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Real and Non-real Time Interaction: Unraveling Multiple Threads of Discourse*

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Recent analyses of discourse have focused on recurring sequential structures. An examination of discourse in different communication media has shown that strict sequentiality is not universal. Instead, discourse in some media is structured with "multiple threads." The significant property of the media producing this difference in discourse was identified as the temporal delay between turns. Discourse in "non-real time" media, such as electronic message systems, contain time-saving devices that produce multiple threads. These differences between media are discussed in light of the relative resource limitation of real time interaction and the data limitation of non-real time interaction.

Recent research has identified sequential structures in discourse, both in verbal and written modalities. For written discourse (text), researchers have proposed such multi-sentential units as "threads of discourse" (Grimes, 1975), "topic structures" (Deutsch, 1974), and "story schema" (Rumelhart, 1975). For oral discourse, the units proposed have ranged from those encompassing a few utterances, such as "adjacency pairs" (Sacks, Schegloff, & Jefferson, 1974), those composed of a moderate number of utterances, such as instructional sequences (Griffin & Humphrey, 1978; Mehan, 1979) and "dialogue-games" (Levin & Moore, 1977), to those composed of many turns of interaction, such as "scripts" (Schank & Abelson, 1975), "lessons" (Griffin & Humphrey, 1978; McDermott, Gospodinoff, & Aron, 1978; Mehan, 1979) and interviews (Labov & Fanshel, 1977; Fisher, 1980).

Although these proposed high-level representations differ from each other in many respects, they all share the central concept of *sequentiality*. Discourse

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constitutents follow one another in time and follow a "pattern of linear organization" (Grimes, 1975). Although there are sometimes optional occurrences, communcative events have a regular sequential structure: greetings are followed by greetings, questions are followed by answers, requests for clarification are followed by informatives, conversational openings precede conversational closings.

Even in situations like cocktail parties, where there are many simultaneous interactions in a single room, while people have the possibility of attending to many parallel discourse events, they in fact participate in only one discourse event at a time (Goffman, 1959; Norman, 1969).

Is sequentiality an inherent property of human communication? As a result of our comparison of discourse conducted in different communicative modalities, we find that the answer to this question is "no." The temporal properties of some media can allow people to participate in multiple threads of discourse simultaneously.

We came to this conclusion by comparing communicative phenomena in several different communication modalities under naturally occurring circumstances. By doing so, we were able to see variation in some of the aspects of human communication and thus see how media influences the structure of interactions. The advantage of comparing communication from different communication media is that the set of possible explanations for a given conversational phenomena is constrained. Any hypothesis regarding discourse structure must explain why a given phenomena occurs in one medium and why it does, or does not, occur in another medium.

DISCOURSE IN DIFFERENT MEDIA

Previous work, such as that by Chapanis (1975), attempted to measure the effects of different communication media. However, the dialogs studied were generated in a laboratory setting, which raises questions about their "ecological validity." For research to be ecologically valid, it must "maintain the integrity of the real life situation it is designed to investigate" (Cole, Hood, & McDermott, 1978). In Chapanis' studies, for example, subjects were asked to solve problems created by the researcher. The subjects were engaging in discourse to fulfill an experimentally defined set of operations. In our study, subjects asked questions and discussed topics based on their own interests and needs.

Yet the ability to control variables which affect discourse is highly desirable, and can yield impressive results if there is some way to let discourse occur naturally. We believe that our "cross-media" method provides at least a partial solution to problems such as ecological validity encountered in the study of discourse.

Our analyses focused on discourse which occurred as part of a course taught by one of the authors (H.M.) at the University of California, San Diego. The

course, "Classroom Interaction," uses a discussion format. In the spring of 1980, the class was divided into two groups; one participated in discussions in the regular classroom modality, while the other conducted interaction via an electronic message system known as MSG (Black & Levin, 1980) which runs on a PDP 11/70 computer.

Electronic Messages and Face-to-Face Interaction

We are all familiar with face-to-face discourse, as it is a part of our everyday activities. Discussions conducted through electronic message systems are not so familiar and deserve a brief description. Electronic message systems make use of a computer's extended storage capabilities. Each individual has a personal message file and can send messages to others by typing them into the computer, addressed to the recipient. Each can check for messages or send out new ones at any time. Because of this feature, the interaction is not time bound, so that electronic message discussions can take place in "non-real time."

