

The Effect of the Emotion-related Channel in 3D Virtual Communication Environments

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ABSTRACT

An emotion-related channel was combined with electronic chat in a 3D virtual communication environment. Users can convey specific feelings by manipulating the facial expressions and gestures of their 3D characters (avatars). To examine the effects of the emotion-related channel, an experiment was carried out in two elementary schools with fifty-five student participants. It was found that the children were able to communicate more freely and effectively than by simple electronic chat sessions. In addition, the emotion-related channel also served to stimulate textual dialogue between partners. Our findings indicate that text-based media communication environments could be greatly enhanced with an emotion-related channel.

Keywords: *communication, emotion, avatar, gesture, facial expression, electronic chat*

Paper Received 10/2/2005; received in revised form 10/11/2005; accepted 17/11/2005.

1. Introduction

Text-based media communication such as e-mail and electronic chat have been widely distributed and become to be popular and indispensable tools. However, such forms of communicative media using only a verbal channel are ineffective in conveying one's emotions (Mehrabian & Ferris, 1967; Mehrabian & Wiener, 1967). Mehrabian et al estimated the contribution of three different communication channels; words, voice intonation, and facial expression, to convey the emotions of like, neutrality, and dislike. It turned out that the contribution of the word channel was a mere 7%.

Using emotional-icons known as emoticons embedded in e-mail messages is an useful channel in communicating emotions. Consider the following example: for a grin, one would simply type :) or for a smile, one would type :-} and insert them into the text of an e-mail message to alert any reader not to take the message too seriously. There are a number of reports studying the effect of usage of emoticon (for example;

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Mikropoulos & Strouboulis, 2004). Rivera et al (1996) found that communicators were more satisfied with a system employing emoticons than one in which emoticons were not present, including group discussions. Walthier et al (2001) reported that emoticons used in computer-mediated communication supplement the nonverbal cues. These findings about the effects of emoticons suggest the high potential of introducing emotion-channels in text-based communication environments.

The communication environment used in this experiment is one of CVEs; collaborative virtual environments (Mak & Palia, 2005; Benford & Greenhalgh, 1995), named Community Place. It is a communication environment utilizing 3D virtual spaces on the Internet which enable users to control the motions of their virtual characters or avatars as they move around the space (Lea et al, 1997). Users of Community Place are able to communicate by way of text messaging (electronic chat) when the two avatars are in close enough proximity within the 3D space. The Community Place program used in this experiment was customized for elementary and junior high school students as like other educational virtual environments (for example; Wolf, 2000) A unique feature was incorporated into the design of our program to allow the users to convey their emotions by manipulating the facial expressions and gestures of their avatars. These two non-verbal channels are representative of the ones used to convey emotions in face to face communication (Ekman & Friesen, 1969; 1971). Although the avatar's facial expressions and gestures are merely rough simulations they still have the potential to convey the emotions or feelings of users. In this way, our customized version of Community Place could carry two channels of communication: one to convey ideas by way of text messaging (so-called verbal channel) and the other to convey facial expressions and gestures (user emotions). The latter will be referred to as the 'emotion-related channel' in this paper.

There have been several communication environments where, as with Community Place, users are able to express their emotions as the avatar's facial expressions or gestures (Kurlander, et al, 1996; Fabri, et al, 1998; 2005; Salem, et al, 2000). There are several studies which have concerned themselves with the effects of the avatar's emotional expressions. Nijholt, A. (2002) reported that gaze behavior of embodied agents affected the impression of users. Fabri and Moore (2004) reported that creating avatar representations using only a limited number of facial features allowed emotions to be effectively conveyed.

In this study, the effect of emotion-related channel on communication performance in CVEs was investigated. An experiment was carried out in two elementary schools with

fifty-five student participants to compare the communication performances with and without the emotion-related channel in the 3D virtual communication environment.

2. Method

2.1 System Description

Community Place is a server-client system. The client personal computer uses Windows. Users can move their avatars around a 3D virtual space with a mouse and can input text messages and their emotions. A typical 3D virtual space used in this experiment is shown in Fig. 1.



