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How Do Frequency and Duration of Messaging Affect Impression Development in Computer-Mediated Communication? [1] [2]

Yuliang Liu
(Southern Illinois University Edwardsville, United States
yliu@siue.edu)

Dean Ginther
(Texas A&M University-Commerce, United States
Dean_Ginther@tamu-commerce.edu)

Paul Zelhart
(Texas A&M University-Commerce, United States
Paul_Zelhart@tamu-commerce.edu)

Abstract: Computer-mediated Communication (CMC) has been commonly compared to face-to-face (FtF) communication in recent CMC literature. Research comparisons suggested depersonalizing effects of CMC. However, this experimental study indicates that CMC is a potentially viable mode of social-emotion-oriented communication. In this study, the effects of frequency and duration of messaging on impression development in CMC were investigated. Undergraduate participants were randomly assigned to each of the four experimental groups. For a period of two weeks, participants monitored discussion lists that differed in relation to the frequency and duration of messaging in asynchronous CMC environments. ANOVA results indicated that duration and frequency had significant main effects on impression development in asynchronous CMC environments. No interaction effects were found. The results of this study not only theoretically support the social-emotion-oriented model in CMC, but also lay foundations for further research in many popular types of interactive CMC environments, including e-learning, e-commerce, and e-health.

Keywords: frequency of messaging, duration of messaging, impression development, nonverbal cues, computer-mediated communication, social-emotion-oriented model, social information processing model

Category: C.2, J.4, K.3, K.4, K.6

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[1] This study was a portion of the first author's doctoral dissertation at Texas A&M University-Commerce in 2000. For detail information, please refer to Liu, Y.: "The effects of nonverbal cues on impression formation in computer-mediated communication: An exploratory study"; Dissertation Abstracts International, 61, 4 (2000), AAT 9965844.

[2] An earlier draft of this article was presented at the International Communication Association Annual Conference in Washington, DC, USA in May 2001.

1 Introduction

Impression formation is a significant aspect of human interpersonal communication and is one of the early and major topics within social psychology. Impression formation refers to the interpersonal process by which people employ all available information and make general judgments of other's personality characteristics. The idea of impression formation is usually associated with the work of Asch [Asch 1946]. Since Asch's original work, there has been additional research about impression formation in face-to-face (FtF) environments. Asch emphasized forming a unified impression of the entire person through his/her trait(s) in interpersonal communication. Most early impression formation research followed the assimilatory tradition [O'Keefe and Delia 1982]. This tradition investigated the determinants of differential accuracy in perception. This type of research focused on judgments of personality traits and used a research paradigm based upon the simple matching of perceivers and target responses to personality inventories and questionnaires. Since the 1980's, social cognition has contributed much to the study of impression formation. This is a major focus shift in impression research from the problem of accuracy to the problem of how inferences are formulated and constructed in forming overall evaluations and impressions of others [Hampson 1990; O'Keefe and Delia 1982].

Recent FtF research [Krauss and Fussell 1996; Kraut 1978] has consistently indicated that both nonverbal cues and verbal cues jointly affect the process of impression development. Since Asch's [Asch 1946] classic study, the nature of impression formation, and especially the influences of the nonverbal cues on impression formation, has been studied extensively. According to Patterson [Patterson 1994], nonverbal cues can be managed for particular interpersonal goals, such as engaging the other people. The nonverbal cues primarily explored in the previous literature focused mainly on three types of cues: visible (e. g., facial expressions, eye contact, touch, etc.), paralinguistic (e. g., frequency, speech duration, vocal intensity, speech rate, pause, response latency, etc.), and psychological (e. g., attention, attribution, mood, primacy effect, and recency effect). However, the influences of language variables on impression formation have not received much attention until recently [Bradac and Street 1989/90]. The verbal cues primarily explored in recent literature focused mainly on language norms, language intensity, verbal immediacy, lexical diversity, powerful and powerless styles, gender-related language, verbal influence strategies, and ironic remarks.

In recent years, computer-mediated communication (CMC) has emerged as a new communication format. CMC offers many modes of communication, both synchronous and asynchronous. The former includes computer conferencing and electronic databases, while the latter is made up of e-mail and bulletin boards [Rice 1990]. Since CMC is quite different in nature from our traditional FtF communication, it has been described as an "altered state of communication," including altered physical environments, altered time and space, and altered structures in communication [Vallee, Johansen, and Sprangler 1975]. Thus, CMC may "change the psychology and sociology of the communication process itself" [Turoff 1978, p. 10].

Therefore, there is an urgent need to study the psychological and sociological aspects of CMC.

