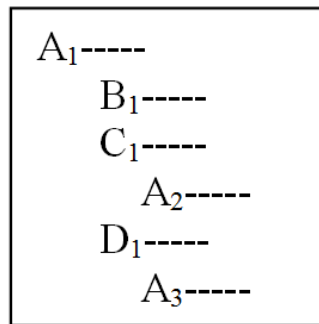


Figure 5. Typical structure of an OG conversation.

Just like email OG format only allows the participant to respond to one comment at a time. The way that an OG presents the data though focuses more on where the new message fits in the grand scheme of the conversation.

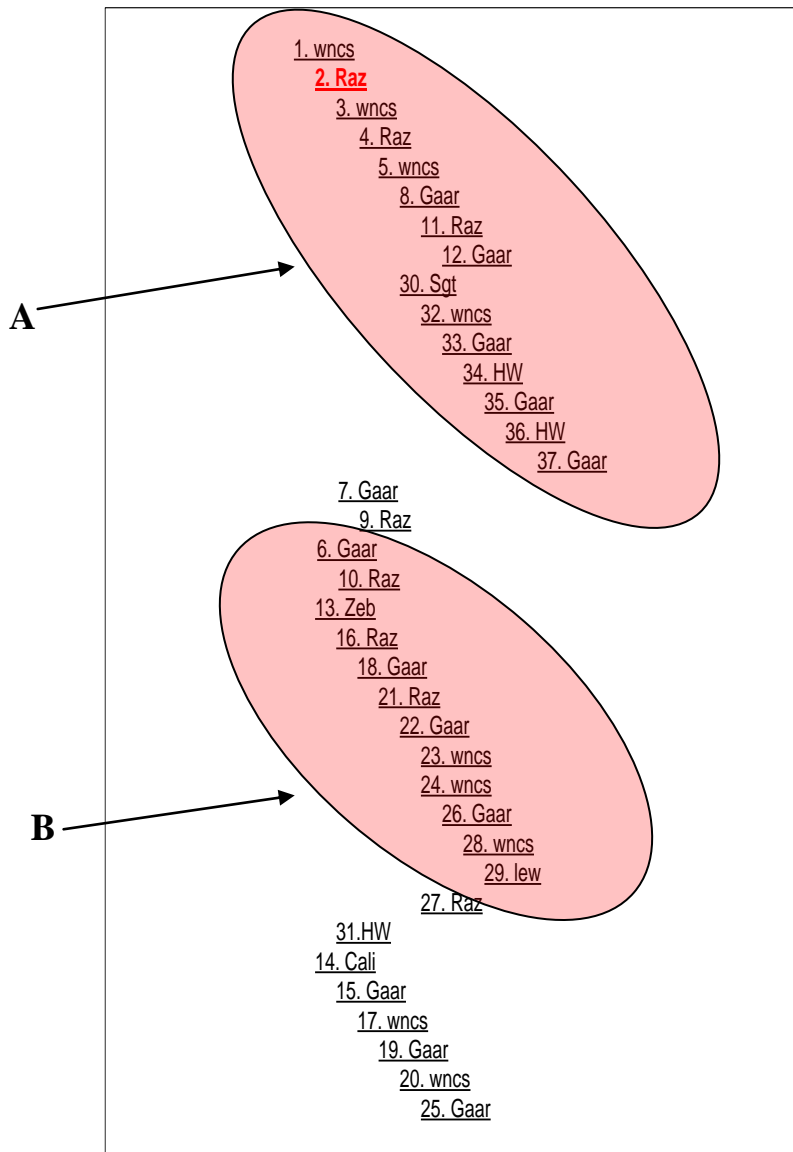


Figure 6. A tree structure representation of the data collected from an OG.

Figure 6 shows a representation of the data used to create Figure 2 above. When a new message comes in it would be placed directly below and to the right of the post it was responding to.

The hypothesis of this research is that there will be quantifiable differences between asynchronous group conversations that take place through email versus ones that takes place through an online discussion group.

Review of Literature

Language Use.

When examining language use it will be assumed that spoken face-to-face conversation is the benchmark for language use. It is important to note that I don't mean for this to be best, but rather a baseline for comparison sake. Clark (1996) describes the basic features of face-to-face conversation shown in Table 1.

Table 1. The basic features of face-to face conversation.

| | | |
|----|--------------------|--|
| 1 | Copresence | The participants share the same physical environment. |
| 2 | Visibility | The participants can see each other. |
| 3 | Audibility | The participants can hear each other. |
| 4 | Instantaneity | The participants perceive each other's actions at no perceptual delay. |
| 5 | Evanescence | The medium is evanescent – it fades quickly. |
| 6 | Recordlessness | The participants' actions leave no record or artifact. |
| 7 | Simultaneity | The participants can produce and receive at once and simultaneously. |
| 8 | Extemporaneity | The participants formulate and execute their actions extemporaneously, in real time. |
| 9 | Self-determination | The participants determine for themselves what actions to take when. |
| 10 | Self-expression | The participants take actions as themselves. |

Sections 1-4 show the immediacy of face-to-face conversation, meaning that the participants are able to see and hear one another without interference. Before moving on to the other sections it is important to understand the differences between face-to-face conversation and asynchronous electronic communication. The first two features, co-presence and visibility, show the most significant differences between the two settings for

communication. The first effect that occurs is that subtle differences like facial gestures, voice inflections, eye movements, etc., are lost in the electronic communication setting. For example, the loss of these cues is a likely reason that sarcasm doesn't come across well over email. For the problem at hand the major impact that the loss of these two features has is that when a participant joins the conversation, nobody knows.

Let us imagine what would happen if an invisible man walks into a room of people having a conversation. From the point of view of the people in the room the conversation should continue on as normal, taking full advantage of the established common ground. From the point to view of the invisible man, it is going to take a while to gain full understanding of the conversation. Contrast the invisible man case with what would have normally happened. In polite company the new person would walk into the conversation and a brief summary would have been provided, thus allowing him to understand and utilize the established common ground. The case of the invisible man is similar to what I was facing walking into the 38 emails.

The third feature, audibility, is functionally replaced with text. There are subtle differences that do impact the conversation. Text takes longer for the participant to generate and consume. Text also has the ability to be revised before the utterance is sent out to the group, which has the potential to cut down on confusion. As mentioned above text does not convey any subtly of voice inflection, which can be used to convey meaning.

The final feature in this section, instantaneity, is also an important difference between the two settings. In face-to-face conversation the time between an utterance being spoken and the utterance being heard is almost instantaneous. The impact of this is

that conversations proceed in a somewhat linear fashion. Participant A speaks then participant B, participant A responds, etc. If two participants do talk at the same time and it leads to confusion, the participants are able to address the problem quickly before moving on (Suchman, 1987). Now let's look at how this impacts asynchronous electronic communication.

