

Processes of Collaboration and Communication in Desktop Videoconferencing: Do They Differ From Face-to-Face Interactions?

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Abstract

The impact of desktop videoconferencing (DVC) upon interpersonal communication are explored to determine if this communicative context affects the processes required for effective communication. Twenty undergraduate participants acted as Clients during a stimulated service encounter (The Travel Game) in one of two contexts, DVC or face-to-face. The content and structure of the interactions are examined using Conversational Games Analysis. The results of the analysis show that participants in the DVC and face-to-face contexts interacted and collaborated in different ways. In the DVC dialogues participants elicited a greater amount of listener feedback (Align Games), offered more information about the task and their activities (Explain Games), and sought more information by asking a greater number of yes-no questions (Query-yn Games). These results are discussed within the framework of a collaborative model of communication.

1. Introduction

Establishing mutual understanding, or 'common ground', is required for effective communication. This is referred to as the 'process of grounding' (Clark and Wilkes-Gibbs, 1986; Clark and Schaefer, 1989). Grounding is a collaborative, interactive process, which ensures that participants have understood a previous utterance, to a level sufficient for their current purposes. The process of grounding can be affected by several factors. Clark and Schaefer (1989) suggest that different conversation purposes impact on grounding, so task related conversations might require stronger evidence of understanding than social dialogues. It has also been proposed that the process of grounding changes with communicative context (Clark and Brennan, 1991). This is because contexts vary in the number of channels of communication they support, and hence the range of 'grounding constraints' (ways of constraining the many possible interpretations of utterances or messages) afforded by the communicative context. Some methods of grounding appear to require very little effort in communicatively rich contexts, but using the same grounding constraints in another context may take considerably more effort. For example, while it is easy to use non-verbal behaviour to show agreement and understanding in face-to-face communication, this is not so easily achieved during a videoconference, where the visual channel is often impoverished. The effort required to maintain the process of grounding would therefore vary dramatically with communicative context (Clark and Brennan, 1991). In video-mediated communication (VMC), attenuation of visual signals can make it difficult to time the effective use of non-verbal signals to show understanding (Heath and Luff, 1991). Users of VMC systems should use the grounding constraints that require the least collaborative effort. The question being addressed in this paper is whether they do so or not.

Although there have been a number of studies of the impact of VMC on users (see for example, Sellen, 1995; Anderson et al. 1996; O'Conaill et al., 1997), very little research has investigated whether collaboration over the content of communication and establishment of common ground is affected by communication medium. This paper reports the results of detailed discourse analysis of dialogues that took place in two of the communicative contexts explored by Anderson et al. 1996, face-to-face interactions and desktop videoconferencing. The aim is to see if the content and structure of dialogues from these contexts differed in terms of observable patterns of pragmatic function. The research builds upon earlier research, which has examined the effect of a range of communicative contexts upon task performance and the structure of dialogues in collaborative task-oriented interactions (for example, Anderson et al, 1997; Doherty-Sneddon et al 1997).

Conversational Games Analysis (Kowtko, Isard and Doherty-Sneddon, 1992), which is used in this paper, provides a framework for looking at the communicative functions (conversational goals and sub-goals) that speakers attempt to convey in their contributions. Conversation Games Analysis (CGA) is derived from artificial intelligence models of communication, specifically from the work by Power (1979), Houghton (1986) and Houghton and Isard (1987). The analysis involves coding every utterance in terms of what the speaker is attempting to achieve. It is based upon the function of the utterance rather than its linguistic form or content. In this way, patterns of pragmatic functions in the dialogues can be observed (Newlands et al., 1996; Doherty-Sneddon et al., 1997). CGA can be used to elucidate the process of grounding in dialogues. The distribution of the Conversational Games and Moves can highlight the ways in which grounding may differ between face-to-face interactions and desktop videoconferencing.