Since CMC appeared several decades ago, there has accumulated much research in recent CMC literature. Recent research indicates that there have been two dominant research models in CMC: the task-oriented model and the social-emotion-oriented model [Liu and Ginther 1999a]. Within the task-oriented model, there are three variations: Social Presence Theory [Short, Williams, and Christie 1976], Media/Information Richness Theory [Daft and Lengel 1984, 1986], and Social Context Cues Theory [Kiesler, Siegel, and McGuire 1984]. Since these three variations share similarities, they are all categorized within the "cues-filtered-out" perspective [Culnan and Markus 1987]. According to the "cues-filtered-out" perspective, CMC users cannot see each other and the CMC environment is restricted in terms of nonverbal cues; therefore, CMC tends to be tasked-oriented, depersonalized, then preventing the development of interpersonal relationships between CMC users. Most prior CMC research tended to be consistent with the model of the task-oriented communication and seldom dealt with CMC's emotional content because of the lack of nonverbal cues within the CMC context [Connolly, Jessup, and Valacich 1990; Hiltz, Johnson, and Turoff 1986].

However, contrary to the task-oriented model, Walther [Walther 1992] proposed the Social Information Processing Model to explain how interpersonal relationships could be established in CMC environments. Specifically, this model explains how CMC communicators process social information using various media in CMC and FtF environments, as well as the effects of such information on interpersonal communication. In addition, a few recent studies have investigated how communicators are involved in social-emotion-oriented communication [Breazeale 1999; Halbert 1999; Jacobson 1999; Lawrence and Mongeau 1996; Lea and Spears 1991; Parks and Floyd 1996; Rice and Love 1987; Utz 2000; Walther 1995, 1996; Walther, Anderson, and Park 1994; Walther and Burgoon 1992; Wright 1999]. Other studies have found that CMC communicators are involved in both task-oriented communication and social-emotion-oriented communication [Tangmanee 1999]. Even so, compared with research within task-oriented model, there have not been many studies related to social-emotion-oriented model in CMC [Liu and Ginther 1999b]. A few recent studies have identified the existence of certain nonverbal cues in CMC and have investigated the effects of certain nonverbal cues on social emotion development, such as temporal aspects [Hesse, Werner, and Altman 1988; Walther and Tidwell 1995], primacy and recency effects [Rintel and Pittam 1997], pictographs or typographic marks and emoticons [Asteroff 1987; Reid 1995; Thompsen and Foulger 1996]. However, there is no published literature regarding the effects of frequency and duration on social and emotional development in CMC.

Similar to FtF environments, impression development is an important topic in CMC [Walther 1993a, 1993b]. But there have not been many published studies in this area in recent literature. In addition, more recent research has indicated that CMC users can adapt both verbal and paralinguistic behaviors to communicate in CMC environments [Reid 1995; Walther 1996; Walther, Anderson, and Park 1994]. Walther and Burgoon [Walther and Burgoon 1992] found that CMC groups could adapt their verbally transmitted or textual messages to some degree of social-emotional

content in CMC environments and improve to higher levels in some relational aspects; these subsequent levels were very close to those of FtF groups.

Based on his Social Information Processing Model and the characteristics of CMC, Walther [Walther 1993a] constructed a quantitative measure of impression development to be used in CMC research. The measure predicted that impressions were expected to develop differentially over time. Therefore, the measure was time-sensitive rather than the traditional trait-reflective. According to Walther [Walther 1993a], the measure can capture impressions from natural CMC interaction rather than just checking accurate recall of manipulated traits. Meantime, Walther [Walther 1993b] used the above measure to examine the effects of time on the development of interpersonal impressions in CMC vs. FtF. He found that CMC communicators developed impressions of others gradually over five weeks, exhibiting a linear increase in impression development and reaching the level of FtF groups. Therefore, Walther [Walther 1993b] concluded that accumulation of interpersonal impressions in CMC over time could be conveyed by the adaptation of written language. This is also supported by MacKinnon [MacKinnon 1995]. In MacKinnon's view of the CMC environment, one's social currency is primarily based on the information he/she manages and the wit he/she contributes to it rather than media richness.