The same professor led the computer discussion and the classroom discussion for the 3 week period of the project. It is important to note that the instructor made a deliberate attempt to present and discuss the course topics in the same manner in both modalities. The professor had an account that allowed him to send and receive messages, as did two assistants who helped with problems concerning the system. Each student in the computer discussion group received a computer message account (referred to as MSG) and was provided with both written and verbal instructions on the use of the MSG system and on the location of available terminals. Messages could be sent to the professor alone, to other students, or to the whole computer discussion group.

Printouts of all discussions conducted over the MSG system, and transcripts of in-class discussions, were collected. A "discourse map" of a dialog was then drawn to provide a graphic representation of discourse flow. The discourse map organizes discourse by displaying the pursuit of different topics across time and in order of their occurrence. These maps were then analyzed and compared.

Differences Between Electronic Message and Face-to-Face Interaction

Electronic message discussions and face-to-face discussions differ in many ways: the temporal pacing of interaction, the spatial relations of the participants, and the modality through which discussions are pursued. Face-to-face interactions are conducted by two or more individuals at the same location at the same time. Individuals engage in discussions through the use of verbal utterances and non-verbal gestures. Responses are usually limited to topics which are being or have just been discussed. In contrast, electronic message interactions occur through the typing and reading of text on a computer terminal. Individuals are not spatially or temporally bound in their discussion. Because computers can store text and retrieve it on command, a participant in a non-real time interaction

can respond to a question at any time and from any location which has a computer terminal.

The differences between the two modalities have pervasive effects on naturally occurring discourse. First, several topics can be pursued simultaneously in computer discussions, in "multiple threads of discourse," rather than one at a time as they are in face-to-face discussions. Second, the sequential organization of computer discussions is a two part, Initiation-Reply structure, while the sequential organization of classroom discussions is the three part, Initiation-Reply-Evaluation Structure. That is, the "overt evaluation" element associated with classroom interaction is submerged in computer discussions. Third, the lag time between the initiation and reply components is longer in computer discussions than in face-to-face discussions. It is hours or days in the former modality, while it is seconds in the latter modality. Fourth, the conversational "backchanneling" associated with verbal discourse is minimal in discussions which use computer terminals, creating "dangling conversations." We will now discuss each of these four differences in turn.

Multiple Threads of Discourse

Face-to-face discussions are typified by a sequential organization. Discourse is composed of interactional sequences, and these sequences are linked to form larger units, up to and including discourse events. For example, classroom interaction has been shown to consist of three sequentially linked components: Initiation, Reply, and Evaluation (Griffin & Humphrey, 1978; Mehan, 1979). Sequences occur at a rapid pace, with "no gaps and no overlaps" between the componets (Sacks et al., 1974). When violated, participants work to re-establish the integrity of this sequential structure.

The following dialog illustrates the sequential arrangement of discourse.

S1: Have a peculiar request . . . do you know how I can get a file put on dectape in PDP-11 compatible format? Or who would know?
S2: I suggest you try to reach [name 1].
S1: Okay. Thanks.
S2: Sure. Bye.

A simple "discourse map" (see Figure 1) functions as an analytic device to trace the flow of conversational topics from speaker to speaker. The individual initiating a dialog is shown as S1, the person receiving a message is shown as S2. The connecting link between speakers is shown by a line.

Most discussions are more complex than this. As discourse structures become more complex, so does the discourse map. Figure 2 shows a "discourse map" of a typical real time classroom discussion from our study. The following discussion starts with the instructor's overview of three main topics for a particular class meeting. It occurred after the viewing of a videotape of teacher/student interactions.

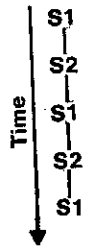

FIG. 1. A simple real time discourse map.

Bud Mehan [labeled T]: I think we can stop it [the videotape] there. It goes on much in the same pattern if we keep going. But I think that's enough to at least start discussion on the tape. In addition to what you said last time, perhaps even modifying what we said last time, what observation did you make about the teacher role, the student role, the process of schooling. What is the teacher doing? What is the student doing? What is being communicated? What is being learned? [S1]?
S1: Some things are . . . . . [inaudible] . . . . you can't do something else and listen and interact.
T: All right, you do one thing at a time. Okay? You identified last time the student role as follows: the teacher gives the stimuli, that is, the question, you identified a question as a form of stimuli. And the follower, the student, responds and does one thing at a time. Do one thing only. Okay now. What else happens? [S2]?
S2: Well, she's definitely an authority figure. But . . Em, what she's doing is like . . [inaudible]. In limited places on there she asks Ramona what she said and she really didn't give the children a chance to answer. She just goes right on.