2. Goal of the Paper

The paper attempts to add to the literature on video-mediated communication, by exploring the effects of a DVC system which provides low quality visual images but high quality (full duplex) audio signals. The effects of this VMC context are compared with face-to-face communication, to see what impact the impoverished video channel had upon communication and collaboration. The structure and content of the VMC dialogues were explored using Conversational Games Analysis to see if the quality of the visual signals available in the DVC context affected the processes of communication and collaboration.

3.1 Design and Procedure

Using an experimental paradigm, twenty pairs of participants took part in a collaborative problem-solving task in a simulated travel agency (The Travel Game, Anderson et al., 1996; Newlands et al., 1996). Participants were asked to plan an itinerary around the United States; their goal is to visit as many destinations as possible given the restrictions imposed by available connecting flights. Ten pairs of participants undertook the task in a face-to-face context, using paper maps of the USA which showed the position of available airports. They were assisted by a Travel Agent who had details of flight times and possible connections. Participants in the VMC context were presented with a multi-media version of the Travel Game. The map was displayed in a shared screen facility and users communicated with the remote Travel Agent via video and audio links run over a dedicated local area network. The quality of the video images was low, temporal resolution was 4-5 frames per second, this being a common feature of publicly available VMC systems. The audio link provided high quality full duplex audio signals. Full orthographic transcriptions of the face-to-face and DVC dialogues were made from high quality audio recordings.

3.2. Method of analysis:

CGA was applied to the transcribed dialogues by two trained coders. Table 1 shows the full set of Conversational Games found necessary and sufficient to capture the speaker's communicative intentions in coding the Travel Game Dialogues. Definitions are provided, along with examples of the Conversational Games from the face-to-face (Face) and DVC communicative contexts.

Table 1. Seven Types of Conversational Games used in Coding Travel Game Dialogues.

INSTRUCT: Communicates a direct or indirect request for action or instruction.

Examples:

Face: You'll need to take a note of the flight times

DVC: Hang on a minute, no I'll change my mind and go to Michigan

CHECK: Listener checks their own understanding of a previous message or instruction from their

conversational partner, by requesting confirmation that the interpretation is correct.

Examples

Face: I'm sorry, which airport did you want to fly to?

DVC: And what was the city?

QUERY-YN: Yes-No question. A request for affirmation or negation regarding new or unmentioned information about some part of the task.

Examples:

Face: Can I move on to Detroit?

DVC: Can I get a connecting flight to Casper?

QUERY-W: An open-answer Wh-question. Requests more than affirmation or negation regarding new information about some part of the task.

Examples:

Face: Where would you like to go from Syracuse?

DVC: Is there anywhere else you would like to go in Montana?

EXPLAIN: Freely offered information regarding the task, not elicited by coparticipant.

Examples:

Face: I am sorry, there isn't actually a connection between those two airports.

DVC: Right, so that will be day 4 before you can fly out of New York

ALIGN: Speaker confirms the listener's understanding of a message or accomplishment of some task, also checks attention, agreement or readiness.

Examples:

Face: I think it said that in the instructions, didn't it?

DVC: So you leave on day 22, is that okay?

DIRECTIVE: Communicates a decision made by the speaker.

Examples:

Face: Right I'll fly to Memphis to start with.

DVC: Okay, I'm going to fly into Portland, Maine.

The following extract gives an example of a dialogue from the face-to-face context of the Travel Game, and shows the application of Conversational Games Analysis to this task. In this extract 'TA' refers to the Travel Agent, and 'C' to the client. Conversational Games are indicated above the text of the dialogue in upper case, and Conversational Moves are shown underneath the text in italics. The start and end of each Game is shown.

Extract 1. Example of coded face-to-face dialogue.

Game 1: QUERY-W

TA: where would you like to go from Syracuse?

Move: Query-w

Game 2: QUERY-YN embedded

C: I can still go, I have to be still in New York

Move: Query-yn

Game 3: EXPLAIN embedded

TA: you have just to stay in New York until 5.30 that day/

Move: Explain

C: 5.30 >

Move: Acknowledge

End Game 3, End Game 2.