In addition, Adkins and Brashers [Adkins and Brashers 1995] studied the influences of powerful and powerless language styles on impression formation in decision-making in CMC environments. In their experiment, powerless language style is characterized by the participant's consistent use of hedges, hesitations, intensifiers, and tag questions. Their experiment involved three conditions. Each condition involved two confederates with training in preparation for the experiment. First, both confederates used powerful language. Second, both used powerless language. Third, one used powerful language and the other used powerless language. Their results have indicated that a communicator using a powerful language style in CMC environments is perceived as more attractive, credible, and persuasive than the communicator using a powerless language style. These perceptions may have effects on subsequent behaviors in CMC environments. In addition, contrasting language styles made perceptions more extreme than if a similar language style was shared by the communicators. Impression formation could be achieved relatively quickly, within a 20-minute group interaction, among communicators with zero-history in CMC. Therefore, Adkins and Brashers concluded that powerful and powerless language styles had a great influence on impression formation in CMC environments.

More recent research has indicated that CMC not only has verbal cues, but also has nonverbal cues available that can be manipulated to develop interpersonal relationships among CMC users [Liu and Ginther 1999b; Walther 1992]. In CMC, many nonverbal cues exist which include individual differences, chronemics (time of sending and receiving a message), frequency and duration of messaging, primacy and recency effects, gender composition, group size, or paralinguistic cues.

The first nonverbal cue identified and studied in CMC was chronemics or temporal aspects of CMC. Hesse, Werner, and Altman [Hesse, Werner and Altman 1988] proposed a transactional framework to study temporal aspects in CMC interaction. According to Hesse et al., temporal aspects of CMC involves four major aspects: temporal scale, sequencing, pace, and salience. In addition, according to

Walther and Tidwell [Walther and Tidwell 1995], chronemics is a very important nonverbal cue and can be transferred via CMC. Variations in chronemic cues can affect a communicator's judgments about their intimacy/liking or dominance/ submissiveness in CMC relational communication. Specifically, (a) a nighttime emotion-oriented message conveys more intimacy than a daytime emotion-oriented one, while a nighttime task-oriented request connotes less intimacy than a daytime task-oriented one; (b) an emotion-oriented message sent at night indicates more equality or less dominance than an emotion-oriented one sent in the day, while a task-oriented message sent at night is more dominant than a task-oriented message sent in the day; (c) a slow reply to an emotion-oriented message conveys greater intimacy/affection than a fast one, while a slow reply to a task-oriented message connotes less intimacy/affection than a fast one, and (d) a fast reply indicates less dominance while a slow reply conveys greater dominance.

Other major nonverbal cues in CMC that have been identified and studied include primacy and recency effects. According to Rintel and Pittam [Rintel and Pittam 1997], the lack of nonverbal behavior is not an insurmountable problem for communicators. In order to create a positive impression on the desired receivers, there are critical factors for initial impression formation in the opening stage in an Internet Relay Chat (IRC) environment. These include the choice of names such as nicknames, the use of orthographic exaggeration, extension, expansion, and paralinguistic marks such as smileys. Therefore, according to Rintel and Pittam, the opening and closing phases of IRC interactions are crucial for the initiation, development, and maintenance of interpersonal relationships. Moreover, in terms of the general functions of the strategies used, interaction management in synchronous CMC interactions is similar to that in casual group FtF interactions. The content, structure, and ordering of the strategies, however, are subject to modification. Therefore, it can be inferred that interaction management in FtF may be applicable to synchronous CMC interaction. In the opening stage, a communicator may attempt to achieve a positive primacy impression, while attempting to achieve a positive recency impression in the closing stage.

In addition, other researchers, such as Asteroff [Asteroff 1987], Reid [Reid 1995], and Thompsen and Foulger [Thompsen and Foulger 1996], have consistently found the benefits of the use of pictographs or typographic marks and emoticons in CMC interaction because these marks can convey social emotions and reduce perceptions of flaming. In some cases, they may convey facetiousness; in other cases, they may convey sarcasm.

Paralinguistic cues not only include emoticons or smileys, but also include frequency and duration of messaging, as well as latency of response. Many previous studies have indicated that paralinguistic cues in CMC can help written communication to be forceful and explicit [Krout, Lewis, and Swezey 1982]. According to Lea and Spears [Lea and Spears 1991], paralanguage is not only available in FtF interaction, but also available in written communication in the form of typographical marks and other characteristics of the text. Paralanguage does convey socially shared meanings although it has no lexical meaning. Therefore, paralinguistic cues not only facilitate the understanding of the transmitted message, but also help define the message style from which receivers may infer certain impressions about the

communicator's personality traits. For instance, the appearance of typing errors in a message may imply that the sender is in a hurry when composing the message. However, the repetitive appearance of typing errors in a series of messages may imply that the sender is careless and incompetent. Similarly, repetitive use of typographical marks may imply that the sender is a lively and spontaneous person. In addition, Lea and Spears found that spontaneously generated paralinguistic marks were related to impression formation for both novice and experienced CMC communicators and that whether their interpretation was positive or not completely depended on the pre-established groups or individualistic context of the interaction.