Utterances in an email can be delivered anywhere from seconds to weeks apart. In an email conversation between two people this is acceptable, because one does not respond until they have heard a reply from their partner. Where increased perceptual delay has a significant impact for sorting out confusion in group conversation. For example, participant B could send out an utterance to the group minutes after participant A. Then participant C sends out an utterance a few minutes after B. In this example let us assume that the message the participant C posts is vague. First, the vagueness may not be recognized right away, and once it is realized one of the first steps to resolving the conflict is to understand who participant C was responding to A, or A & B. Because of the lack of instantaneity, recognizing a problem and taking the first steps to resolving it is greatly delayed.

Dimensions 5-7 reflect the medium, as in speech versus writing. It is in this group of features that electronic communication gains enough ground to become a viable source of communication. Features five and six, evanescence and recordlessness, are the exact opposite in the electronic communication setting compared to the face-to-face setting. Electronic communications do not fade at all and leave a permanent record. This is an important boost because this allows the participants to have access to everything that was said verbatim.

For dimension 7, simultaneity, electronic communications are not close to the face-to-face setting. It is possible, though unlikely, that two emails could come in right on top of one another. Even in this rare case electronic communications cannot be produced and received simultaneously; there is always some level of sequence. For example, participant A could be posting a comment right as Participant B is formulating theirs. If Participant B does not read it then there is no difference between participants A posting the message seconds or weeks before participant B posts their message. If participant B **does** read participant A's message, participant B now has the choice to alter their new message or leave it the same. That is not an option with face-to-face communication.

Dimensions 8-10 deal with control, meaning how the conversation will move forward and which one of the participants has that control. When comparing between electronic communication and face-to-face conversation how the conversation will move forward there is not much difference. Dimension 8 (extemporaneity) is different in electronic communication than face to face in that the users have more time to formulate their utterances. This difference is not expected to influence the overall control of the conversation. Dimensions 9 & 10 (self-determination and self-expression, respectively) are not felt to be significantly different in electronic communication than face to face communication. Overall, when comparing electronic communication and face to face conversation, how the conversation will move forward there is not much difference.

Computer Supported Communication

The field of computer supported collaborative work (CSCW) began in the mid 1980's (Grudin, 1994) and grew from the realm of office automation. The goal of office

automation was to expand upon the early successes of personal computing namely word processing and spreadsheet programs. Also, office automation was to further help collaboration between people, specifically groups of people. The exact requirements of these systems were not well defined, and by the mid 1980's it was realized that building the technology was not enough. More understanding of how people worked together was needed, and the field of CSCW was born.

One of the first approaches to developing taxonomy for collaborative systems is by defining when and where the groups interact. The matrix that is produced is shown in Figure 7 (Johanson, 1988). On the y-axis of the space/time matrix is the time that the groups collaborate, same time or at different times. On the x-axis is the location that the groups meet same location or different locations. The benchmark cell is same place and same time collaboration. This is the cell that is essentially face to face communication.

The matrix that is shown in Figure 7 is a useful way to bin email and OGs, but it is not quite complete. The argument could be made that chat is also very similar to both email and OGs, so chat should also be considered. I am suggesting thinking about the time space matrix as a more fluid space shown in Figure 8.

| | | | |
|-----------------|-----------|---|--|
| Location | Same | <ul style="list-style-type: none"> • Computer-Mediated Meeting Rooms • Electronic classrooms • Face to Face Conversation | <ul style="list-style-type: none"> • Bulletin Boards |
| | Different | <ul style="list-style-type: none"> • Chat • White Boarding • Audio/Video Conferencing | <ul style="list-style-type: none"> • Non Real-Time Conferencing • Workflow • Email • Online Groups • Snail Mail |
| | | Same | Different |
| | | Time | |

Figure 7. The time/space taxonomy.

The representation of the time-space dimensions shown in Figure 8 removes the borders between the groups. It also allows the different settings to co-exist in different areas of the space at the same time. The last alteration is changing the dimensions from an absolute time-space to expected time – expected distance.

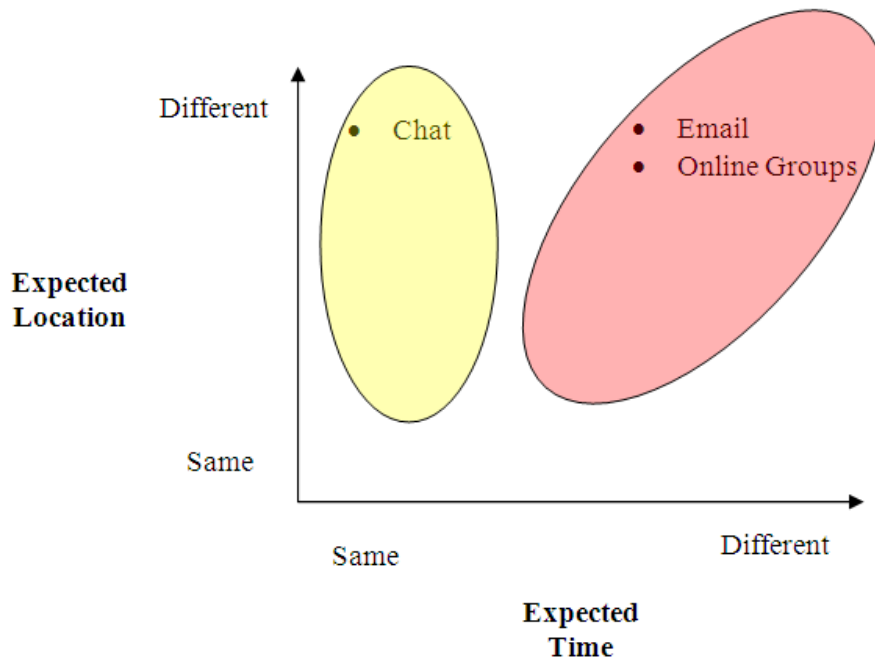


Figure 8. Modified time/space taxonomy.

Computer supported collaborative work started out as technologists trying to learn from anybody that could teach them about group activity. Everybody from educators to economists were sought. While a broad range of perspectives was beneficial to understanding group interaction it also led to the splintering of the field.

The field of CSCW is much too large to review here, but there is a subset that I will review, and that is computer supported collaborative learning (CSCL). The area of CSCL, like its name implies, is concerned with many issues involved in remote learning both synchronous and asynchronous communication. Remote learning, or online learning, is part of the long term strategy of higher education (Allen, 2010). The asynchronous research that has been done in this field is of most interest.

Effect of Representation on CSCL

The OG attempts to aid the user in understanding to whom the reply was meant for through a tiered representation. One problem that OGs create is that as the conversation progress over time the messages begin to only address a subset of the participants, which causes divergence. In Figure 9 Participant A starts a conversation that generates three replies from Participants B, C, and D. When Participant A goes to reply to the comments that Participants C and D made he must make 2 separate posts. This does reduce the workload of the new participant in efficiently determining which messages matter, but it is still difficult for the new participant to get a sense of the whole conversation. The OG format helps the user pair down which messages are pertinent, but this has the potential to lead to conversation linearity.