This segment of transcript can be found at the "A" on Figure 2. The instructor's overview is represented by three T's. Topic one is assigned to discourse pertaining to the student role, topic two is assigned to discussions about the teacher role, and topic three concerns discussions about schooling and two subsets, learning, and knowledge. S1 discusses the student role, and then the instructor prompts the second student, S2, who starts discussing the role of the teacher. The course of the discussion then shifts to a third topic as the instructor tries to move the discussion to the topic of schooling.

T: Okay, So she's acting, okay, so where would you put that in this categorization scheme? Is that a comment on the teacher, student, learning, knowledge, maybe all four? Go ahead.
S2: She's reinforcing speed.
T: Okay, okay. so the process of learning is concerned with repetition recall and definitely speed, that is, very quick learning.
S3: And the other thing which was interesting last time and I noticed she does this time, is after she said "Oh, you're so nice and loud," they all got loud.

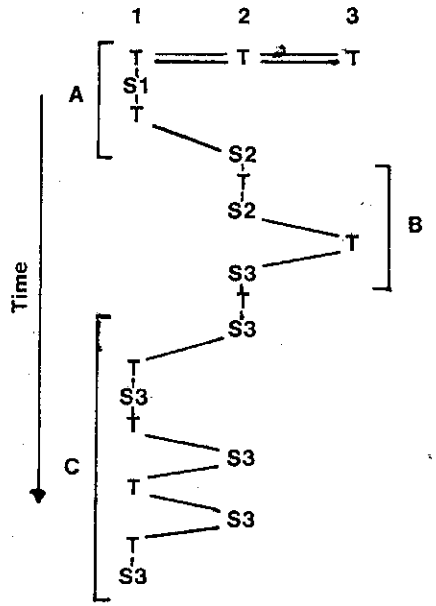

FIG. 2. A discourse map of a real time classroom discussion.

This segment is represented by a "B" on Figure 2. The map has been shortened a bit because of space constraints. The instructor asks S2 to categorize her comment in terms of a scheme being collected on the chalk board. She returns a comment on the role of the teacher ("She's reinforcing . . . "). The instructor then comments that this is "learning" (one of the topics in the scheme), which moves the discussion to topic 3, the process of schooling. Next, a new participant, S3, returns the discussion to the role of the teacher, topic 2. The discussion then continues . . .

S3: So she's reinforcing loudness.
T: Okay, But then what happens right after that?
S3: [inaudible]
T: Yeah, they got loud, yeah go ahead.
S3: She sounds like . . . . It comes out when all of the kids . . . .
T: What does that do for Martha and what does that do for the other kid?
S3: Well, she was saying that . . . [inaudible]
T: What does that do for the other kids?
S3: They feel maybe . . . [inaudible]

In this discussion, the instructor is trying to move to the topic of the student role and keeps asking questions such as "What does that do for the other kids?" to keep student responses in line with this topic.

By contrast, the computer-based discussions were structured in markedly different ways, as shown in Figure 3. Here, several topics are being pursued at once rather than one at a time. That is, there are multiple threads of discourse instead of the one sequential "thread of discourse" (Grimes, 1975) associated with classroom discussions. Not only were there multiple responses from different individuals, but often a given message responded to several topics. There are several instances of this in Figure 3, all represented by parallel lines. We have termed these parallel lines "connectives," which represents the initiation of two or more topics in a single turn. The first line of Figure 3 was, for example, generated by the following message:

To: class
From: bud
Date: Wed Apr 9 12:26:32 1980
Subject: q
cc:
Message:

Hi! As far as I can tel, this sstem is now working. (note that I can't type—so you shouldn't worry about that either. First, some procedural points. There is a video deck and catt terminal in ihe resource room. There is also reserve readin there. It is there on an honor system. Use the materials in the rom, but don't take it away from there. If the materials are ripped off, there will be none left. I hope this is not a problem.