In addition, according to Jacobson [Jacobson 1999], CMC users do develop images of one another although researchers have proposed that it is difficult to form impressions in computer-mediated communication. Jacobson studied how people in virtual CMC communities envisioned each other's offline characteristics, such as their looks and mannerisms in "real life", based on information available online. Jacobson's study has indicated that these impressions are based on all cues available, as well as based on the conceptual categories and cognitive models people use in interpreting those cues. The different prototypical effects such as stereotypes, contribute to discrepancies between online images and offline realities. In addition, different people use different models and categories; this contributes to differences between online expectations and offline experiences.

In FtF environments, frequency and duration of speech have both been considered as good predictors of an individual's participation and impression development in group communication. Persons with a high frequency of verbal responses are perceived as being competent and having greater participation, while persons with a low frequency of verbal responses are perceived as incompetent and having less participation [Willard and Strodtbeck 1972]. Similarly, persons with shorter duration verbal responses are perceived as incompetent and lacking confidence, while persons with longer duration verbal responses are perceived as competent and confident [Koomen and Sagel 1977].

Are the effects of frequency and duration of messaging in CMC the same as those in FtF environments? According to Rice [Rice 1984a, 1984b] and Rice and Love [Rice and Love 1987], frequency and duration of messaging are two major aspects related to the amount of CMC information communication. Frequency is similar to "latency of verbal response" [Willard and Strodtbeck 1972] and refers to how quickly a communicator responds to begin a conversational turn. Duration is similar to the psychological trait of "duration of verbal response" [Koomen and Sagel 1977] and refers to how long one communicates between conversational turns. It addition, these psychological traits are quite stable and reliable and highly correlate with the degree of one's participation in group communication [Hiltz and Turoff 1978]. According to Rice [Rice 1984a, 1984b] and Rice and Love [Rice and Love 1987], sociability implies that social-emotion-oriented persons should exhibit shorter latency of verbal responses and greater duration of verbal responses. In addition, such persons are more likely to achieve leadership in group interaction.

This laboratory study is intended to supplement and extend the research by: (1) offering theoretical support for the social-emotion-oriented nature of CMC, and (2) laying foundations for further research in many popular types of interactive CMC

environments, including e-commerce, e-health, and e-learning. Specifically, this study is designed to explore how the two nonverbal cues--frequency and duration of messaging--affect impression development in asynchronous e-mail communication.

Although CMC researchers have predicted that frequency and duration of messaging in CMC are two important aspects of CMC information communication [Rice and Love 1987] and that these two variables are highly correlated with the degree of one's participation in group communication [Hiltz and Turoff 1978], there has been little published literature regarding the effects of frequency and duration of messaging on impression development in CMC [Liu and Ginther 1999a, 1999b; Parks and Floyd 1996; Walther 1996]. Thus, based on the above statements made by Rice and Love, as well as by Hiltz and Turoff, at least three hypotheses can be derived regarding the impression development in CMC:

> Hypothesis 1: High frequency and long duration of messaging will result in higher mean scores, while low frequency and short duration will result in lower mean scores, on an impression scale in CMC.
>
> Hypothesis 2: High frequency of messaging will result in higher mean scores, while low frequency will result in lower mean scores, on an impression scale in CMC.
>
> Hypothesis 3: Long durations of messaging will result in higher mean scores, while short durations will result in lower mean scores, on an impression scale in CMC.

In addition, according to Walther's [Walther 1992] Social Information Processing Model described previously, CMC users can form and develop impressions over time with their partners through both verbal and nonverbal cues in CMC. Thus, a fourth hypothesis can be derived from Walther's model.

Hypothesis 4: The mean scores for impression development at Time 2 will be higher than those at Time 1 on an impression scale in CMC.

2 Method

2.1 Participants

One hundred and sixteen undergraduate volunteers (Male = 33 and Female = 83) were initially recruited from 11 psychology summer courses at a State University in the United States in 1999. Immediately after the experimenter's (the first author's) classroom presentation, the students were shown a pre-recorded 5-minute video about experimental instructions, then volunteers were asked to complete consent forms and demographic surveys. Participants were equally divided among the four groups and were randomly assigned to each of the four experimental groups. Eighty-three (Male = 24 and Female = 59) participants were used for final statistical analyses, with two groups each having a total of 20, one group having 21, and one group having 22.[3] In

[3] Thirty-three of one hundred and sixteen participants were excluded from final analysis because of the participants' violation of the experimental instructions. Specifically, 30 participants violated (b) and 3 violated (c) in Experimental Instruction section in this paper.

addition, in the final analysis, each group had an almost equivalent ratio of males and females (each group involved 6 males).