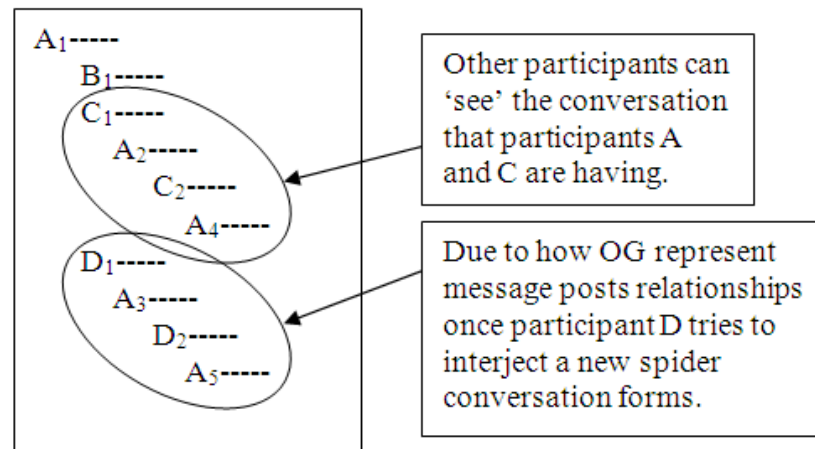


Figure 9. Spider conversations that occur in a threaded (OG) type interface.

The effects that representations play on asynchronous group communication is not completely virgin territory. As mentioned above the field of CSCL is interested in this aspect of asynchronous communication, particularly the issue of convergence (Eastman, 1994). Hewitt (2001) investigated the issue of utterance representation as part of his investigation into convergent processes. He compared three classes that each used a

conventional web-based threaded environment (this is what the OG group uses). In order to identify convergent notes Hewitt classified the utterances into one of four mutually exclusive categories;

1. Stand-alone: An utterance that introduces a new idea

2. Add-on: An utterance that builds on a previous note

3. Multiple references without convergence: Utterances that make reference to two or more previous utterances without converging.

4. Convergent: An utterance that brings together two or more previous utterances

Of the 830 utterances collected across the four classes only 17 (2%) fell into the convergent category. In the discussion Hewitt's hypothesis that limiting the 'reply' function to one message at a time, was the culprit for the lack of convergence. This tendency for the threaded conversations to lack convergence was also noted by Herring (1999).

Marcoocia (2004) also examined threaded conversations and pointed out another potential for confusion when utterances fall into the 'multiple reference without convergence' category.

Indeed, it is often difficult to know whether or not a responding message has also initiated the message following it. [From Figure 9] Is message (C₁) only a reaction to (A₁) or a reaction to (A₁) and (B₁). (Marcoocia, 2004, p.123)

One of the solutions Hewitt calls for to address the lack of convergence is to reject a threaded system in favor of a linear system, or a chronologically ordered list. The

linear system would be similar to email. Hewitt advocated for next generation discourse environments to “provide new representations of discourse structure.” (p 217).

The need to accommodate convergent process raises issues of representation, since conventional text-based mappings... are incapable of illustrating multiple-reference relationships. Therefore, a next generation conferencing environment requires a flexible mapping utility capable of depicting situations in which discourse strands can both branch and come together. (Hewitt, 1999, p 217)

Other attempts to help facilitate asynchronous learning have focused on more than just displaying the relationships of utterances.

Knowledge maps have also been explored to help solve the issue of convergence (Suthers, 2001; Suthers, 2008). Knowledge maps represent relationship among concepts rather than just the utterances. Suthers (2008) investigated convergent behaviors when comparing knowledge map (see Figure 10) based discussions, threaded discussions (OG), and an interface that incorporates both. Suthers had pairs of participants develop a hypothesis explaining a medical phenomenon that was unknown to them. Each participant was give a different pieces of evidence, they then had to work together to develop a hypothesis explaining the phenomenon. Participants that used an interface that contained a knowledge map produced higher quality essays, and were quicker to arrive at hypothesis.

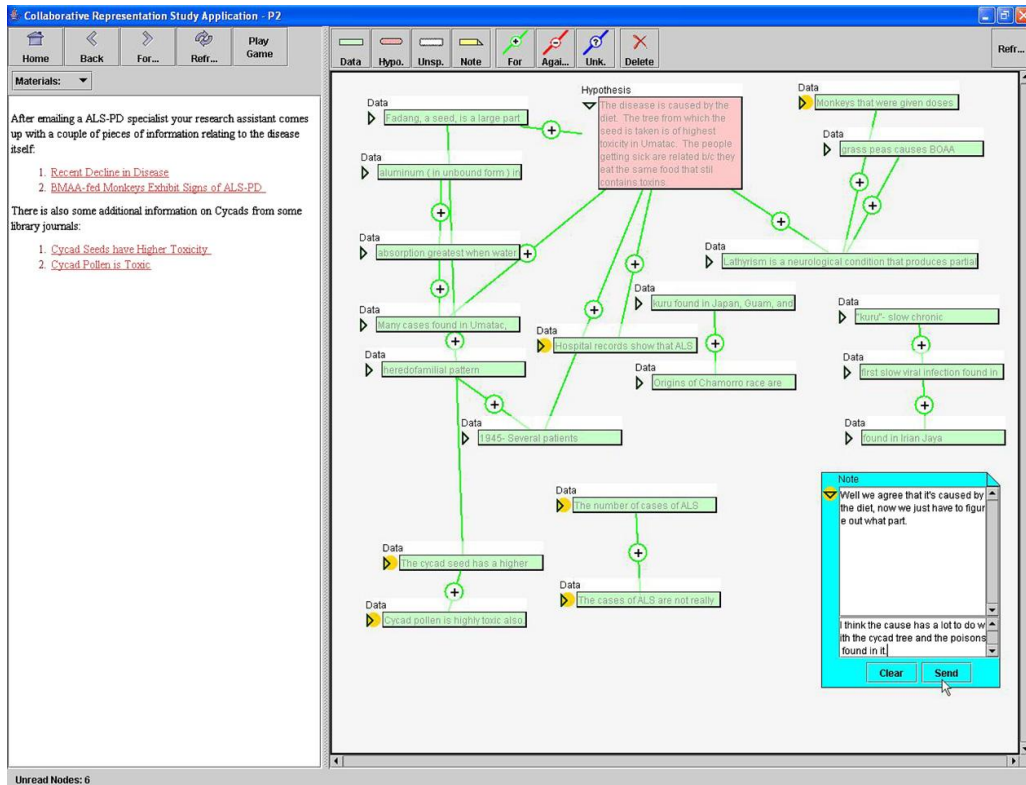


Figure 10. Knowledge map interface from Suthers (2008).

Email supports getting every message out to all of the participants of the conversation (accomplished with the “Reply to All” function).³ The down side of email is that it places a large burden on the user to know which of the previous messages the most current email is including and which it is not. If the participant is continuously engaging in the conversation from the beginning then this burden is lessened. But, for a new participant that is not the case. It takes a lot of work for a participant to understand which of the early emails influenced the later ones.

