Effects of the amount of shared information on communication efficiency in side by side and remote help dialogues

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Abstract: If the sharing of context is now widely acknowledged as a condition for successful communication, existing studies do not allow to determine whether it is necessary to restore the maximum of shared information to obtain the best communicative performance. To address this issue, three help dialogue conditions distinguished by the amount of shared information, are compared. The analyses are focused on the comprehension problems raised by each condition. The results highlight that the quality of a help dialogue is not necessarily linked to the quantity of shared information. They also exhibit that the inability to share some specific information strongly affects communication efficiency. Implications for the design of computer-mediated communication systems are drawn from these results

1. Problem and objectives

Given the current rapid growth of telephone companies providing support to customers (some call centers include more than 2000 agents and handle more than 200 000 calls per day, Rob Walters, 1996), there is a great interest in reducing the time of each communication. As Muller et al. (1995) claimed, « savings of even a tenth of a second per call are multiplied into significant corporate economies.»

One way to reduce communication time in remote settings could be to enhance the sharing of information between the caller -- I will call him the « novice » -- and the helper -- I will call her the « expert » (for convenience, I will use in the

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following « she » to refer to the expert, and « he » to refer to the novice). Many researchers have pointed out that shared workspaces make collaboration easier (e.g., Dourish & Bellotti, 1992, Whittaker, Geelhoed, & Robinson, 1993). Moreover, some theoritical work on communication processes advocates the need for interlocutor to share not only a linguistic code, but also the *context* needed to interpret the literal content of any message (Clark & Marshall, 1981, Sperber & Wilson, 1986, Krauss & Fussell, 1990, Cahour & Karsenty, 1993). According to this trend, shared context is required to avoid misunderstanding. In this sense, improving the sharing of information in help dialogues should decrease the need for clarification sub-dialogues or erroneous interpretations, which both induce waste of time.

Unfortunately, no study provides precise directions on which information to include in the shared workspace. Existing studies (e.g., Tatar, Foster & Bobrow, 1991, Brown & Duguid, 1994, Heath & Luff, 1995) simply lead to state that communicative performances are dependent on the amount of shared information, which includes just as well computer screen, used documents, others' actions as proximity cues (body attitudes, eyes movements, facial expressions, etc.) However, since this statement is not precise enough, designers of computer-mediated communication (CMC) systems may deduce from it that the more the workspace is shared, the better the efficiency of the dialogue should be. It is then not surprising to note that most people currently involved in CMC system design projects believe that good communication performances in remote settings suppose the greatest possible number of communication channels: video, audio, synchronous written interactions, file sharing systems, etc.

Although this assumption seems reasonable, it neglects the *cooperative aspect of a communication process* (Grice, 1975). According to this view, speakers in a dialogue are assumed to be cooperative, which means that they are expected to adapt their speech acts to the hearers' cognitive environment (Sperber & Wilson, 1986). The hearer's cognitive environment consists of a set of beliefs easily accessible at a given time. This set of beliefs includes beliefs on the speaker's workspace and goals. Thus, when the interpretation of a speech act requires the use of contextual beliefs not immediately accessible (i.e., not evoked for interpreting the previous speech act, or not related to the closest perceptible environment), the speaker is expected to make these contextual beliefs explicit. In other words, the speaker is responsible for ensuring the sharing of the interpretative context. Previous studies on task-oriented dialogues without a shared vision (Grosz, 1978) or human-computer help dialogues[1] (Guindon, 1991) seem to support this theory: it was noticed that, under these circumstances, speakers refer to objects and events with very precise descriptions instead of pronouns, and produce very few ellipses and deictic expressions. Other related work on human explanatory dialogues (Karsenty

1 Note that these dialogues are in fact often simulated through a Wizard of Oz setting, where a human mimicks the computerized advisor It is then a form of remote dialogue.

& Falzon, 1992, Karsenty & Brézillon, 1995) is also consistent with this theory: it was noticed that explanations, which may be conceived as speech acts aimed at changing the hearer's interpretative context, are most often volunteered in task-oriented dialogues and not provided after an explanation demand.

Therefore, we should expect novices in remote help dialogues to adapt the content of their requests depending upon the dialogue setting.