2.2 Definitions of Independent Variables

In order to clearly define the independent variables, two separate pilot studies were conducted in several Internet discussion lists to determine typical frequency and duration of messaging. Frequency of messaging was based on the number of messages sent to each discussion list per week and was divided into high frequency and low frequency. According to the results of the first pilot study, high frequency was defined as a minimum of five messages per week and low frequency was defined as two or fewer messages per week. Messages were sent to subjects only during the weekdays, not on Saturday or Sunday. In the high frequency condition, each message was separated by about 24 hours; in the low frequency condition, each message was separated by about 48 hours. In addition, duration of messaging was based on the length of a message sent to the discussion list by each of the four discussants. Duration of messaging was divided into long messages and short messages. According to the results of the second pilot study and the APA criteria (1994) for a long quotation, a long message was defined to include a minimum of 40 words per message and a short message was defined to include a maximum of 20 words.

2.3 Design

This quasi-experimental factorial design involved two independent variables: frequency and duration of messaging. Each of these independent variables had two treatment levels. This resulted in a 2 (high frequency versus low frequency) x 2 (long duration versus short duration) factorial design. There were 4 treatment combinations. These four combinations were respectively described as: condition 1 (long duration and high frequency), condition 2 (short duration and low frequency), condition 3 (long duration and low frequency), and condition 4 (short duration and high frequency). In addition, according to the Social Information Processing Model in CMC [Walther 1992], interpersonal relationships develop over time. Therefore, a time factor was used as a repeated variable in this design, with the dependent variable being measured on two occasions during the study.

2.4 Discussion Lists

The experimenter enrolled each of the subjects in one of the four discussion list groups. Each discussion list group was moderated by the experimenter, which meant that all electronic submissions from participants to each group were under the control of the experimenter. In order to control the influence of the message content, each member of each group was a "lurker" since the subjects monitored but were not allowed to directly participate in the discussion on the lists. The fundamental role of each subject was to read and review the discussion list messages.

2.5 Instruments

The dependent variable in this study is the impression score of Walther's [Walther 1993a] Impression Development Scale [4]. This scale was selected for four reasons: (a) it met the time-sensitive characteristic of CMC, (b) it was the only impression formation scale available in CMC, (c) it has been used in CMC research in recent years, and (d) impression formation scales in FtF are not applicable to CMC. In addition, the results of Walther's (1993a) studies indicated that this scale had very good construct validity. This scale has fourteen 5-interval items. According to Walther, these 14 items (adjectives) were selectively chosen from previous impression scales because they reflect the impression development over time, rather than reflecting the simple physical attributes. The 5 intervals represent strongly agree (1), agree somewhat (2), disagree somewhat (3), strongly disagree (4), and don't know (DK). If a 1, 2, 3, or 4 is selected as a response, each of these responses is worth one point. Therefore, there is no difference whether the impression item is a positive (e. g., sociable) or a negative (e. g., unintelligent) item. A selection of "DK" is worth no points. Thus, the maximum total score in this scale is 14 and this score is counted to measure the degree of impression development. In other words, the higher the total score, the more developed impression, and vice versa.

2.6 Experimental Instructions

Participants received experimental training which described their role as both a member of their respective discussion list and a subject for this study. In addition to a copy of the written experimental instructions, each subject saw a 5-minute pre-recorded video describing experimental instructions. Specifically, subjects were told that they would be required (a) to read all messages generated on their discussion list at least once a day, Monday through Friday; (b) to reply immediately to the list with key ideas about each message, with the original message included in the reply. These key ideas could be several words and were intended to verify whether each participant had read each message on the list. If a participant did not send key ideas within 24 hours of receiving a message on the discussion list, he/she was reminded via email to read the unread messages on the list. If a subject had to be reminded more than two times, he/she was removed from further participation in the study; (c) not to discuss the experimental task with any participants or non-participants. In order to check whether participants did interact outside of the discussion lists, a simple 2-item survey was administered at the end of the experiment via e-mail. If any participant discussed the experiment task with anyone during the experiment, he/she was eliminated from the final analysis; (d) to complete the instrument on Saturdays during the first and the second experimental weeks; and (e) to complete a 2-item survey on Sunday during the second week.

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[4] The authors extend their gratitude to Dr. Joseph Walther's kind permission to use his Impression Development Scale in this study.