Effects of an Artifact on Behavior.

The most fundamental concept of this research is that how a problem is presented will affect the behavior of the person trying to solve it (Werthimer, 1945). This is not a

³ It is important to note that email also has a ‘Reply’ button which only sends an email to one user. This would exclude the other members of the conversation.

new concept, and was recently demonstrated by Bennett & Flach (2011) in the effect problem representation can have on even the simplest of problems. The discussion begins with the two player game ‘Fifteen’.

Consider the game of ‘Fifteen.’ This is a two-player game in which players take turn choosing numbers from the set of digits from 1 to 9 without replacement.

The winner is the first player to have a combination of three numbers that add to fifteen (e.g., 1, 9, 5; 2, 8, 5; 1, 8, 6; 5, 6, 4).

The rules and the goal of this game are fairly straight forward, yet it still requires some mental calculation and possibly a paper and pencil. Let us look at a specific example; Player A went first and has chosen 5, Player B chooses 8, Player A chooses 3, and finally Player B chooses 7.

Table 2. Summary of players move in a sample game of Fifteen.

| Move | Player A | Player B |
|------|----------|----------|
| 1 | 5 | 8 |
| 2 | 3 | 7 |
| 3 | ? | ? |

From this example some questions could be asked. Why did Player B choose 7? This may seem like a poor choice because now he has to pick two more numbers to get to 15 instead of just one. What would a good choice for Player A be? The answers to these questions aren’t what are of interest but rather the time and effort it takes to answer them. Let us look at the problem another way and ask these questions again.

| | | | |
|-------------|-------------|-------------|-----------|
| 6 | 1 | 8 | B1 |
| 7 B2 | 5 A1 | 3 A2 | |
| 2 | 9 | 4 | |

Figure 11. An alternative representation of the game Fifteen. Player's moves are indicated by the bold letters.

The alternative representation of the game 15 is the game of Tic-Tac-Toe where the goal is to match three numbers in a row either horizontally, vertically, or on a diagonal. Now looking at Figure 11 how long does it take and how much effort is required to answer the questions raised above. Why did Player B pick 7? To stop Player A from winning. What would a good choice for Player A be? Numbers 6, 1, & 9 would be fine, number 2 would not be a good choice. Not only is it much easier to determine the qualities of the selection, but the ramifications of a particular move are more apparent. (It was fairly easy to predict that Player B was going to block Player A.)

What is so interesting about this example is that the rules are the same, the goal is the same, and the numbers are the same. The only thing that is different is how the problem is presented to the user. One case plays to the strengths of human and the other does not. Continuing from the assumption that presentation matters the next question is; what is the influence of utterance representation on asynchronous conversation?

METHODS

Ten conversations were pulled from the archives of the CHORA ListServ (<http://listserv.liv.ac.uk/archives/chora.html>) which served as the data for the email conversations. Ten conversations were pulled from the 'The Political Spin Room' from Yahoo! Groups (<http://groups.yahoo.com/group/ThePoliticalSpinroom/>) which served as the data for the OG conversations. All of the data were publically available. Both the email and OG conversations dealt with social issues, but not the exact same social issues. For example the email group may have discussed the morality of the death penalty, where the OG group would have discussed the U.S. wars in Iraq and Afghanistan.

Dependant Measures

The objective measures that were collected are as follows; number of words per post, the total number of posts, the total number of division of utterance effects (DUEs) events per conversation, the number of each of the three types of DUEs described above. The role of the objective measures is not to determine quality differences between the conversations rather they are there to determine that there are differences. Differences without any understanding lead to the natural question of 'So what?'

When visually comparing figures 4 & 6 a difference can be seen right away, the OG display immediately shows the user the conversation threads (highlighted as A & B in Figure 6). This allows the newcomer to more efficiently allocate time trying to generate a response, at least to a specific thread. To further compare the data collected from these two displays the conversations needs a more apples to apples representation. To accomplish this the Flow Chart used in Figures 1 & 2 will be examined more closely.

Figures 12 & 13 are duplicates of Figures 1 & 2, respectively, with the connections removed. An interesting aspect to notice is the behavior that is highlighted.

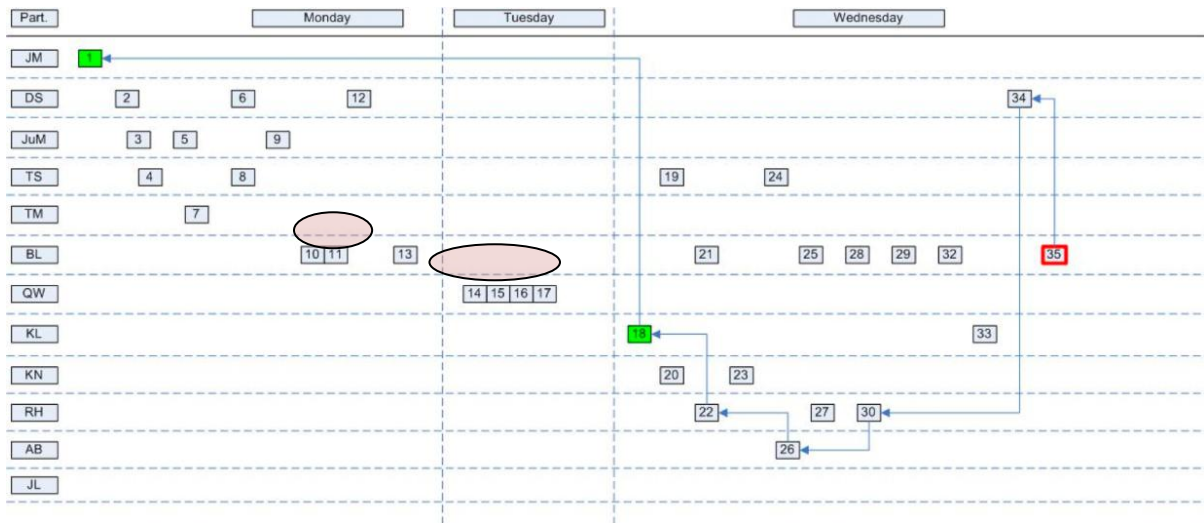


Figure 12. Email generated flow chart with DUEs highlighted.

The highlighted boxes represent an effect I'm calling the 'division of utterance effect' (DUE). The definition used for a DUE is as follows; the chronologically previous post(s) is/are by the same author of the current post. For example consider posts 14-17 in Figure 12. In order to determine if Post 14 is a DUE I, need to identify the author of Post 13 (the chronologically previous post). Post 13 is by a different author so Post 14 is not a DUE. Moving to Post 15 and doing the same thing shows that Post 15 is a DUE. Post 16 and 17 are also DUE's. So the total number of DUE's for Posts 14-17 is 3. Posts 10 & 11 in Figure 12 are another example of the measure. Once the DUE's are counted they are sorted into one of three types

Type I: the current post is relevant to the previous post(s). The author is expounding on an earlier comment.