The study reported in this paper was aimed at testing the two hypotheses that have been formulated:

Hypothesis 1: The greater the amount of shared information is, the better communication efficiency is.

Hypothesis 2: A decrease in communication efficiency is limited by the novices' adaptive linguistic capacities when the amount of shared information is small.

To what extent and under which conditions a decrease in communication efficiency can be limited by the novices' adaptive power were also two central issues of our study. The answer to these questions is important because it should influence the design of CMC systems for help dialogues. Consider at an extreme that the novices' adpative power is proved to ensure mutual understanding in any case: this would highlight that good communication performances in remote settings does not require a mix of communication technologies; only one appropriate channel should be sufficient. At the other extreme, if this adaptive power is proved to be totally inefficient to limit misunderstandings in remote settings with a small amount of shared information, we should conclude that a mix of communication technologies is highly desirable.

Another objective of this study was to estimate to what extent one could expect remote help dialogues enhanced with information sharing tools to be confined to a single dialogue turn (one question-one answer). This question is especially important for user support office managers: if they believe single turn dialogues possible, they will expect (or impose) a certain operators' throughput. This expectation will then influence the way each operator will handle callers' requests. If single turn dialogues are not always possible, or even not always desirable, this managers' expectation will produce frustration and dissatisfaction from every sides: callers, operators and managers.

To tackle these issues, we have compared communicative performances of novice-expert couples placed in three help dialogue settings: (1) side by side by the same screen, (2) at a distance with the expert seeing the novice's screen, (3) at a distance with no shared environment. One may consider that the shared environment is maximal in condition 1, including screen information (buttons, menus, state of the displayed text, cursor, etc.), cues on novice's actions (typewriting, hand moves toward the screen), and proximity cues. The shared environment is intermediary in condition 3, composed only by screen information. And it is nil in condition 3.

2. Method

2.1 Data collection

2.1.1 Procedure

The task domain concerned by this study is text editing (with Microsoft Word™ on macintosh). This task domain was chosen for three reasons: first, it is familiar to most people working in our research area; second, the subjects were motivated to learn about editing tasks; and third, editing tasks require few prerequisites. The experiment consists of three phases:

1. *Phase of familiarization:* during the first phase, each subject is trained to use the computer and the main functions of its interface (mouse handling, understanding of the icon principles, menus, use of the cursor). This phase ensures that all the novices have the same level of experience at the beginning of the experiment.
2. *Phase of goal definition*: just after this first phase, the novice and a word processing expert examine the initial state of the text to be edited and the text to be obtained (target text), both texts being displayed on a separate sheet of paper. The comparison between these texts allows the novice and the expert to define the changes to be carried out (the novice's goals). This phase ends when all the changes have been defined. These changes represent elementary tasks related to a word processing task: replacing/inserting a word, changing the size of characters, creating spaces between lines, justifying lines, creating a footnote, and framing part of the text.
3. *Experimental phase*: just after the second phase, each novice is asked to modify the initial text in one of the three following conditions:

   Condition 1: Side by side. The expert and the novice are set side by side, in front of the same computer screen on which a text is displayed. The novice is asked to carry out a set of word processing tasks. The expert intervenes only when the novice requests help. The expert must not perform any of the novice's task, but is free to use any means judged necessary to provide help.

   Condition 2: Screen sharing. The expert and the novice are placed at a distance in the same room. Both have access to computers linked via a network. Timbuktu® software was used in the « Observe » mode only. This configuration permited the expert to observe the novice's screen (including the cursor movements). No direct intervention was possible. Any assistance offered by the expert was conveyed verbally.

Condition 3: No shared environment. As in the previous setting, the expert and the novice are placed at a distance, in the same room. Direct access to the novice's screen was not permitted. Novice's requests and expert's assistance were conveyed verbally.

No constraint concerning the order of the tasks is imposed. In every experimental session, novices are videotaped so that the computer interface, the actions on the keyboard, and all the novices' hand gestures towards the screen (as well as the expert's gestures in the side-by-side condition) are all recorded.