Game 4: QUERY-W embedded

<TA: you could just stay in Syracuse until 5.30 and choose to st.. fly out of state then if you wish/

Move: Query-w

C: yeah>

Move: Acknowledge

TA: or you could go to another city in the meantime?

Move: Query-w cont

C: no I think I will stay

Move: Reply-w

TA: right

Move: Acknowledge

End Game 4.

TA: so where would you like to fly then

Move: Query-w (continuation of Game 1)

C: I would like to fly to ehmm, let me see, to Detroit

Move: Reply-w

TA: to Detroit ... uh huh ...

Move: Acknowledge

Game 5: EXPLAIN em

C: it's in Micshigan, Michigan

Move: Explain

TA: to Detroit in Michigan,

Move: Acknowledge

End 5.

Game 6: EXPLAIN embedded

TA: I am sorry there isn't actually a connection between those two airports.

Move: Explain

C: right, ehmm

Move: Acknowledge

End Game 6

The distribution of Initiating Moves appears to be different from the typical pattern of Initiating Moves found in the Map Task. The task is primarily one of seeking and giving information, demonstrated by the large number of Explain Initiating Moves (giving information) and frequent use of open-ended and yes-no type questions (Query-w and Query-yn).

4.1. Results

Only the results of the CGA will be reported here. The findings on comparisons of task-performance, turn-taking procedures and rates of interruptions are reported in Anderson et al., 1996. CGA can either be carried out at the level of the Conversational Games, or at the more detailed level of the Conversational Moves. In this paper the analysis is based upon Conversational Moves which initiate Conversational Games, as inter-judge agreement for coding Conversational Moves has been found to be greater than agreement over categorization of Conversational Games (Carletta et al., 1997; Newlands, 1998). An inter-coder reliability test was conducted which showed an inter-judge agreement of 91.5%. Agreement on the classification of each Conversational Move was calculated giving a kappa of 0.94 (N=177, k=2), indicating that agreement between coders was not due to chance factors alone (p<0.001).

The frequency with which each type of Initiating Move occurred in the DVC and face-to-face contexts was calculated, and the standardised frequency scores (per 100 turns of dialogue) were obtained to allow for differences in length of dialogues in the two contexts. The mean standardised frequency of each Initiating Move in the DVC and face-to-face contexts are show in Table 2 below, standard deviations are shown in brackets.

Initiating Moves	DVC	Face-to-face
Explain	30.62 (11.87)	19.82 (7.00)
Query-yn	16.55 (4.57)	10.92 (4.12)
Query-w	12.18 (5.37)	17.05 (7.11)
Check	5.56 (3.36)	8.20 (3.27)
Align	3.68 (2.54)	1.57 (0.95)
Instruct	2.38 (1.74)	3.63 (2.42)
Directive	0.68 (0.63)	1.23 (0.98)

Table 2: Mean standardised frequency of Initiating Moves in DVC and face-to-face contexts.

The data presented in Table 2 shows that some Initiating Moves were used more frequently in the Travel Game than others. Separate analyses of variance (2 way mixed ANOVA) were computed for each category of Initiating Move. Communicative context (DVC vs. face-to-face) was treated as a between group factor, with the role of the participant (Travel Agent vs. client) as a within dialogue repeated measure. The mean standardised frequency of each type of Initiating Move by the Client and the Travel Agent are presented in Table 3 below.