Type II: The current post is irrelevant to the previous post(s). The author is making a new point.

Type III: A technical glitch and/or user error. The software or the author sends out same message multiple times.

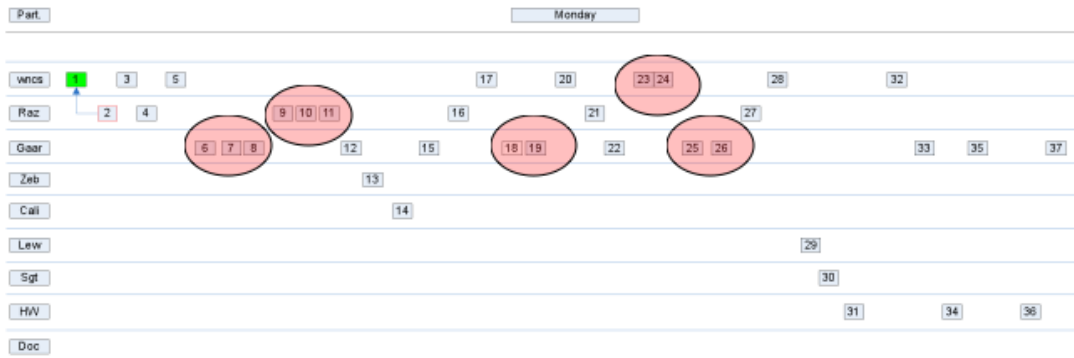


Figure 13. Online group generated flow, highlighting DUEs.

The objective measures that were be collected are as follows; number of words per post, the total number of posts, the total number of DUE events per conversation, the number of each of the three types of DUEs described above. The role of the objective measures is not to determine quality differences between the conversations rather they are there to determine that there are differences. Differences without any understanding lead to the natural question of ‘So what?’ With this in mind more subjective measures will potentially be looked at.

Hypothesis

Hypothesis H1: Expect to see an equal number of Type I DUEs in the OG condition and the email condition.

Hypothesis H1’: Expect to see a greater number of type II DUEs in the OG condition than the email condition.

The type I DUE is not felt to be caused by the interface, because no interface will help an author clarify what they are trying to say or remember a point. However, the

number of type II DUEs is felt to be driven by the interface. The tree structure of the OG interface is expected to be the cause of the increase in type II DUEs.

Hypothesis H2: Expect the ratios of 'a/a+the' and 'this/this+that' to decrease in both conditions as the conversations grow.

Part of the inspiration for this research comes from the importance of common ground. An indication that the authors are developing and exploiting common ground can be found in the examination of the ratios of 'a/(a+the)' and 'this/(this+that)'. The article 'a' can be used to introduce new objects or concepts into a conversation. For example, 'You need a car.' The article 'the' can be used to refer to a previously established item or concept. For example, 'Can I use the car?' At the beginning of the conversation new ideas are expected to be introduced driving the ratio of 'a/(a+the)' closer to 1. As the conversation carries on and common ground is established the number of 'the's is expected to increase thus driving the ratio towards zero. The use of the deictic pronouns 'this' and 'that' are also indicators of common ground being established and exploited. Similar to 'a' the pronoun 'this' can be used to establish a new object or concept into a conversation. For example, 'I like this umbrella.' Whereas the pronoun 'that' can be used to refer to an already established concept or idea. For example, 'I don't like that umbrella.'" The ratio of 'this/(this+that)' is expected to behave the same as the ratio 'a/(a+the)' for the same reasons.

Hypothesis H3: Expect the word count per post to decrease as the conversation grows.

Another indicator of the development and exploitation of common ground is the number of words per post. One of the benefits of developing common ground is that it

allows the participants of the conversations to produce more efficient utterance, i.e. more can be said with fewer words. From this, it is expected that the utterances of the authors become smaller, because they would be able to draw on common ground.

Hypothesis H4: Expect the word count to be less in the OG condition than the email condition.

The tree structure of the OG condition is expected to cause fragmentation of the author's utterances. The impact of this is that the average number of words per post is expected to go down for the OG condition. Since the data collection is for the first 30 posts of the conversation the total word count for the OG condition is expected to be less than the email condition.

RESULTS

The data was generated from twenty group discussions, ten that were generated from email and ten that were generated from an online group. A discussion is defined as the first thirty utterances that were posted in chronological order. The conversations were also broken up into six chronological blocks (each block containing 5 utterances). The topics of the conversations were political/philosophical (ex. should the death penalty be legal, Should the US have invaded Iraq?) A one-way ANOVA was conducted. Table 3 shows an initial look at the differences seen between the OG and email conditions. The largest effects were seen in the average words per post ($F=47.38$, $p < .0001$), and the average time elapsed per conversation ($F=23.57$, $p < .001$). No difference was seen between the average number of type I DUE's, but an effect was seen for the type II DUE's ($F=5.11$, $p < .05$) with the OG condition producing slightly more than the email condition.

Table 3. Summary of data.

| | OG (n=10) | Email (n=10) |
|--|-----------|--------------|
| Average Words per Post** | 41.7 | 321.44 |
| Average Time Elapsed (Min)** | 1410.4 | 13920 |
| Average Number of DUE's | 5 | 3.4 |
| Average Number of Type I DUE's | 0.2 | 0.7 |
| Average Number of Type II DUE's * | 4.8 | 2.7 |
| Average Number of Authors per Discussion | 7.4 | 6.3 |

* Significant at the .< 05 Level

** Significant at the .< 01 Level

One of the largest effects was the size of the posts between the two groups. Figure 14 is a histogram that depicts the frequency of word count per post for all the data. The vast majority of the OG posts that had word counts of less than 100 words. For the email condition the distribution of posts was wider with the majority of the posts having less than 800 words. Figure 15 shows the histogram of posts that 800 words or less, to get a closer look at the email distribution.

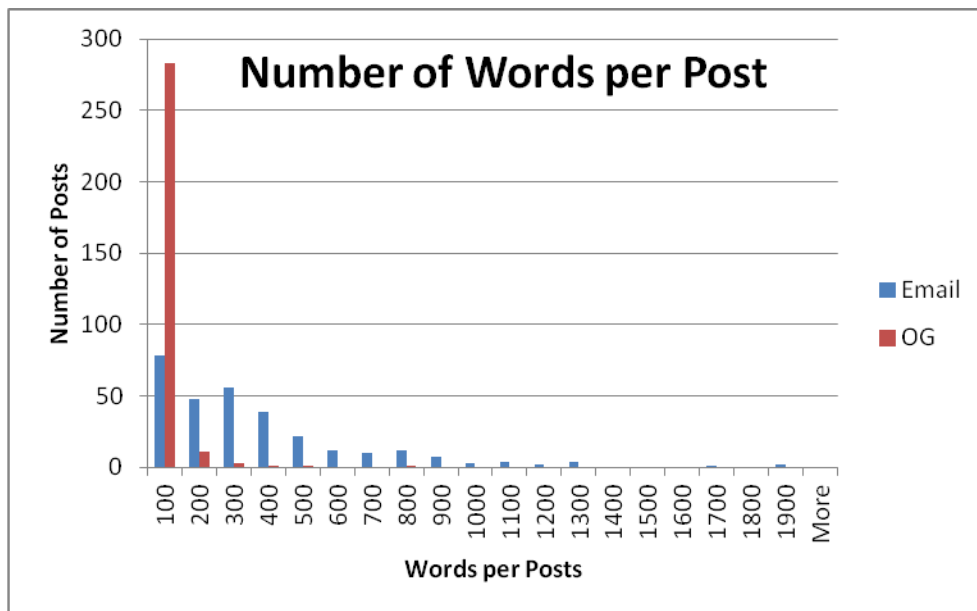


Figure 14. Histogram that depicts the frequency of word count per post.