2.7 Experimental Stimulus

Initially, in order to control the content validity of the discussion topic in this study, the experimenter planned to involve the participants in a neutral discussion topic, such as statistics. But it was soon predicted that this type of topic would hardly stimulate participants' interest. Then, the experimenter chose another potentially interesting topic for participants. This topic was the Littleton, Colorado school shootings that occurred on April 20, 1999. Each of the four discussion lists discussed this same topic. Each discussion list had four members that, for purposes of this study, were referred to as discussants. Essentially, the subjects in this study were told that they were "lurking" on a discussion list with four active members.

An experimental assistant helped the experimenter to select and adapt the messages that were later provided to each subject in their discussion list group. The experimenter and the assistant selected a minimum of 40 archived actual messages about the Colorado school shooting from an existing discussion list. These messages were messages that were posted to the CNN web site at http://community.cnn.com/ on April 21, 1999. The detailed pre-scripting procedure is described as follows.

1. The experimenter and the assistant identified four members of the discussion list in CNN web site at the http://community.cnn.com/ to serve as model discussants. Each of the four selected list members was chosen because they tended to produce long duration messages of high frequency. Ten messages produced by each of the four list members were selected for later presentation to each of the four subjects in the long duration/high frequency condition of this study.
2. The 40 messages selected to represent the long duration/high frequency message condition were then reviewed and modified to produce the messages for the other three experimental conditions. For the short duration/high frequency messaging condition, the 40 messages of the long duration/high frequency condition were reduced in length for the short duration/high frequency condition. This reduction in length was done in such a manner as to maintain the syntax, grammar, vocabulary, and essential meaning of the original messages.
3. The 16 messages for the long duration/low frequency condition were selected from the 40 messages selected for the long duration/high frequency condition. These messages were selected so that the thread of the discussion was maintained. Similarly, the 16 messages for the short duration/low frequency condition were selected from the 40 selected for the short duration/high frequency condition.

In addition, in order to control the influence of the verbal cues in list messages during the experiment, the contents of all list messages were pre-scripted and were embedded in an ongoing dialogue, and were designed to be as neutral as possible. Specifically, all list messages were selected or modified to contain (a) no typing or spelling errors, (b) no "flaming" language and personal attacks, and (c) no obscene language.

During the treatment phase of this study, the experimenter sent the selected messages to each respective experimental discussion list with the subject header in each message as Littleton, School Shootings. For conditions 1 and 4, each message was sent on Monday through Friday mornings, for conditions 2 and 3, each message was sent in the mornings on Monday and Wednesday. For each subject-discussant, a separate e-mail account was established, so the messages appeared to the subjects to be generated by four separate individuals. Verification comments made by each subject were sent to the list but intercepted by the list moderator (the experimenter) and not distributed to list members.

2.8 Administration of the Dependent Measure

The Impression Development Scale was administered to participants on two occasions via e-mail: once on Friday afternoon of the first experimental week and once on Friday afternoon of the second experimental week. This time frame was similar to several previous studies about impression development in CMC [Walther, 1993b]. Participants in each of the four experimental groups were told to rate only one of the four designated discussants and to e-mail their responses back to the experimenter within 24 hours after receiving the instruments.

3 Results

Preliminary statistical ($\underline{t}$ and X^2) results of demographic variables indicated that there were no significant differences among the four experimental groups in terms of participants' characteristics. In addition, statistical assumptions were checked before statistical analysis and results indicated that impression scores at Time 1 and Time 2 were normally distributed and none of the ANOVA assumptions were violated[5]. The detailed statistical results of the impression scores at Time 1 and Time 2 are presented in Tables 1 to 6.

First, Tables 1 and 2 below indicated that there were no interaction effects between frequency and duration on impression scores at Time 1 ($\underline{F}_{(1, 82)} = 1.35$, $\alpha > .05$) and at Time 2 ($\underline{F}_{(1, 82)} = 1.82$, $\alpha > .05$). Therefore, hypothesis 1 was not supported.

[5] The Levene's test from SPSS 10.0 indicated no severe departure from homogeneity across the groups. In addition, the boxplot tests from SPSS 10.0 indicated no severe departure from multivariate normality observed across the groups.

Source	df	SS	MS	F	ω^2
Duration	1	39.27	39.27	4.59*	.038
Frequency	1	71.22	71.22	8.33**	.078
Duration * Frequency	1	11.53	11.53	1.35	
Error	79	675.62	8.55		
Total	82	797.64			

Note. * $p < .05$. ** $p < .01$.

Table 1: Analysis of Variance for Impression Scores at Time 1 (N = 83)

Source	df	SS	MS	F	ω^2
Duration	1	36.63	36.63	6.19 *	.054
Frequency	1	48.48	48.48	8.20 **	.075
Duration * Frequency	1	10.75	10.75	1.82	
Error	79	467.39	5.92		
Total	82	563.25			

Note. * $p < .05$. ** $p < .01$.