2.1.2 Participants

Participants included 15 first year psychology students from a large university in the southwestern region of France. Three groups of 5 subjects were formed, one group per dialogue setting. No student was familiar with a computer. Their participation was doubly motivated: first, it was a chance for them to be initiated to word processing systems before their second year where such an initiation is mandatory; second, each subject was paid (100 francs).

Two experts were chosen for helping the novices. These experts were students from the same university but attending a master's degree in psychology. I call them « expert » because they were familiar users of the macintosh and the Microsoft Word™ software.

In order to guard against order effects, experts were randomly assigned to one of the 15 help dialogues.

2.2 Data coding

The dialogues between the novices and the experts were all extensively transcribed for the analysis, reporting every verbal interaction as precisely as possible (but without intonation), hand gestures, and actions on the system.

Six out of the 15 recorded dialogues were exploited for this paper. Data coding was done by two analysts, with all discrepancies reexamined in a combined session.

2.2.1 Help interactions

Only specific sequences, corresponding to « help interactions », were coded. An « help interaction » consists of any sequence of dialogue aimed at solving a novice's problem, initiated by a novice's help request, and ended by one of the following conditions: (1) the novice performs the appropriate action(s) with respect to the expert's answer, (2) the novice addresses another help request, either on a different topic, or aimed at clarifying the expert's answer. We identified 255 help interactions in our data.

Note that every help interaction is not initiated by a novice's request in the « side by side » and « screen sharing » conditions: these conditions allow the experts to

anticipate some novice's problems, and consequently to volunteer help (see fragment 2, sequences 26 to 28). This type of help interaction has not been taken into account because this study is focused on problems of understanding raised by the novices' help requests.

Help interactions were all extensively transcribed for the analysis, reporting every verbal interaction as precisely as possible (but without intonation), hand moves, and actions on the system.

2.2.2 Communication efficiency and suboptimal communication

Communication efficiency has been measured using a single variable: the frequency of *suboptimal communication*. The notion of suboptimal communication refers in this study to any situation where the expert cannot immediately understand and/or adequately respond to a novice's help request, and asks him for further information. We consider suboptimal communication as an indicator of the situations where the context needed to understand and handle a novice's request is not shared.

2.2.3 Levels of contextual informativeness in help requests

According to relevance theory (Sperber & Wilson, 1986), a speaker should adapt her/his message to the hearer's cognitive environment. As a consequence, one can hypothesize that the level of contextual informativeness of help requests should be different with respect to the dialogue setting. We distinguish three levels of contextual informativeness:

- *I1: Requests with any reference to the novice's context.* Here are two examples: (1) « Do I need to select another menu ? », (2) « Do I do the same thing ? » Note that in the second example, a reference to the dialogue context exists: the asker refers to a procedure (« the same thing ») which has just been described by the expert. This type of contextual reference was not taken into account because any dialogue settings complicate the access to the dialogue context.
- *I2: Requests with a deictic reference* (« this », « here », etc.) A deictic reference does not convey contextual information per se, but helps the expert in finding the right context. In a sense, one may say that deictic references are « contextualization instructions ». In our data, the context indicated by the observed deictic expressions specifically corresponds to a piece of text or interface object displayed on the novice's screen. An example of this type of request is: « Do I shift my cursor here ? », where « here » refers to a location on the displayed text.
- *I3: Requests with elements of the context made explicit.* This type of request makes part of the novice's context explicit, often under the form of a justification of the help request. In the following example « *I want to write 'Toulouse'*, do I need to delete this now ? », the first part of the request makes the novice's goal explicit. I3 requests are also identified when

the novice specifies a given mode of action in his request, as in the following example: « So, *with the mouse*, how do I do it ? ».

Note that in this study, only verbalizations *making explicit* some element composing the novices' context are treated. It is important to stress that information about the novices' context can also be conveyed implicitly, as it is illustrated in the following example:

N: That's not the right menu which has just unrolled

This statement implicitly conveys that another menu has just unrolled, one that was not desired. However, this implicit mode of communication will be neglected since the focus of this study is on cases where a novice feels that it is necessary to make her/his context explicit to the expert.