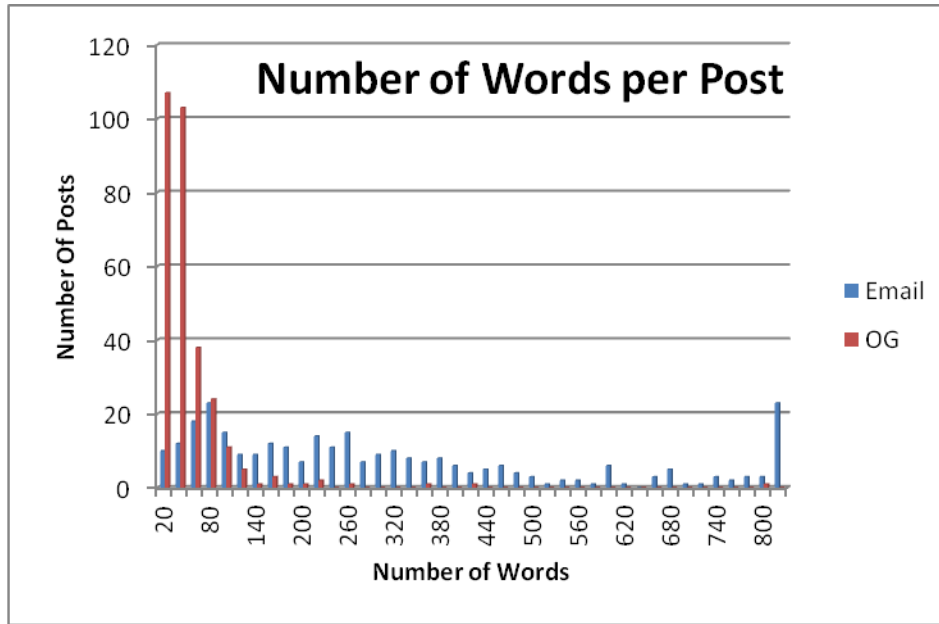


Figure 15. Histogram of posts that 800 words or less (the majority of the email data).

Figure 15 shows that the distribution for the majority of email data was relatively flat and the word count across posts were relatively evenly distributed. Figure 15 also starts to hint that the OG distribution is not so evenly distributed. Figure 16 shows a histogram of the posts with 200 words or less, to get a closer look at the OG data. As can be seen from the Figure 16 the OG data is more representative of a long tailed distribution.

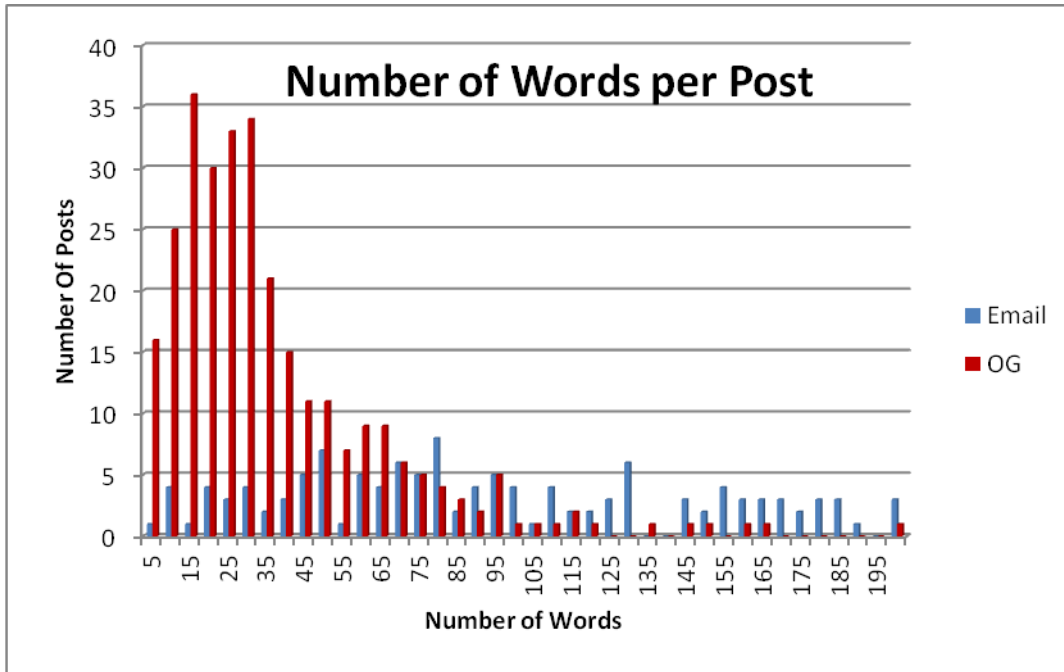


Figure 16. Histogram of posts that 200 words or less (the majority of the OG data).

The histograms of the word count don't give a complete picture of how the email and OG groups are different in terms of utterance length. A one-way ANOVA was conducted and no significant difference was found (, however this is still worth looking at for future research.) Figure 17 shows the z-score word count by block for both the email and OG data. The trend for the OG data was a reduced word count as the conversation carried on. The email data showed that the highest word count was in block 4 then started dropping off.