Table 2: Analysis of Variance for Impression Scores at Time 2 (N = 83)

Second, Tables 1 and 2 also indicated that frequency had significant main effects on impression scores at Time 1 ($F_{(1, 82)} = 8.33$, $\alpha < .01$) and at Time 2 ($F_{(1, 82)} = 8.20$, $\alpha < .01$). Similarly, duration had significant main effects on impression scores at Time 1 ($F_{(1, 82)} = 4.59$, $\alpha < .05$) and at Time 2 ($F_{(1, 82)} = 6.19$, $\alpha < .05$). Therefore, hypotheses 2 and 3 were supported.

In addition, in order to understand the proportion of variance explained by each independent variable, Hays' (1988) Omega Squared (ω^2) was calculated separately to estimate the strength of association between the independent variables and the dependent variables at both Time 1 and Time 2. Specifically, the calculation formulas for a two-factor ANOVA are: (1) factor A: SSa - (j - 1) * Mserror /Mserror + Sstotal, where j is the number of levels (groups) for factor a; (2) factor B: SSb - (k - 1) * MSerror/Mserror + Sstotal, where k is the number of levels for factor b; and (3) factor AB: Ssinteraction - (j-1) (k-1) * MSerror/Mserror + Sstotal. The values of Omega Squared for each significant outcome at Time 1 and Time 2 are also presented in the above two tables, respectively. Tables 1 and 2 indicate that there was a medium association between frequency and impression scores at Time 1 ($\omega^2 = .078$) and at Time 2 ($\omega^2 = .075$). Both associations were statistically significant. In addition, compared with frequency, the associations between duration and impression scores were smaller at Time 1 ($\omega^2 = .038$) and Time 2 ($\omega^2 = .054$).

Third, since there was no significant interaction between frequency and duration, it is necessary to more clearly understand the specific differences in impression scores at Time 1 and Time 2 among the four experimental groups. Thus the Bonferroni multiple comparisons procedure [Sincich 1993] was conducted. According to Tables 3 and 4, the results of the Bonferroni multiple comparisons procedure indicated that

there were significant differences between the group of short duration/low frequency and the group of long duration/high frequency, as well as between the group of short duration/low frequency and the group of short duration/high frequency at both Time 1 and Time 2. In addition, there were significant differences between the group of short duration/low frequency and the group of long duration/low frequency at Time 2.

(I) Group	(J) Group	Mean Difference (I-J)
1	2	3.23 **
	3	1.11
	4	.63
2	1	-3.23 **
	3	-2.12
	4	-2.60 *
3	1	-.11
	2	2.12
	4	-.48
4	1	-.63
	2	2.60 *
	3	.48

Note. 1 = Group 1 (long duration/high frequency), 2 = Group 2 (short duration/low frequency), 3 = Group 3 (long duration/low frequency), and 4 = Group 4 (short duration/high frequency). * $p < .05$. ** $p < .01$.

Table 3: Results of Bonferroni Multiple Comparisons among Impression Scores at Time 1 (N=83)

(I) Group	(J) Group	Mean Difference (I-J)
1	2	2.86 **
	3	.81
	4	.61
2	1	-2.86**
	3	-2.05 *
	4	-2.25 *
3	1	-.81
	2	2.05 *
	4	-.20
4	1	-.61
	2	2.25 *
	3	.20

Note. 1 = Group 1 (long duration/high frequency), 2 = Group 2 (short duration/low frequency), 3 = Group 3 (long duration/low frequency), and 4 = Group 4 (short duration/high frequency). * $p < .05$. ** $p < .01$.

Table 4: Results of Bonferroni Multiple Comparisons among Impression Scores at Time 2 (N=83)

In addition, since this study involved a very imbalanced toward female group in subject pool, the mean difference in terms of the impression scores between female and male groups at Time 1 and Time 2 are conducted and presented in Table 5. The two paired t tests in Table 5 indicated that there was no significant difference in terms of impression scores between the two gender groups ($\alpha > .05$) at Time 1 or Time 2 although the male group involved a higher mean score on two occasions.