3. Results

3.1 Number of suboptimal communications for each dialogue setting

Across all dialogue settings and within all types of help requests, only 36 cases of sub-optimal communications were noticed out of 255 help interactions. The following analyses are mostly based on this sample of 36 cases. I am aware that this relatively small number reduces the significance of the conclusions drawn from this study. However I have found that the trends revealed by the following analyses lead to theoretical and practical considerations that are of value both for the study of cooperative work and the design of computer-supported cooperative work systems. The results may also serve as a basis for further investigations. A special emphasis will be put on these implications in the conclusion of this paper.

Some expectations have been formulated regarding the number of suboptimal communications for each dialogue setting: it should be the highest in the « no shared environment » condition, intermediate in the « screen sharing » condition, and the lowest in the « side by side » condition. Table 1 (below) shows that these expectations are partially met by our data. Specifically, we notice that suboptimal communications are significantly more frequent in the "no shared environment" condition than in both others ($\chi 2=12,03$, significant at $p<0.01$). But, surprisingly, we also notice that the number of suboptimal communications in the screen sharing condition, which is relatively small compared with the one obtained in the no shared environment condition, is virtually identical to the number of suboptimal communications in the side by side condition.

Table 1: Frequencies of suboptimal communication for each dialogue setting

Condition	Optimal communication (total number)	Suboptimal communication (total number)	Percentage of suboptimal communications
Side by side	78	7	8,2%
Screen sharing	62	5	7,5%
No shared env.	79	24	23,3%

Given the lack of difference between these conditions, how can we explain the occurrence of sub-optimal communications in the « no shared environment » condition ? In particular, does the lack of a shared environment make linguistic adaptations of the content of the help requests more difficult ? If it is the case, how to explain this failure ? We explore these issues in the following section.

3.2 Linguistic adaptations of the help requests according to the dialogue settings

If novices adapt their help requests to the dialogue setting, we should observe different distributions of types of help requests. More specifically, we expect to find:

1. More I2 requests (with a deictic reference) in both the « side by side » and « screen sharing » conditions;
2. More I3 requests (with part of the novice's context made explicit) in both of the remote dialogue settings, but more importantly in the « no shared environment » condition.

Table 2 exhibits results that confirm these hypotheses: there are more I2 requests in both the « side by side » and « screen sharing » conditions than in the « no shared environment » condition. There are more I3 requests in the « screen sharing » condition and still more in the « no shared environment » than in the « side by side » condition. These differences are statistically significant (χ^2 = 13,35, p≤.01).

Table 2: Number and percentages of help requests characterized by their level of contextual informativeness for each dialogue setting

	I1	I2	I3	I1	I2	I3
Side by side	49	19	17	57,6%	22,4%	20%
Screen sharing	30	17	20	44,8%	25,4%	29,9%
No shared env.	57	9	37	55,3%	8,7%	35,9%

Let us now consider to what extent these linguistic adaptations are appropriate and sufficient to ensure an immediate mutual understanding of a help request. The very fact that an important number of suboptimal communications have been noticed

in the « no shared environment » condition tends to highlight that these linguistic adaptations are not sufficient. A more specific way to handle this issue consists in registering the number of help requests implying suboptimal communication, and observing how this number varies according to the dialogue setting (see table 3).

Table 3: Number and percentages of suboptimal communications/total number of each level of contextual informativeness for each dialogue setting

	I1	I2	I3	I1	I2	I3
Side by side	4/49	2/19	1/17	7,7%	7,7%	5,5%
Screen sharing	1/30	2/17	2/20	5,1%	5,3%	10%
No shared env.	9/57	3/9	12/37	15,8%	33,3%	32,4%

These results reveal that I2 and I3 requests imply, somewhat frequently, suboptimal communication, but specifically in the « no shared environment » condition (33,3% for I2, 32,4% for I3). The novices' linguistic adaptations are thus not sufficient to ensure an immediate mutual understanding of the help requests when experts and novices communicate only verbally.

3.3 Specific difficulties for communicating with no shared environment

In the following section, we explore several aspects that may explain why the novices' linguistic adaptations may be inadequate to ensure a shared context. The exploration of these aspects will help us to decide how to best support remote help dialogues. Four avenues are examined: (1) novice's misjudgments of the expert's cognitive environment, (2) expert's inability to recover communication errors, (3) discrepancies between experts' and novices' language, reasoning, and knowledge, (3) novice's inability to ensure the sharing of the context required to solve his problem.