Fig. 1: A typical 3D virtual-space.

Users can input the emotion they feel by using the mouse to click on the window shown in Figure 2. The avatar changes its facial expression and gesture in line with the inputted information. So, by looking at the avatar, the person being communicated with can recognize changes in the emotions of the sender. Users were given five emotional states to choose from: 'joyful', 'delighted', 'sad', 'tired', and 'angry'. Each emotional state has three degrees: 'somewhat', 'so so', and 'very', thus there is a total of 15 buttons (5 x 3) arranged along the axes of the three pentagons, which share a common center, as shown in Fig. 2. The three sizes of pentagons correspond to the three emotional degrees. Facial expressions and emotional adjectives corresponding to the five emotional states are located at the apexes of the outer pentagon.

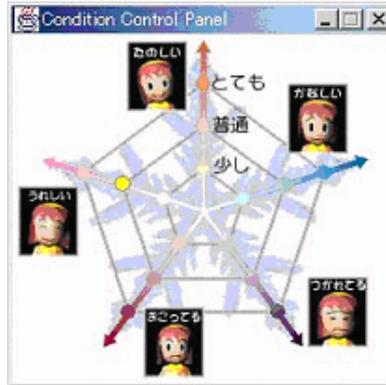


Fig. 2: The emotion input window.

Figure 3 and 4 shows the faces and gestures of the avatars corresponding to five emotional states.



Fig. 3: The faces of the avatars corresponding to five emotional states.

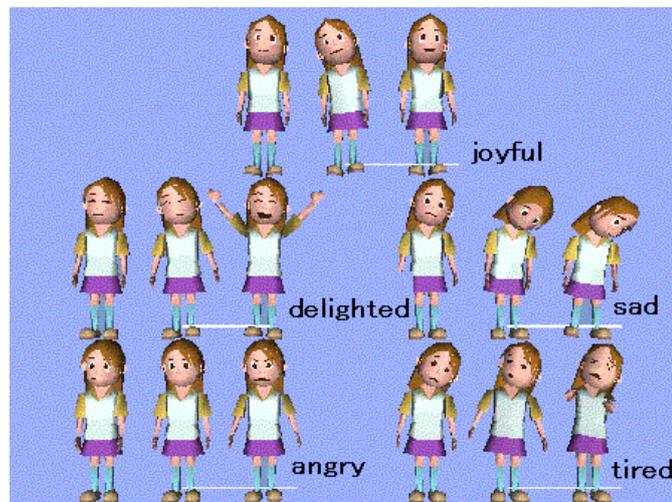


Fig. 4: The gestures of the avatars corresponding to five emotional states.

Figure 5 shows a typical example of the entire operational window. The window consists of a 3D virtual space window (top left) and an emotion input window (bottom left), the text window for electronic chat (top right), and the soft keyboard (bottom right). The soft keyboard was designed to be user-friendly for children, however, almost all the participants in this experiment used conventional keyboards.



Fig. 5: The operational window.

2.2 Experimental Conditions

This experiment was performed at the Kita 9 Jou and Kaisei Elementary Schools in Sapporo, Japan. These two schools are about three kilometres apart, and the students at both schools had no close acquaintance with those at the other. Twenty-eight sixth graders, aged from 11 to 12 years old and consisting of 14 males and 14 females, at Kita 9 Jou and twenty-eight fifth graders aged from 10 to 11 years old and consisting of 9 males and 19 females, at Kaisei participated in this experiment. Groups consisting of 4 or 5 students were organized. Each group used one PC in which Community Place software had been installed and connected to the Community Place server. There were a total of twelve groups, 6 at each school. Each group at the first school communicated to only one group at the other school. To communicate with the remote school students using the system, group members first discussed and decided on the intended text message and emotion to be communicated, then one participant inputted that message and emotion into the system using a keyboard and a mouse. Although the ability to move the avatar around the 3D space is a key feature of this system, it was removed for this experiment because we wanted to keep things simple for evaluating the effect of the emotion-related channel. Figure 1 shows a typical window where one user's avatar stands in front while the other's avatar stands in back. The two avatars appear to be engaged in conversation.