Context	Face-to-face		VMC	
Role	Travel Agent	Client	Travel Agent	Client
Instruct	0.17 (.033)	3.46 (1.22)	0.38 (0.55)	1.99 (1.34)
Directive	0.04 (0.1)	1.19 (1.99)	0.00 (0.00)	0.66 (0.63)
Explain	17.01 (5.99)	2.80 (4.05)	27.64 (9.22)	4.50 (3.99)
Query-yn	5.29 (2.33)	5.63 (3.44)	3.40 (1.88)	12.55 (4.42)
Query-w	13.71 (8.25)	3.72 (2.08)	7.78 (2.3)	4.40 (2.77)
Align	1.05 (0.75)	0.52 (0.66)	3.29 (2.58)	0.39 (0.54)
Check	2.13 (1.24)	6.06 (3.53)	2.75 (2.35)	2.80 (1.75)

Table 3. Mean Initiating Moves by Travel Agent and Client in the VMC and Face-to-face Contexts (Standardised data).

The analyses revealed non-significant main and interaction effects for the Instruct, Directive, Query-w and Check Initiating Moves ($p > 0.1$), but significant main and interaction effects were observed in the frequency of Explain, Align and Query-yn Initiating Moves.

Explain Initiating Moves

The analysis showed that there was a significant main effect of context [$F(1,18) = 6.33, p < 0.05$]. A greater number of Explains were initiated in the DVC context than in face-to-face interactions (means being 15.32 vs. 9.91 respectively). The main effect of role of participant was also significant [$F(1,18) = 119.91, p < 0.001$]; the Travel Agent initiated a greater number of Explain Moves than the client (means 22.17 vs. 3.05). The interaction between communicative context and role of participant was also significant [$F(1,18) = 7.94, p < 0.05$]. Further analysis by Simple Effects showed that the Travel Agent initiated more Explain Moves in the DVC context than in the face-to-face context [$F(1,18) = 8.82, p < 0.01$].

Query-yn Initiating Moves

The analysis showed that there was a significant main effect of context [$F(1,18) = 8.37, p < 0.01$]. A greater number of Query-yn were initiated in the DVC context than in face-to-face interactions (means being 8.28 vs. 5.46 respectively). The main effect of role of participant was also significant [$F(1,18) = 18.48, p < 0.001$]; the client initiated a greater number of Query-yn Moves than the Travel Agent (means 9.09 vs. 4.64). The interaction between communicative context and role of participant was also significant [$F(1,18) = 15.79, p < 0.001$]. Simple Effects analysis showed that the client initiated more Query-yn Moves in the DVC context than in the face-to-face context [$F(1,18) = 15.69, p < 0.001$].

Align Initiating Moves.

The analysis showed that there was a significant main effect of context [$F(1,18) = 6.03, p < 0.05$]. A greater number of Aligns were initiated in the DVC context than in face-to-face interactions (means being 3.68 vs. 1.57 respectively). The main effect of role of participant was also significant [$F(1,18) = 13.68, p < 0.01$]; the Travel Agent initiated a greater number of

Align Moves than the client (means 2.17 vs. 0.45 Aligns per 100 turns of dialogue). The interaction between communicative context and role of participant was also significant [$F(1,18) = 6.57, p < 0.05$]. Simple Effects analysis showed that the Travel Agent initiated more Align Moves in the DVC context than in the face-to-face context [$F(1,18) = 6.94, p < 0.05$].

These analyses highlight the effect of communicative context and role of participants in the Travel Game. In the DVC dialogues the Travel Agent initiates a greater proportion of Explain and Align Moves, and the Client increases the use of Query-yn Moves in DVC compared to face-to-face context.

5.1. Discussion

The Conversational Games Analysis showed that participants in the two contexts interacted and collaborated in different ways. In the DVC Travel Games the Travel Agent used proportionally more Initiating Moves to elicit feedback from the listener (Align Moves), or to offer information about the task and her activities (Explain Moves) to the Client. At the same time, the client sought more information by asking a greater number of yes-no questions (Query-yn).

In order to determine why these differences occurred, examples of Explain, Align and Query-yn Games were extracted from the dialogues to determine their functions and the types of information they were eliciting or offering. The increased use of Explain Games occurs because the Travel Agent offers more information to the Client concerning the Agents activities and what she was currently attending to. This also occurred in the face-to-face dialogues, but very rarely. For example, the Travel Agent would tell the Client that she was looking up the flight details, or inform the client that they had now arrived at their destination. The following extract demonstrates this usage of Explain Initiating Moves in DVC dialogues.