3.3.1 Novice's misjudgments of the expert's cognitive environment

A certain amount of sub-optimal communications could be explained by the fact that novices make incorrect judgments about the expert's cognitive environment (i.e., the expert's mental representation of the novice's context). The following extract illustrates such a case, stemming from a « no shared environment » dialogue.

(N has just deleted a word, but because his cursor was incorrectly located, the last letter of the word remains)

11 N: And the « E » there ?

12 E: Which « E » ?

13 N: An « E » is remaining on the line.

14 E: Ah OK, put you again after it [...]

When uttering « And the « e » there » ? », N seems to believe that E can see the « E ». The fact that he uses a definite reference (« the ») to refer to the object « E » supports this assumption: some experimental studies (Clark & Wilkes-Gibbs, 1986, Isaacs & Clark, 1987) demonstrated that the use of definite references is generally observed when a speaker refers to an object believed to be mutually shared. As a matter of fact, in the extract above, the referred object is not mutually shared, hence E's question in line 12.

The extract below illustrates another case when N seems to attribute to E the knowledge of his goal, when in fact this is not the case.

88 N: Here too, I go down again ?

89 E: What should you do now ?

90 N: Well, put spaces before « monsieur »

91 E: Oh yes, you need a blank line [...]

When we examined the data, we observed 15 cases wherein N's help requests implying a suboptimal communication indicated that N wrongly believed that a given object was mutually shared. This number represents nearly 42% of the total number of help requests implying suboptimal communication. Furthermore, most of these cases (9 out of 15) were in the « no shared environment » condition. It thus seems that the occurrence of a novice's misjudgment is relatively more important when the dialogue setting does not allow the sharing of the novice's environment. But one must also note that this phenomenon is not totally absent from the two other experimental conditions.

We can hypothesize that these features arise from factors which are intrinsic to the achievement of editing tasks by a novice: this situation would be very demanding in itself, and limit the novice's communication abilities, whether the expert is near or at a distance. This could account for the fact that novice's misjudgements of the expert's cognitive environment are observed in every dialogue setting. But how to explain the higher frequency of suboptimal communications caused by novices' misjudgements? We believe this is due to the experts' inability to recover communication errors.

3.3.2 Expert's inability to recover communication errors

The sharing of a novice's environment, permitted in both the « side by side » and the « screen sharing » conditions, may allow experts to uncover the correct meaning of the help requests when their content is unsuited. As an example, let us examine the case where an expert would see the novice's interface at a distance, and receive the help request presented above: « And the « E » there ? » Even if the expert does not immediately understand which « E » is meant, she can look for it on the novice's screen, and in many cases find it. If she feels sure she has recognized the « E » identified by the novice, she will directly provide him with

the appropriate answer, without any need of a clarification sub-dialogue, as in the original extract above. According to this view, it would not be so much the appropriateness of the novices' linguistics adaptation that would differ, depending on the dialogue settings, as the expert's ability to *recover* a novices' misjudgment.

This hypothesis is supported by observations made on remote dialogues between airplane pilots and air controllers. These observations (Hansman, Pritchett & Midkiff, 1995) reveal the importance of the « party line » effect on mutual understanding and safety. Within the aeronautical field, the words « party line » refers to the fact that all airplanes evolving inside the same air sector receive the same air trafic control messages. The party line allows pilots to augment their situational awareness (the number of airplanes flying through a given air sector, their relative positioning, etc.), which is then at least partly shared among them. Many pilot reports exhibit situations where the party line has been used to detect mistakes in an air trafic controllers' instructions or in a pilots' misunderstanding of the controllers' instructions. The shared environment provided by the party line then makes it possible to recover communication errors.

3.3.3 Discrepancies between experts and novices' language, reasoning and knowledge

According to Falzon (1991), work dialogues may be split into two categories: expert-expert and expert-novice dialogues. The invoked distinctive feature is the form of language used by the cooperative partners: expert-expert dialogues rely on specialized professional languages (restricted and domain-specific syntax and lexicon, with few ambiguities) while novice-expert dialogues essentially rely on a more flexible and semantically open language (Falzon used the words « natural language » to designate it), which is necessary to palliate discrepancies between partners' knowledge.