There were two experimental conditions:

- *Condition 1: participants used the emotion-related channel to communicate

*Condition 2: participants did not use the emotion-related channel to communicate

Under Condition 2, the emotion input window was closed. The emotion state was the most neutral, 'somewhat delighted.' The initial state of Condition 1 was the same.

Participants communicated under both conditions for twenty minutes each time. To eliminate the order effect, half of the groups started communicating under Condition 1 and the other half started under Condition 2. The topics of the conversations were not specified, so the teachers suggested that students ask about the other students or the other school in order to facilitate smoother exchanges in the beginning.

2.3 Evaluation Methods

Date, time, group, ID number, group nickname, emotion state, and text messages were recorded in the server. The voices and pictures of each group were recorded using video cameras, which were located on PC desks and shot activities of whole group members, to enable later study of how they felt when receiving messages and how they decided on what messages to send.

The checked points in video-observation were as follows.

- Response to the message appeared on PC display from the partner.
- Communication about the message.
- Discussion about the reply to the message.
- The process to determine their reply.

The following characteristics for each 20-min. communication period were evaluated:

- (1) The number of times the emotion-related channel was used
- (2) The number of letters typed
- (3) The number of lines typed
- (4) The number of turns taken
- (5) The number of letters per line (letters / typed lines)

After a group finished communicating, its members were given a questionnaire consisting of four questions. Questions #1, #2, and #3 used a ranking method followed by a free description space for their reasons. They were asked about each experimental period. Ranks: 'Yes, very much', 'Yes', 'So so', 'Not very much', 'Not at all'. These were numbered 5, 4, 3, 2, 1 respectively, for analysis. Question #4 asked the

students to describe the difference between communicating with and communicating without the emotion-related channel. Questionnaire sheet is shown in ANNEX.

3. Results

3.1 Overview of participants' attitude and communication

We observed the participants' activities in each group using the recorded video. The following is a brief summary of this observation. Each group eagerly communicated with its partner group, and participants excitedly discussed what to write as a reply. The participants in a group first discussed the meaning of the message sent to them. Typically, when a group received a message, one of the participants in the group would read the message aloud, then its meaning would be discussed. They then would discuss possible replies. After they reached an agreement, one participant in front of the PC input the message.

Table 1 shows the averages of the Questionnaire answers under both experimental conditions. The relatively high average values indicate that most participants felt satisfied about their communication.

Question	averaged values
#1 Did you enjoy communicating with your partner?	4.09
#2 Did you have a lively exchange with your partner?	3.85
#3 Could you convey your feelings to your partner?	3.45

Table 1: The averages of the Questionnaire answers
('Yes, very much'(5),'Yes'(4),'So so'(3),'Not very much'(2),'Not at all'(1))

3.2 Use of the Emotion-related Channel

The emotion-related channel was used 38 times in this experiment. Before using the channel, most groups discussed which emotional state and degree to send. Clear reactions to receiving an emotion-related channel message were observed in 12 of the 38 cases.

Whenever an emotion-related channel message was received, participants would point to the remote partner's avatar and discuss it within the group. Two issues were usually discussed:

- 1st: The avatar's expression and gestures
- 2nd: The reason their partner sent the message

Some groups replied using the emotion-related channel while others preferred sending a text message. An example of the use of the emotion-related channel is shown in Fig. 6. The upper part corresponds to a group in school 1, and the bottom part corresponds to a group in school 2. The length of the bars indicates the number of characters in the message.