[Several lines discussing class procedure occurred here]

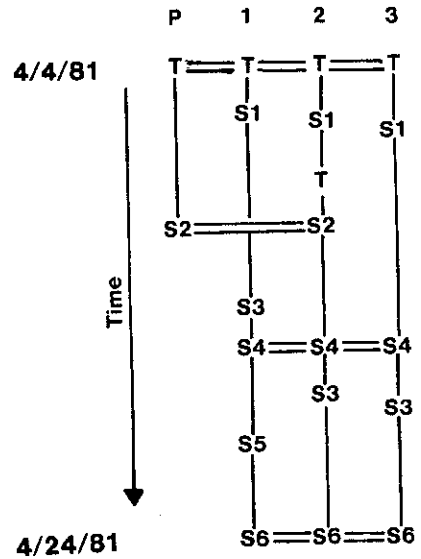

FIG. 3. A discourse map of a non-real time discussion.

Now, lets try some questions about the course. the machine mediated group (mmg) didn't get the benefit of the first lecture (such as it was, such as it is) So, I'd like to start with that material. My plan will be to ask a couple of general questions at first, and then as answers come back, ask some more. So, here goes

1. this one is based on Spradley and mcCurdey. Would they agree with the statement that holidays, dances, religious festivals are a representative conception of culture?

((So: as some of you answer this, then we can start a discussion.))

Lets try another. What does Hymes mean when he says "ethnography is like the ministry, in that it speaks to their condition" (where "their" means "the people.")

3. Of what value is ethnography for the educational practitioner, especially the teacher?

The first part of this message is shown in Figure 3 as TP. Questions 1, 2, and 3 are labeled as topic 1, 2, and 3 respectively and joined by parallel lines. In contrast to Figure 2, there are multiple student responses (for example, S1 and S3). More importantly, multiple threads are established through the many replies to the teacher's multiple questions. For example, the following message is from a student (labeled S6 on the discourse map).

To: bud
From: chappie
Date: Mon Apr 14 15:32:54 1980
Subject: the first three questions
cc: class
Message:

Well, its about time, but here goes. Question 1: Holidays, religious festivals and dances are social situations. Culture includes these situations, the people who are involved, the language they use, knowledge common between those people and the situation. Question 2: I think that bill's answer is realy good. and I don't have anything to add. Question 3+ Ethnographies are very valuable to the teacher in that it is necessary for them to see how the students define what goes on in class. There is a sentence in the intro by hymes on page 49 that i think sys it well, "if the child is to participate in the community of the teacher, then the teacher must be able to participate in the community of the child." _ _ _ _ _ _ _ "chappie"

For this dialog turn, a line is drawn from the previous discussant for each discourse thread or, in this case, questions 1, 2, and 3. If several questions or topics are responded to in a single turn as S6 did, then the responses are joined with parallel lines under the appropriate question or topic thread.

Comparison Across Multiple Media

The differences between electronic message interaction and face-to-face interaction could be caused by many different properties of the media used. The differences in interaction could be due to the lack of non-verbal cues, the use of the written word, the use of typing, the temporal delay between messages, the spatial separation of participants, or the number of participants in these interactions.

The discussions reviewed so far have all focused on large group interactions rather than on dyadic ones. Perhaps multiple threads are only found in these large group interactions. We decided to address this problem by focusing on the helping interactions which involved the students in the experimental electronic message group.

The helping dialogs were gathered from messages sent to research assistants from individual students participating in the experiment. These dialogs were, for the most part, dyadic in nature. To control for media related differences, and in an attempt to isolate the temporal variable, we analyzed helping dialogs from a third data source. Called "Link" dialogs, these were real time helping interactions conducted via computer. The link dialogs were then compared to helping interactions which occured over the electronic message system. The link dialogs were chosen because of the following similarities with the electronic message dialogs.

1. Both media required the use of a computer terminal.
2. Both required the use of a typewriter-like keyboard.
3. Both media lacked nonverbal cues.
4. Both media self-transcribed their dialogs in the process of normal discourse.
5. Both media were used to conduct dialogs for the participants' own reasons, not those of the researcher.

Table 1 provides a graphic representation of the similarities and differences present in all three data sources. The key difference between these two dialog sources is that the TENEX LINK dialogs occur in real time, where the MSG dialogs occur in non-real time.