Our study confirms the relevance of the distinction between expert-expert and expert-novice dialogues, and allow a better understanding as to why the use of a domain-specific language is not possible with novices. Four reasons are pointed out below:

(1) *a novice does not necessarily follow a logical order across tasks.* This is due to his relative lack of knowledge with respect to the word processing software used. For instance, a novice may want to right justify a given text line, although he must right justify a whole paragraph which includes this line of text. In such a case, the expert may expect the novice to first correctly type all the lines composing the paragraph, and then right justify the whole paragraph. This is what we call here a « logical » order across tasks. This wrong expectation may lead the expert to experience difficulties in understanding the novice's question « Do I select the line? ».

(2) *a novice may employ inappropriate words to indicate his goals.* For instance, many novices uttered the question « Do I go down? » while their intention was to include blank lines between two paragraphs. Pilkington (1992) also reported the

same type of observation, and linked this characteristic of the novices' language to their lack of knowledge concerning the system functioning.

(3) *a novice's help request may be based on an erroneous goal representation.* For instance, a novice asked the expert if he had to select a piece of the text, his goal being to copy this piece of text and to paste it at the bottom of his sheet, as a footnote. The expert did not immediately understand this request because the selection of a piece of text is usually not required to create a footnote; the user must open a window called « footnotes », and types the piece of text directly inside.

(4) *novice's actions may result in intermediary goals, which the expert does not expect.* In particular, errors produced by a novice raise new goals aimed at recovering these errors. An expert placed at a distance, especially in a work setting without a shared environment, cannot observe the novice's erroneous actions. If the novice did not make them explicit in his request, the expert will contextualize the novice's request with a wrong representation of the novice's situation. Such a discrepancy between the expert's expected representation of the novice's situation and the novice's actual situation may cause difficulties in understanding.

In total, these four factors account for 12 cases of sub-optimal communication (which represents 33,3% of the total number of sub-optimal communications). We did not find that they occurred more frequently in either dialogue settings. After all, one can consider that this is normal, because all these factors are basically linked to the very fact of being a novice, and this does not change across the three dialogue settings.

3.3.4 Novice's inability to know all the relevant contextual information needed by the expert

Sometimes, the additional information requested for by the experts is not required to *understand* the novices' requests, but rather, it appears necessary to *solve* the novices' problems. In such a situation, it is somewhat normal that novices do not provide experts with all the relevant information. The following extract, stemming from a « no shared environment » dialogue, illustrates this latter case.

1. N: So, I delete « SOCIETE » ?
2. E: Yes
3. N: Damn ! It doesn't work ...
4. E: Is your cursor located where it should be ?
5. N: Ah no...Ok, so I'll move it up

In this extract, N attempts to delete a word, but does not succeed. He then expresses this inability (line 3). E does not directly provide him with the procedure that could allow N to reach his goal, because she lacks some information. In particular, she does not know where the cursor is. Given the novice's inability to delete the word, the expert assumes that the error stems an incorrect positioning of the cursor. The expert's information demand in 4 is the expression of a diagnosis activity: by invoking the cursor location, E expresses an hypothesis that could

explain N's inability to reach his goal. Furthermore, this information demand is the expression of the fact that E has understood N's problem: she has understood that N was unable to delete the word « SOCIETE », and more specifically, that N had probably carried out some actions that failed to achieve the desired result. In brief, E has understood N's problem, but does not have all the required information to solve it.

This distinction between the information-needed-to-understand and the information-needed-to-solve is important for the following reason: one cannot expect a novice user to spontaneously make the latter type of information explicit since he is unaware of its significance on account of his being confronted with a problem. If he knew the significance of this information, he would know at the same time how to solve his problem. One could even say that there would be no problem at all.

In total, nine sub-optimal communications due to a lack of information needed to solve the novice's problem were noticed. All these cases were found in the « no shared environment » condition.