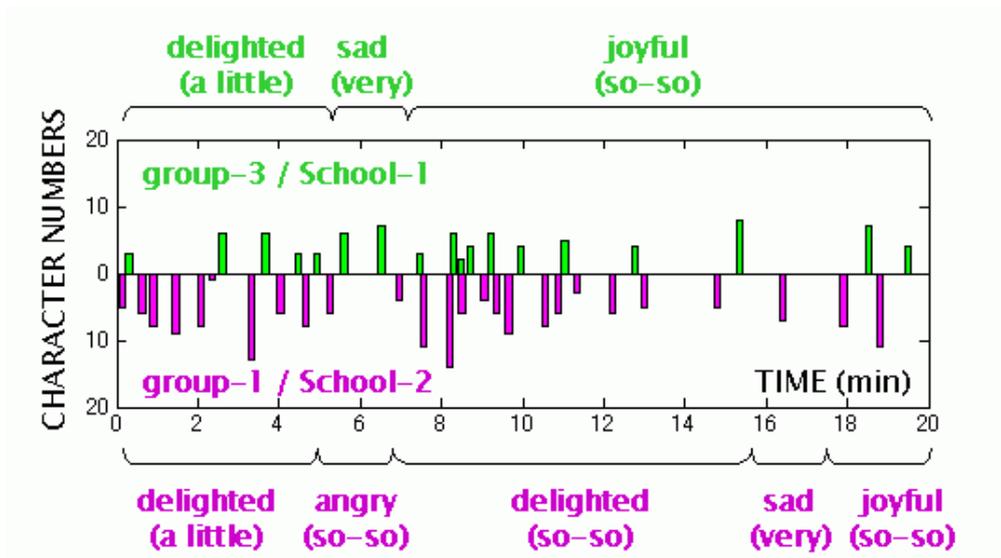


Fig. 6: Emotion-related channel use in one session (group-3 in school-1 and group-1 in school-2)

3.3 Effect of the Emotion-related Channel [Communication Characteristics]

The average values of the communication characteristics defined in section 2.3 were calculated. Table 2 details the data of the three characteristics that had large changes. It also shows the level of significance calculated by the pair-T test. One of the communication characteristics (turn taken) significantly increases under Condition 1 (with the emotion-related channel). The other two characteristics showed no significance. These indicate that the channel serves to stimulate text communication.

Characteristics	With		Without		Difference	Level of Significance
	average	SD	average	SD		
typed letters	212.7	54.8	157.7	90.0	55.0	0.084
typed lines	23.6	5.0	17.3	10.3	6.3	0.063
turn taken	34.1	7.4	24.4	12.2	9.7	0.022

Table. 2: The average values and standard deviations (SD) of the communication characteristics for conditions with / without the emotion-related channel.

3.4 Effect of the Emotion-related Channel [Answers to Questionnaire]

The average values of all Questionnaire answers for both conditions are given in Table 3.

Question	With		Without		Difference	Level of Significance
	average	SD	average	SD		
#1	4.16	1.01	4.00	1.15	0.16	0.32
#2	3.88	1.11	3.82	1.23	0.06	0.77
#3	3.63	1.13	3.22	1.17	0.41	0.02

Table. 3: The average values and standard deviations (SD) of all Questionnaire answers for conditions with / without the emotion-related channel:

- #1 Did you enjoy communicating with your partner?
- #2 Did you have a lively exchange with your partner?
- #3 Could you convey your feelings to your partner?

Comparing the two conditions, the average values of the answers to Question #3 are significantly higher when the emotion-related channel was used. The average values of the answers to the other two questions showed no significant difference.

The answers to Question #4 are free responses. Forty-two out of 55 participants answered the question. The answers mentioning the effectiveness of the emotion-related channel are outlined in Table 4. The emotion-related channel received a positive evaluation by the participants, as is shown in the table.

Question #4 answers	Number of Respondents
Better to have it	32
Does not matter	10
Better not to have it	0

Table. 4: A breakdown of the answers to Question #4.

Among the 32 answers "better to have it", eight stated reasons for the effectiveness of the emotion-related channel. The answers, listed below, can be categorized as: "expressing feelings"; "recognizing feelings"; and "effect on text messaging".