Extract 2. DVC dialogue

C: Right, can I get a connection to Jacksonville?

Move: *Query-yn*

TA: I'll just check that for you

Move: *Explain*

Yes you can

Move: *Reply-y*

Do you want to go there?

Move: Query-yn

C: Yes.

Move: Reply-y

TA: (pause) Right, you're in Jacksonville

Move: Explain

C: Okay.

Move: Acknowledge

These types of explanations accounted for nearly 42% of Explain Moves initiated by the Travel Agent in the DVC context. This would indicate that, in the DVC dialogues, the Travel Agent spent a considerably amount of time and effort in keeping the Client informed of her activities, or their position in the task. This may be a result of the restricted information provided by the visual channel, and by the low quality of the video signal. In effect, the Travel Agent verbally offered the Client information that would have been available visually in face-to-face interactions.

Examining the functions of Query-yn Moves initiated by the Client in the face-to-face and DVC dialogues, revealed that these questions were used to gain a wide range of information. For example, yes-no questions were asked to gain information about the rules of the Game, or the possibilities of changing the itinerary. However, the majority of the Initiating Moves occurred when the Client asked the Travel Agent if there were connecting flights between two Airports. These questions accounted for more than 78% of all of the Query-yn Moves initiated by the Client in DVC dialogues, but only 40% of Query-yn Moves initiated by the Client in face-to-face interactions. The following extracts show incidences of yes-no questions (Moves are emphasised in bold print) in which the Client asks about the possibility of connecting flights between airports. The extracts are taken from both communicative contexts.

Extract 3. Face-to-face dialogue

GAME 1. QUERY-W

TA: where would you like to go from Salt Lake City

Move: Query-w

C: I will stay there for three days, and then I will fly out of State

Move: reply-wh

TA: Okay

Move: Acknowledge

GAME 2. QUERY-YN embedded

C: can I, is there, are there flights to Seattle from there?

Move: Query-yn

TA: I'll check that.

Move: Explain

Extract 4. DVCC dialogue

TA: Right, you've now arrived in Grand Rapids, in Michigan

Move : Explain (Ends previous Game)

GAME 1. QUERY-YN

C: Can I move on to Detroit?

Move: Query-yn

TA: I'll just check.

Move : Explain

No, you can't fly to Detroit from Grand Rapids.

Move: Reply-no

C: Right, okay.

Move: Acknowledge. Ends Game 1

GAME 2. QUERY-YN

Uhhh, can I fly to Great Falls?

Move: Query-yn

TA: Ehmm lets see. No, I'm afraid you can't fly to Great Falls either.

Move: Reply-no. Ends Game 2

The examples show typical use of Query-yn Initiating Moves in the two communication contexts. In face-to-face interactions, the Client is often prompted by an open-ended question (Query-w Initiating Move) from the Travel Agent to say where he would like to go next, and many of the Client's Query-yn Moves concerning flight connections then occur within the context of an already initiated Query-w Move. In the DVC dialogues the Travel Agent tends to round off each set of Games by offering explicit information about the Client's progress in the task, this puts the Client in the position of starting off the next stage of the Travel Game. The Client can achieve this most simply (and most explicitly) by asking the Agent if there are connections to a particular airport. Thus, this behaviour does seem to be an indirect affect of the DVC context, but probably depends in part on the Travel Agent's response to the DVC condition.

Searching through the coded dialogues revealed that Align Moves are used in a variety of ways. The following extracts demonstrate some of the ways in which Aligns were used by the Travel Agent to elicit feedback in the face-to-face and DVC contexts. In these extracts the following symbols are used: TA and C indicate the Travel Agent and Client respectively; a short pause is represented by three dots (...).