The USC TENEX dialogs, collected by Mann, Moore, and Levin (1977), are dialogs between users of an interactive computer system and the computer's operators. In these TENEX dialogs, the participants pursue their interaction through a mechanism known as a "link." The discussion takes place in a "real time" fashion with each participant reading on his or her computer terminal what is typed by the other. There is a rapid succession of turns until the problem or issue is resolved. An example of a typical TENEX dialog can be seen in the following.

LINK FROM [L], TTY 42
L: How do I get runoff to work, I keep xeqtn it but it just grabs my input file and then says done but gives me no output? GA
O: The output comes out on the line printer

TABLE 1
Properties of Different Media

	Face to Face	LINK	MSG
printed text		yes	yes
typed input		yes	yes
computer intermediary		yes	yes
ability to retrieve previous turns		yes	yes
remote in space		yes	yes
real time	yes	yes	

L: Throw it away but can I get it to go to a file? GA
O: Confirm your commands with a comma and you'll be queried for files, etc. GA
L: Thanx mucho
BREAK

["GA" stands for "go ahead" and BREAK indicates termination of the link.]

Much like the real time class discussions, the real time link dialogs tended to follow a single thread of discourse. From discourse maps of the link dialogs and the MSG helping dialogs, the number of connectives, i.e., the number of multiple topic initiations and replies within a single turn, were counted. Represented on the discourse maps by two horizontal parallel lines, the connective provided an index for occurrences of multiple topic initiation and replies, and served as a base for comparing the link and MSG helping dialogs. Out of 40 Link dialogs, the mean for the connective was found to be .01 connective/dialog-turn. Out of 75 helping messages, the mean was found to be .43 connective/message, a significantly greater difference. These numbers are computed on a per turn basis.

To: levin
From: marti
Date: Fri Apr 11 16:32:17 1980
Subject: amount time on system
cc: steve marti

Message:
how does a student determine the amount of time that s/he has spent on the system. At the logout portion of the system it tells you the amount of time and money spent for that particular entry. what about all my entries taken together. als to use a question mark within a message (im afraid that it will give me all the commands).

Marti

To: marti
From: levin
Date: Mon Apr 14 08:25:02 1980
Re: amount time on system
cc: levin steve marti mehan
Message:
Hi Marti,
Yes, ? is ok within a message. Anything is ok, except for a control D a the beginning of a line.
We will get printouts at the end of each week telling how much each account spent so far, so check with Bud if you want.
jal

Notice the time lag (2.5 days) between the first message ("initiation") and the second ("response"). This temporal property is one of the features that exemplifies the non-real time nature of these dialogs.

Two questions were initiated by Marti. The first is a question about time spent on the system, and the second asks if a question mark can be used in a message. We would interpret this as the initiation of two separate threads of discourse, but the initiation of multiple threads must be followed by a reply to establish them as a part of dialog structure. Observing the reply to Marti's request, we can see that both her questions are answered by the helper, jal. The map of this dialog can be seen in Figure 4. We would count two connectives in this dialog, one for the initiation of the second thread of discourse (Marti's question concerning the use of a question mark within the text) and the second for jal's reply to the second thread.

In contrast to non-real time dialogs, the real time dialogs were rarely found to use multiple threads, and correspondingly lacked a high percentage of connectives in their discourse maps. Let us consider the following interaction, an apparent contradiction.

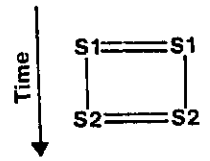

FIG. 4. A discourse map of a helping interaction.

LINK FROM [L], JOB 23, TTY 4

[The first two turns have been left out here.]

3 L: I have a rather old manual and I am trying to get runoff to print to my TTY on line . . . I have tried a couple of things when it asks for output file, but have only managed to spit a few copies of junk to the LPT. When specifying an output file, I have used the comma and enabled the "pause" portion, but when having to type from the formatted output file this does not take effect. So two questions: (1) How can I specify output to the TTY without making an output file? (2) Can I force it to make entries at the beginning of a page without inserting a lot of empty lines?
Go ahead.

4 O: Checking . . . According to what I have, you are proceeding correctly for directing output to TTY. Are you sure the source file is O.K.?