< expressing feelings >

- (i) "It was fun to express my feelings."
- (ii) "With the emotion-related channel, it was easier to ask the remote partner to stop making unpleasant statements."
- (iii) "Without the emotion-related channel, I could not make the partner understand well what I wanted to say."

< recognizing feelings >

- (iv) "It was good to see my partner's feelings on his avatar's face."
- (v) "I could recognize my partner's feelings by the channel."
- (vi) "Without the channel, I could not recognize what my partner felt."
- (vii) "It was good to know whether or not my partner was angry by using the emotion-related channel."

< effect on text messaging >

- (viii) "The emotion-related channel helped me think of the words I wanted to write."

These descriptions suggest that the entire communication environment became a favorable place for participants because they could convey their feelings through the channel. It is suggested that this improvement of the environment made participants feel more at ease about communicating but not necessarily only through the emotion-related channel. Statement (viii) shows one direct effect the emotion-related channel had on text communication.

4. Discussion

The environment discussed in this paper has two communication channels: a text or verbal channel and an emotion-related channel. The answers to Question #3 indicate that participants conveyed their feelings more easily through the latter channel with a level of significance of 2.2%. This question, however, asked only about the sender's ability to express feelings through the channel, whereas a considerable number of statements contained in the free responses to Question #4 pointed out the effectiveness of receiving feelings as well.

There were 27 statements concerning the effectiveness of the emotion-related channel, and among them, 16 were about sending feelings and 11 were about receiving them. Nearly the same results were obtained in the free responses to Question #3, which contain 3 statements about sending feelings and 4 about receiving them.

Although the effect on the users' sending and receiving feelings is confirmed, the emotion-related channel has negligible effects on the answers for Questions #1 and #2. To make clear the origin of this difference, descriptive answers followed by each score

answers were analyzed. These descriptive answers were transformed into a number of simplified statements each containing a single idea. Totally, 153 statements regarding both conditions were obtained. Next, the statements were classified into four categories according to the topic:

(A) Personal Statements

For example: "I could / could not chat a lot"; "I could / could not type a lot during communication"; "I laughed a lot"; and "I could use the soft keyboard".

(B) Statements about the remote-partner

For example: "Our remote-partner seemed to enjoy the communication"; "Our remote-partner seemed to be an interesting person"; "My partner was anonymous to me"; and "My partner had / did not have the same interest as me".

(C) Statements about the communication

For example: "We could talk about a lot of topics"; "We could introduce our schools"; "We could develop our communication"; and "We had difficulty understanding what we said to each other".

(D) Statements about the emotion-related channel / conveying feelings

For example: "I used the emotion-related channel"; "Our partner responded to our choice of emotion by the emotion-related channel"; "We could convey our feelings to each other"; and "We talked so much by chat that we did not use the emotion-related channel".

Table 5 shows the number of statements for each of the four categories and has some remarkable features. This topical profile relates to the respondents' thoughts as they answered the questions.

- (a) The number of personal statements is relatively small when compared to the number of those about the communication or the number those about the partner.
- (b) Almost all the statements for Question #1 concern either the communication or the partner.
- (c) Almost all the statements for Question #2 concern the communication.

- (d) The number of statements for Question #3 concerning conveying feelings is high, and the number of statements concerning the communication or that concerning the partner are relatively low compared to the cases of Questions #1 and #2.

original question	Topic of the Statement				
	Personal	Partner	Communication	Channel	Total sum
#1	5	26	31	4	66
#2	7	38	5	2	52
#3	9	13	0	13	35

Table. 5: The number of statements of each category classified according to topic
 #1 Did you enjoy communicating with your partner?
 #2 Did you have a lively exchange with your partner?
 #3 Could you convey your feelings to your partner?