Extract 5. Examples of Align in Face-to-face

TA: Can you make a note of your decisions as we go along

**M Instruct*

TB: Uhhmm

**M Reply-y*

TA: I think it said that in the instructions

**M Align*

TB: Sure, yeah it did.

**M Reply-y.*

Extract 6. Example of Align in DVC context

TA: Its actually going to be day 28 before you can actually leave Arizona

*M Explain

TA: Okay?

*M Align

As these extracts show, Align Initiating Moves can be quite lengthy (as in extract 5), but sometimes they can be initiated with just a single word (extract 6). Examination of the dialogues showed that these shorter, one word, Aligns occurred more frequently in the DVC dialogues than the face-to-face interactions: 60% of the DVC Travel Agent's Aligns consisted of single words, such as 'okay', 'right', compared to 46% of Aligns in the face-to-face interactions. It is possible that these one word Aligns were being used more frequently in the DVC context to assist the process of grounding; short Align Moves were used instead of gaze to ascertain that the Client had understood the previous contribution. In the face-to-face context participants could see each other clearly, non-verbal forms of establishing mutual understanding were easily accessible, so the need to use verbal alignments was reduced in this context.

Is there any support for these suggested explanations in use of Conversational Games from previous literature? The most relevant paper is by Doherty-Sneddon et al (1997), who examined the structure and content of dialogues from face-to-face and remote spoken contexts as well as several VMC contexts. The findings from Conversational Games Analysis of these contexts showed that people communicate in a more cautious manner when they use an audio-only context; they adopt what Shadbolt (1984, in Doherty-Sneddon 1997) calls a 'low risk' style of communication. This was apparent in the greater use of Align and Check Games in remote spoken interactions, and an increased use of Align Games in a remote computer-mediated (audio-conferencing) context. Doherty-Sneddon et al. concluded that participants interacting in a spoken only context use a greater number of verbal alignments, and a more cautious style of communication.

The results from this study also show an increased use of verbal alignments. In this case, the effect may be due to the poor quality of the visual signals, rather than the total absence of video images. The quality of the visual signals may have been low enough to engender a more cautious style of communication than occurred in the face-to-face context. So the findings reported by Doherty-Sneddon et al. do support the view taken here, that the increased use of verbal alignments could have been due to the quality of the visual signals provided by the DVC system in this study. The other differences in structure and content of the DVC dialogues (increased use of *Explain* and *Query-yn* Initiating Moves) receive no support from previous literature. However, as suggested in the previous discussion these changes may demonstrate some of the different ways in which users adapted to working in a DVC context which affords low quality video images. Travel Agents requested a greater amount of listener feedback (*Align* Moves), and they spent proportionally more time informing the Client of their activities. The Client appears to have responded to

this style of interaction by making greater use of simple yes-no questions.

Overall, the findings support the view that in a DVC context where the visual channel provides restricted visual signals, participants may attempt to achieve a greater amount of collaboration through the verbal channel since the quality of the visual channel limits the use of non-verbal communication. This appears to be the common theme linking the differences in proportional use of the Align, Explain and Query-yn Moves in the DVC context. Users of these systems make greater use of the verbal channel to establish common ground, and to ensure that the process of communication proceeds smoothly. These variations in use of pragmatic functions also change the style of communication by users of the DVC system. Users adopt a more explicit style of interaction, offering more information about the task and their activities. This style of communication allows users of DVC to maintain a greater amount of verbal contact with each other than occurred in the face-to-face context, and could be due to the low quality of the video images and could indicate collaborators when the quality of the video images is low.

These findings demonstrate the subtle manner in which people adapt to a video-mediated environment. These adaptations may be difficult to observe when only the surface structure of the dialogues is examined; as the length of turns and number of turns may not be greatly affected. The finer grain pragmatic analysis undertaken in this study therefore has advantages over other ways of determining the impact of communicative contexts upon collaboration and communication.

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