The information-needed-to-solve can be accessed by two means: (1) either the expert can infer it, (2) or she initiates a sub-dialogue aimed at making it explicit. The results of this study reveal that the expert, placed in work conditions without a shared environment, frequently opts for the latter strategy. This seems to highlight her difficulty in inferring the information-needed-to-solve under these circumstances.

On the other hand, it seems reasonable to assume that the need of sub-dialogues in remote cooperation could be reduced by a work environment providing a certain level of shared environment. We develop this proposal in the following section.

4. Conclusion

This study highlights that the quality of communication aimed at supporting users is not necessarily linked to the quantity of shared information. Considering comprehension problems raised by the handling of help requests, this study has revealed that remote help dialogues with a shared screen and audio communication are as efficient as side by side dialogues.

However, without a shared screen, remote communication efficiency becomes poorer when compared to side by side and « screen sharing » dialogue settings. Thus, good communicative performance at a distance may be obtained under certain conditions, and a shared screen, showing the state of the work in progress, appears as one of these conditions.

These results are important because they question an assumption often encountered in CMC system design projects: this assumption is that the more the workspace is shared, the better communication efficiency should be. Rather than looking for a mix of technologies ensuring a « maximum shared environment »,

decision-makers should provide participants in remote collaboration with a limited set of tools simply ensuring an « optimal shared environment ». Providing an « optimal shared environment » seems sufficient because the communicative system, composed by the caller and the expert, may adapt to its environmental resources: on the one hand, novices can adapt the literal content of their messages, to help an expert in considering the right interpretative content; on the other hand, the expert seems able to adapt his interpretative strategies, especially by exploiting differently her/his available environmental resources (recovering of dialogue errors without the need of further sub-dialogues). We can speculate that the fact that that *doubly adaptive human-human dialogue* can explains why a maximally shared work environment is not necessarily required to obtain better communicative performance.

This study also highlights that one should not expect help dialogues, whether at a distance with appropriate support tools or even face to face, to be confined to a single turn (one question-one answer). The reason explaining this conclusion if that novices, given the very fact of being novices, may pose questions which *cannot* be immediately understood by experts. In particular, their goals may be underspecified in their requests (see also Pollack, 1985, Aaronson & Carroll, 1987), and they cannot volunteer all the information needed to solve their problems.

Implications on the design of computerized support for remote help dialogues

This notion of « optimal shared context » has implications on the type of computerized support that could enhance remote help dialogues. It does not seem necessary to provide the helper and the helpee with the whole battery of available collaborative tools. In particular, this study suggests that a video link could be superfluous.

However, it also suggests that computer-mediated communication could make the help dialogue process easier. More specifically, this study leads to recommend a cooperative work environment exhibiting three main features[2]:

1. *The target system* (i.e. the system used by the user to achieve his tasks) *should be integrated with electronic communication facilities* (e.g., e-mail). This requirement is necessary to provide the communication system with a set of information that would be automatically recorded while the user uses the system and then transferred to the assistance service. Some other results of this study (not yet published) lead to expect the following pieces of information to be especially useful: (1) the current state of the interface, (2) previous user's actions (it should be sufficient to store only a limited amount of a user previous actions), (3) intermediary interface states

2 I do not claim that these features are new Rather, I hope that readers will find in the results of this study new arguments for advocating their necessity.

associated to these user actions. Mechanisms for automatically capturing and transferring this information, for instance as attached files, should then be implemented. It would be more appropriate to let the user to choose to attach these files. One may anticipate that concerns over proprietary or security issues would preclude the viewing of sensitive material by a third party.

2. This study suggests that the novice's current goal is often too poorly specified to allow the expert to directly supply the appropriate help. As a result, we recommend providing a *structure to the user's messages* that are addressed to the assistance service around two text fields: the first one would be devoted to the *goal description*, the second to the *request description*. This structure should not force the user to fill in both text fields (one can figure out particular requests where the goal description could be avoided), but only encourage him to do so.
3. The results of this study do not lead us to consider that it is possible to confine every help dialogue to a single turn dialogue, even with the functionalities described above. These considerations conduct us to recommend *interaction-based solutions*. Interactivity can rely on electronic written communications. More simply, interactivity can rely on telephonic communications.

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