5 L: I think so, . .

[Interaction continued for 4 turns concerning question 1.]

9 L: that might be the answer . . . Go Ahead.

10 O: That should certainly work . . . as for 2, I'm not sure I understand question.

11 L: Let me try it by answering the output file with TTY and see what happens. Going the output file route doesn't accomplish what I want . . .
Mahlo (thanks)

12 O: O.K., G'luck and let me know how it works. Bye.

13 L: O.K. sure will.
BREAK

Let us examine turn 3, in which L initiates two separate questions as in the interaction just presented. However, O and L pursue the question sequentially by first discussing question 1 and then proceeding in turn 10 to question 2. Even though the dialog was initiated so as to create possible multiple threads, it was pursued sequentially and we would count only one connective.

The map of this dialog can be seen in Figure 5.

Non-real time discussions, unlike real time discussions, employ multiple discourse threads. This deviation from a single thread discussion suggests that time has a direct influence on discourse structure.

Unraveling Multiple Threads of Discourse

In face-to-face discussions and, more importantly, in the larger realm of real time conversations, individuals compete for turns in the interaction. Turns are exchanged fairly rapidly, with few gaps or overlaps. A large number of turns comprise a discussion. At any point in the discussion, an individual may comment upon and ask for expansion upon a previous utterance.

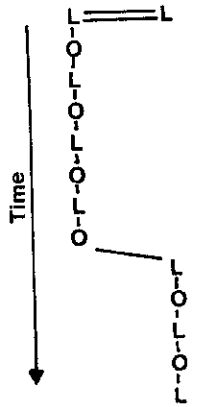

FIG. 5. A discourse map of real-time helping interaction.

By contrast, in non-real time dialogs many individuals may respond to a question at once, without interfering with one another. Turn exchanges take place over a much longer period of time (in our study, the mean response time was approximately 24 hours). This temporal parameter contributes to the presence of multiple threads of discourse in non-real time discussions.

The time delay in non-real time discussions constitutes a problem for discussants.[1] One solution to this problem is to pack more information in each message. In this manner, the first part of two or more adjacency pairs may be initiated, and they in turn can be responded to, reducing a four turn sequence into a two turn sequence, as Marti did in a previous example. The efficiency of the discussion is thereby increased through the initiation of multiple threads of discourse. The connective, then, can be viewed as a "time-saving" mechanism for increasing efficiency.

In helping interactions, a quick solution to the problem at hand is of paramount importance. Rather than initiating a single question at a time, an individual may pose several in non-real time. When responding to questions or problems, the helper must be sure of the context in which a specific violation occurred, and yet he or she cannot spend as much time clarifying the context through the use of more turns because of time constraints. What evolves is a greater use of conditional statements, each of which is contingent on a certain context. Do-it-yourself books are an excellent example of this, reflecting a situation in which the author cannot be certain of the specific problem at hand and must instead provide a list of possible solutions contingent upon the context. This situation is similar to that of the "helper" in non-real time helping discussions.

[1] In a post-class questionnaire, the delay between messages was the most common complaint about the use of the electronic message system for class discussion (Quinn et al. 1983).

He or she must try to account for a great number of contingencies in order to resolve the problem rapidly.

Our discourse map has a special symbol for representing statements of the conditional nature through the use of a "▲". Its purpose is to show the possible alternate courses discourse may follow. The following dialog segment shows its application to the discourse map from the dialog itself.

To: levin steve
From: toyel
Date: Mon Jun 2 9:01 1980
Subject: msg and me
cc: toyel
Message:
Hi I have a question, how does one remove from the "Active" msg file, that which one has moved to mbox? I did it once before, but it was accidental, however, now I would like to eliminate all of the duplications in my
how do I get rid of them in my msg file?
Thanx
Toyel

To: toyel
From: levin
Date: Tue Jun 3 08:08 1980
Re: msg and me
cc: levin steve toyel
Message:
Just delete them, then do an o(verwrite and confirm with y
They will then be forever gone. Good luck
jal

To: levin
From: toyel
Date: Tue Jun 3 14:25 1980
Subject: deletions
cc: toyel
Message:
Hi Jim,
Thanks for the info on deleting. It worked so well I inadvertently deleted several other messages too. Oh well, last night I had made copies of the most important ones anyway so it's no great loss. Intellectually however, I would like to know why I lost 15 messages when I told the computer to d(elete) 35. I then exited and confirmed the update in the file. I know it had to be my error, computers don't make mistakes do they?
Thanks also for all of your help this quarter. I've really enjoyed "playing" with the catt. Have a good summer.