One possible reason why the effect of the emotion-related channel is clear for Question #3 but not for Questions #1 and #2 is the difference in topical profile of each question shown in Table 5. Question #3 is relatively definite asking about the conveying of feelings. It might be easier for respondents to answer this question as opposed to Questions #1 and #2 which relate to more general ideas, i.e. the communication and the partner. The other possible reason is that the period of communication, 20 min., is not enough for participants to fully enjoy communication and/or enter into a lively exchange. In fact, almost all of the participants seemed to be unaware of this enhancement, even the turn taking increased 40% on average. Only one response, (viii) for Question #4, was related to the enhancement. It might be difficult for participants to notice the positive factors attributable to the emotion-related channel in such a short period.

5. Conclusion

The effect of the emotion-related channel in the 3D virtual chat communication environment was investigated. An experiment comparing the use and non-use of an emotion-related channel which enables users to convey their feelings through an avatar's facial expressions and gestures was performed in two elementary schools with 55 participants.

Two effects of the emotion-related channel were substantiated:

- (1) Conveying users' feelings in communication
 (by the questionnaire survey shown in Table. 3);

(2) Stimulating chat communication

(by an analysis of text messages recorded in the server shown in Table.

2).

The answers given in the free response section suggests the origin of the stimulation to be a positive change in the participants' impression of the environment due to the influence of the emotion-related channel.

In daily life, people express their feelings in both intentional and unintentional ways.

People use intentional means to communicate more freely. For the experiment, the participants had to operate a mouse to choose buttons on the emotion-input chart in order to express their feelings. This is a complicated process compared to face-to-face interaction. It is therefore noteworthy that the emotion-related channel in this system can convey feelings and stimulate text communication though the process is cumbersome. This study indicates that text-based media communication environments could be greatly enhanced with an emotion-related channel realized by a simple but not so sophisticated system, as was suggested by the observed effects of emoticons in text messaging. It is also suggested that developing an emotion-related channel interface (for example; Rieger, 2003) would enhance the effects substantiated by this study.

Acknowledgments

The authors thank Mr. K. Ebina, Sapporo City Board of Education; Mr. T. Saito, Kita 9 Jou Elementary School; Ms. Kato, Kaisei Elementary School for their support of this study. We also thank Prof. Ikuo Daibo, Department of Social Psychology at Osaka University and Ms. Mari Saito, Sony Corp. for their helpful discussions.

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ANNEX. Questionnaire sheet (English version)

Grade:	
Male / Female:	
Group Name:	

#1 Did you enjoy communicating with your partner?

- | First Time | Second Time |
|--|--|
| <input type="checkbox"/> Yes, very much. | <input type="checkbox"/> Yes, very much. |
| <input type="checkbox"/> Yes. | <input type="checkbox"/> Yes. |
| <input type="checkbox"/> So so. | <input type="checkbox"/> So so. |
| <input type="checkbox"/> Not very much. | <input type="checkbox"/> Not very much. |
| <input type="checkbox"/> Not at all. | <input type="checkbox"/> Not at all. |

Please explain your answers.

#2 Did you have a lively exchange with your partner?

- | First Time | Second Time |
|--|--|
| <input type="checkbox"/> Yes, very much. | <input type="checkbox"/> Yes, very much. |
| <input type="checkbox"/> Yes. | <input type="checkbox"/> Yes. |
| <input type="checkbox"/> So so. | <input type="checkbox"/> So so. |
| <input type="checkbox"/> Not very much. | <input type="checkbox"/> Not very much. |
| <input type="checkbox"/> Not at all. | <input type="checkbox"/> Not at all. |

Please explain your answers.

#3 Could you convey your feelings to your partner?

- | First Time | Second Time |
|--|--|
| <input type="checkbox"/> Yes, very much. | <input type="checkbox"/> Yes, very much. |
| <input type="checkbox"/> Yes. | <input type="checkbox"/> Yes. |
| <input type="checkbox"/> So so. | <input type="checkbox"/> So so. |
| <input type="checkbox"/> Not very much. | <input type="checkbox"/> Not very much. |
| <input type="checkbox"/> Not at all. | <input type="checkbox"/> Not at all. |

Please explain your answers.

#4 Please describe the difference between communicating with and communicating without the emotion-related channel.