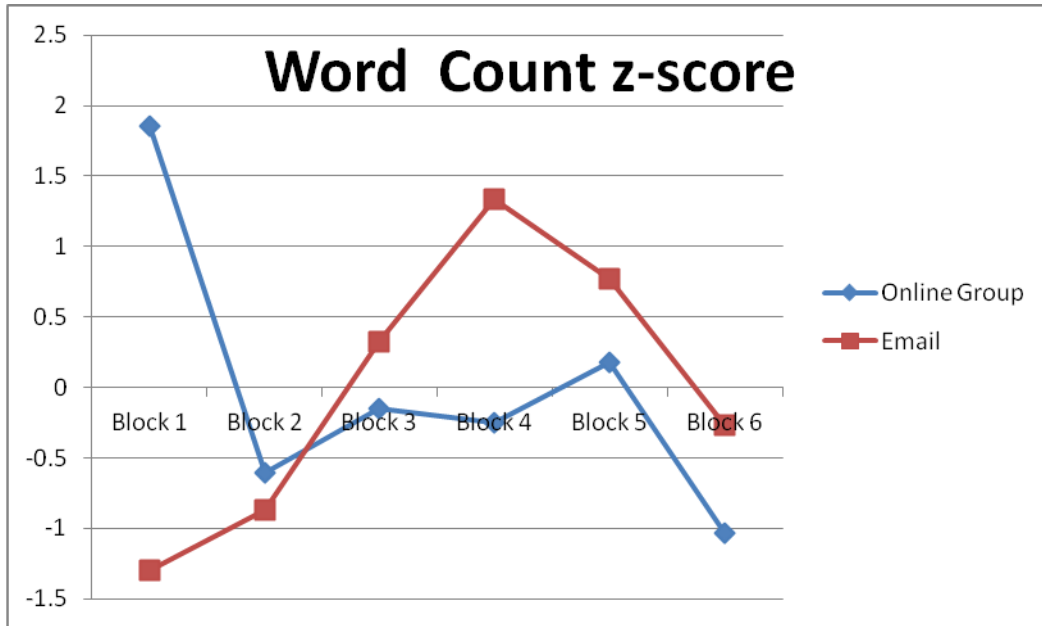


Figure 17. The z-score by block for both email and OG.

A deeper understanding to the structure of the utterances was also sought, beyond the word count of the posts. A one-way ANOVA was conducted for the two ratios ‘a/(a+the)’ and ‘this/(this+that)’ and no significant difference was found, but again the data will be discussed for future research. The posts were analyzed to get a sense of whether or not common ground was being developed and exploited. The ratio’s of the demonstrative pronouns ‘this’ and ‘that’. The pronoun ‘this’ refers to things that are near (in our case near in time) and the pronoun ‘that’ refers to things that far. The ratio used was the number of ‘this’ divided by the number ‘this’ plus the number of ‘that’. If common ground was being developed and exploited the ratio would start off high and get smaller as time went on. The demonstrative pronoun ratio for the OG group was largest for the first block then quickly dropped, and leveled out. For the email group the ratio peaked in Block 3. Both ratios are shown in Figure 18.

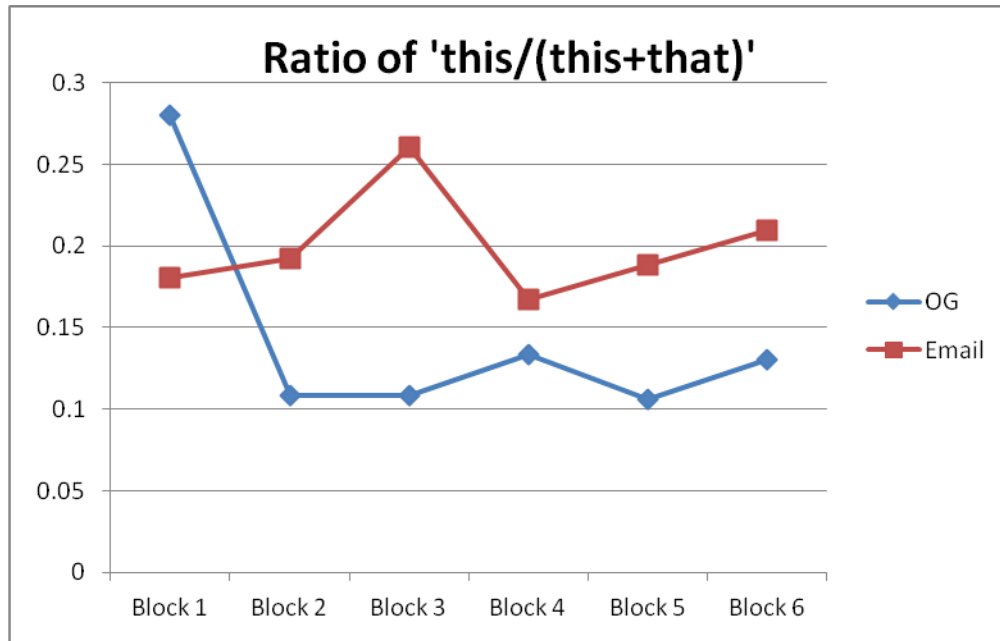


Figure 18. Ratio of demonstrative pronouns ‘this’ and ‘that’.

The articles ‘a’ and ‘the’ were also analyzed, again with the intention of trying to determine whether or not common ground was be developed and exploited. The ratio of the number of ‘a’ divided by the sum of the number of ‘a’ plus the number of ‘the’. The article ‘a’ can be used to introduce an item into conversation (ex. We need a pencil.). The article ‘the’ can be used to refer to a previously determined item (ex. The pencil is broken.). Hence, I expected the ratio to be larger at the beginning of the conversation and decline. The data collected, shown in figure 19, shows a fairly flat ratio for the email group and a more variable ratio for the OG condition.

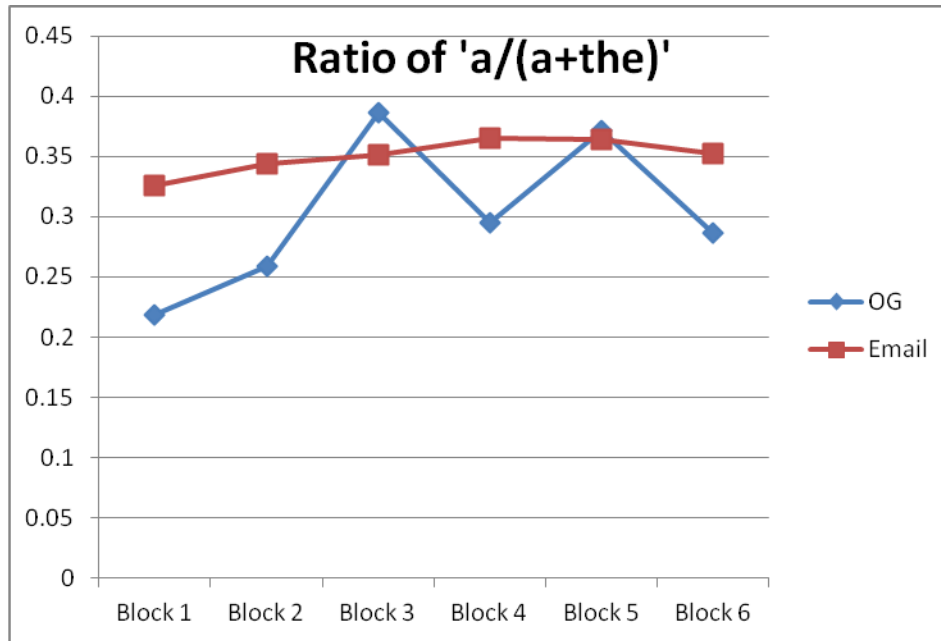


Figure 19. Ratio of the articles 'a' and 'the'.