To: toyel
From: levin
Date: Wed Jun 4 08:33 1980
Re: deletions
cc: levin toyel steve
message:
Hi Toyel,
Of course computers make mistakes.
In this case, msg moved your undeleted messages into a file called mbox. I think it is a mistake for the program to do this without telling you. Or else malevelence on its part (computers are malevelent, aren't they?) If you r(ead that file from within msg (after the <-) prompt, you will find those messages appended at tje end (if not, let me know).
jal

To: levin
From: toyel
Date: Wed Jun 4 15:04 1980
Subject: deleted messages
cc: toyel
Message:
Hi Jim,
Well I checked my mbox file and the missing messages don't appear, I guess the computer was just hungry and decided to make lunch out of my mail.
Toyel

In turn 4, Levin instructs Toyel on a course of action and leaves a conditional statement in closing which is dependent upon the outcome of Toyel's future attempt to use the read command. As we can see in turn 5, it did not resolve her problem, and she now reports to Levin the result of her attempt. The "▲" represents this. The "no" side of is the channel through which this discussion flows, as seen in Figure 6.

Our research has shown this to be commonplace in non-real time helping interactions. The mean average of conditional statements was 0.23 per MSG mes-

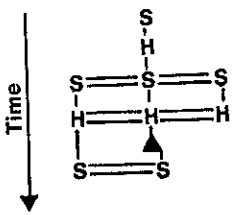

FIG. 6. A discourse map with a conditional statement.

sage, while in the Link interactions there were 0.015 conditionals per dialog turn.

The use of multiple threads and conditional statements increases the efficiency of non-real time dialogs, but, as response time drops, it becomes easier to clarify the specific context of the violation through the exchange of dialog turns rather than through using these structures. In the previous example, the Toyel dialog, the specific context was quickly defined and the solution to the problem was the next step in completing this "dialogue game" (Levin & Moore, 1977). The second problem was tackled in the same manner.

The use of "connectives" and "conditionals" serves to increase the efficiency of each turn, in order to reduce the time required to finish the interaction. This is why we previously referred to these as "time-saving devices," since they provide a way for dealing with the initiation-response lag.

Resource and Data Limitations on Interation

Why are the phenomena of multiple threads and time-saving devices not found as frequently in real time dialogs? Research into attention has found that individuals have a difficult time attending simultaneously to more than one channel. The ability to attune to more than one is dependent in part on the complexity of the stimulus of each channel. Norman and Bobrow (1975) propose that we possess a limited amount of cognitive resources with which to process stimuli. As the complexity of the stimulus increases, so do the information processing requirements, and these tax an increasing amount of the "resource pool." If we treat each thread as a separate "channel" which must be attended, then the task of comprehending all of the information on all the channels could be overwhelming. Real-time discourse is a task which requires a great deal of cognitive processing over a limited time. Switching between topics requires additional processing. This additional requirement may thus exceed usual cognitive abilities. This may then be the reason for the relative absence of time saving devices such as multiple threads in real-time discourse, especially given the availability of alternate ways to achieve the same goals.

The expansion of the temporal dimension allows for more processing time, making it possible to pursue multiple threads of discourse. At the same time, the increased lag between initiation and response makes this desirable by lowering the individual's "effort cost" through reducing the number of responses. In Norman and Bobrow's terms, discourse in real time media is "resource limited," while discourse in non-real time media is "data limited."

CONCLUSION

By comparing discourse in several different media, we found that strict sequentiality is not a universal feature of discourse. Discourse in non-real time media has multiple threads. We first noticed these different arrangements in the classroom and in the computer class discussions. By considering discourse in different media, we isolated the temporal variable as the critical factor for creating multiple threads.

We believe that these findings say a great deal for the adaptability of human interaction. When communicating through a medium which was not temporally bound, individuals adapted by increasing the density of information in each message to help compensate for the lag between messages, using timesaving devices. The structure of discourse is not fixed, but rather the product of participant interaction and properties of the medium through which dialog is pursued.

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