The average number of authors per conversation is shown in Table 3, was 7.4 and 6.3 for OG and email groups, respectively. However the number of unique authors was 29 and 34 for the OG and email groups, respectively. This points out an unintended consequence of collecting multiple conversations from the same source, author overlap. Author overlap occurred when one author participates in more than one of the conversations. Figure 20 shows a histogram of the author overlap for both the email and OG conditions. Both the OG and email condition showed the same trend, the majority of the participants only participated in one conversation.

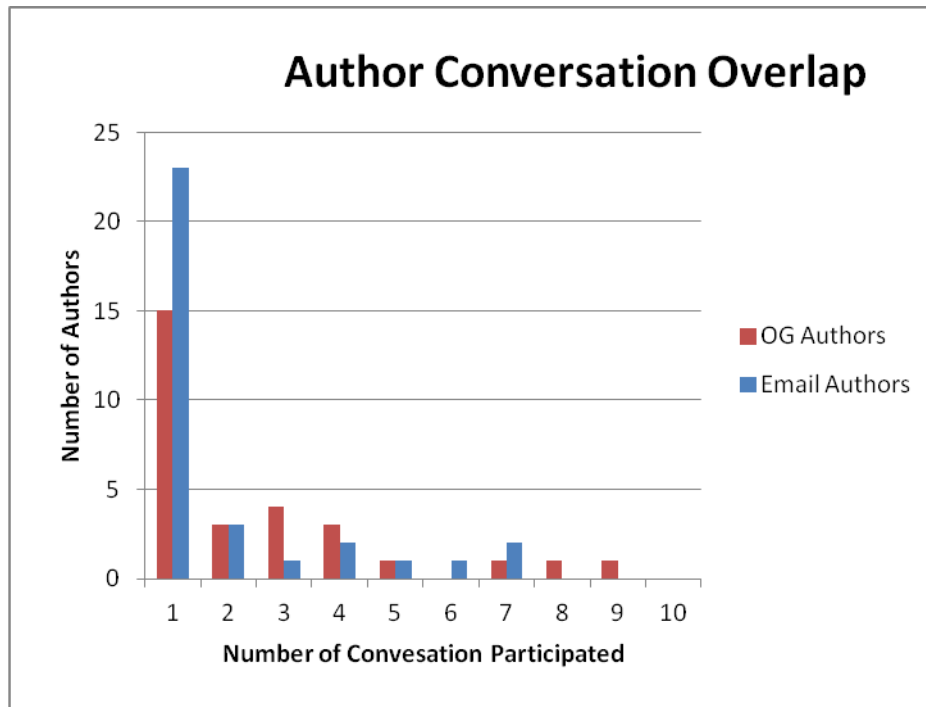


Figure 20. Histogram of author overlap.

DISCUSSION

At a high level the goal of this research was to determine if there would be quantifiable differences between asynchronous group conversations that take place through email interface versus ones that takes place through an OG interface. Besides observing general differences specific attributes of the conversations were recorded and analyzed with goal of trying to understand what attributes matter for future research. One of the main areas of interest was to gain understanding of what impact the interface played on how the participants developed their utterances. Utterance development is also impacted by the author's use of common ground. The effect of utterance development will be the first to be discussed.

The metrics that were collected in order to gain insight into the impact interface plays on utterance development were the DUE, the word count per post, the ratios of 'a/(a+the)' and 'this/(this+that)', and words per count per condition. After reviewing the

word count data there may be a confounding factor that mitigates its use to gain insight into utterance generation that will be discussed below. There were no significant differences between the Type I DUEs and a weak significant difference between the Type II DUEs. Both of these results support hypothesis H1 and H1', albeit weakly. The question now is 'what may have caused those results?' In order to address this issue it will be useful to consider the data collected that sheds light on the development and exploitation of common ground.

The data collected that examines the exploitation of common ground consists of the word count per post, and the ratios of 'a/(a+the)' and 'this/(this+that)'. Figure 17 shows the z-score of the word count by block for the two conditions. While not statistically significant the pattern shown by the OG condition is what would be expected if the authors were exploiting common ground the number of words per post went down (which supports hypothesis H3). However, this was not the case for email conditions. The word count per post for the email condition peaked in the fourth block, which goes against hypothesis H3'. The ratio of 'a/(a+the)' (shown in figure 19) is fairly level across blocks for the email condition, while the OG condition is more erratic, the trend is still fairly level. These results are not expected from hypothesis H3. The ratio of 'this/(this+that)' (shown in figure 18) behaves as expected by hypothesis H2 for the OG condition, decreasing as the conversation continues. However, the results from the Email condition were erratic, but trended flat across blocks, which does not support hypothesis H3.

The OG condition behaved mostly as expected. The utterances seem to become more efficient over time, and the ratio of 'this/(this+that)' also trended as was expected.

The email condition did not behave as expected, the word count grew and peaked in the middle of the conversations, and neither of ratios behaved as thought. A possible explanation could be that user under the email condition were having a more indepth conversation than the OG condition, increasing the quality of the posts. The large differences between the number of words per post between the two groups (41.7 for OG and 321.4 for Email), may be indicative of more in-depth conversation taking place in the email condition versus the OG condition.

Hypothesis H4 expected to see a word count difference between the two groups with the OG condition having fewer words, which was the case. However, it does not seem likely that the difference was caused by the DUE as hypothesized, but rather a difference in the quality of the conversations.

A question of interest is ‘Did the conversational differences between the two condition confound the number of Type II DUEs?’ It seems reasonable that a more in depth conversation would introduce more new ideas, potentially causing more Type II DUEs, but that is speculation. The next section discusses future research that would help gain an understanding of the role that the interface plays in asynchronous communication.

Future Research

When first considering how best to investigate the influence that interface plays an asynchronous communication I was torn between doing a controlled lab study verse an ecological field observation. Obviously, in the end I traded the control of lab for the greater potential of discovery of the world. The rationale behind this was to gain insight

into real world phenomenon then use that knowledge to build a more informed experiment. The foundation for the next step is discussed below.

Interface

One of the hypothesis of this research is that interface will impact asynchronous group conversations. Future research should go farther to test this hypothesis. Not only should future research consider looking at using OG, and email based interfaces, but it should also consider an interface based on Flow Charts. A prototype of such and interface is currently being developed by the researcher. It is felt that the Flow Chart based interface will retain the best features⁴ of both email and OG interface, while removing the worst. The interface should be the main manipulation of future research.

Participants and Group Size

To reduce the confounding factor of individual differences between the interface treatments the group should be more uniformly composed. Of the research that was reviewed the group sizes were smaller than what was observed. A group size of 6 to 7 participants is recommended.

CONCLUSIONS

This research was inspired by my frustration in trying to contribute to an asynchronous group discussion. While my initial instinct was to attempt to build an interface that would have facilitated my participation easier, I quickly realized that I need to see how these interaction occurred ‘in the wild’, with the goal being to see if there was evidence of the interface affecting the behavior of the participants. The research

⁴ Low cost to enter a conversation late (OG) and less spidering of topics (Email).

conducted did provide some evidence that how the posts are presented to the user will affect how the conversation develops, while this research provided me with better insight into the phenomenon questions still remain.

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