	Gender	Mean	SD	N	T	P
Time 1	Males	11.04	2.03	24	1.67	.099
	Females	9.80	3.41	59		
Time 2	Males	11.38	2.28	24	1.38	.173
	Females	10.51	2.72	59		

Table 5: Means and Standard Deviations for Male and Female Groups on Impression Scores and t Tests between Males (n = 24) and Females (n = 59) at Time 1 and Time 2

Fourth, Table 6 below shows the means and standard deviations on impression scores for the four groups formed by the 2x2 combinations at Time 1 and Time 2, as well as the t test results of impression scores between Time 1 and Time 2 in all four groups. The four paired t tests in Table 6 indicated that there was no significant difference in impression scores between Time 1 and Time 2 in any of the above four experimental groups ($\alpha > .05$). Therefore, hypothesis 4 was not supported.

Groups	Duration	Frequency	Mean	SD	N	t	P
1	Long	High (1)	11.36	2.48	21	-.79	.44
		(2)	11.81	1.86	21		
3		Low (1)	10.27	2.62	22	-1.03	.31
		(2)	11.00	2.07	22		
4	Short	High (1)	10.75	3.39	20	-.73	.47
		(2)	11.20	2.88	20		
2		Low (1)	8.15	3.17	20	-1.71	.10
		(2)	8.95	2.82	20		

Note: (1) = Time 1; (2) = Time 2

Table 6: Means and Standard Deviations for 2x2 Groups on Impression Scores and t Tests between Time 1 and Time 2 (N = 83)

4 Discussion

CMC is now a popular mode of communication. Like FtF, CMC involves not only verbal cues, but also certain nonverbal cues [Liu and Ginther 1999a, 1999b; Walther and Tidwell 1995]. Most recent research in the area of CMC has focused on comparison studies between CMC and FtF environments involving both task-oriented and social-emotion-oriented models [Lawrence and Mongeau 1996; Walther and Burgoon 1992]. However, the present study took another quite different methodology, which emphasized the effects of two nonverbal cues on impression development in CMC environments. Specifically, this laboratory study explored the effects of frequency and duration of messaging on impression scores in CMC. Generally speaking, two hypotheses (hypotheses 2 and 3) in this study were supported, while two others (hypotheses 1 and 4) were not. As stated previously, there were no interaction effects between duration and frequency on impression scores in CMC. However, frequency and duration both had significant main effects on impression scores in CMC. Therefore, the main effects of frequency and duration on impression scores in CMC are discussed below.

First, contrary to the expectations, hypothesis 1 was not supported. That is, there were no interaction effects between duration and frequency of messaging on impression scores in CMC. This result was different from the results in previous studies within FtF environments [Koomen and Sagel 1977] and previous predictions in CMC environments [Hiltz and Turoff 1978; Rice and Love 1987]. According to Rice and Love, as well as Hiltz and Turoff [Hiltz and Turoff 1978], duration and frequency of messaging in CMC, similar to duration and latency of verbal response in FtF, should have significant interaction effects predicting an individual's participation in CMC group communication. They all maintained that long duration and high frequency are related to greater perceived sociability and leadership in group interaction in CMC environments.

Second, hypothesis 2 was supported. Frequency of messaging had significant main effects on impression scores in CMC. That is, high frequency resulted in higher impression scores than low frequency in CMC at both Time 1 and Time 2. This result was well demonstrated in groups 1 (long duration/high frequency) and 4 (short duration/high frequency). Both of these groups involved high frequency and developed higher impression scores than the other two groups involving low frequency. This result was in agreement with the results in some previous studies in FtF environments [Willard and Strodtbeck 1972]. Therefore, it appears that frequency of messaging is an important factor in CMC and may have similar effects on impression development in both FtF and CMC environments. So, frequency of messaging is a good predictor of an individual's participation and impression in small group interaction in CMC environments. Specifically, CMC users with high frequency are perceived as being competent and having greater participation, while those with low frequency are perceived as less competent and having less participation in CMC.

Third, hypothesis 3 was supported. Duration of messaging had significant main effects on impression scores in CMC. That is, longer duration resulted in higher impression scores than shorter duration in CMC at both Time 1 and Time 2. This result was well demonstrated in groups 1 (long duration/high frequency) and 3 (long

duration/low frequency). Both of these groups involved long duration and developed higher impression scores than group 2 which involved short duration. This result was in agreement with the results in some previous studies in FtF environments [Koomen and Sagel 1977]. Therefore, it appears that duration of messaging is also an important factor in CMC and may have similar effects on impression development in both FtF and CMC environments. So, duration of messaging is also a good predictor of an individual's participation and impression in small group interaction within CMC environments. Specifically, CMC users with shorter duration are perceived as less competent and lacking confidence, while persons with longer duration are perceived as competent and confident.

In all, hypotheses 2 and 4 partially support the predictions of Hiltz and Turoff [Hiltz and Turoff 1978] and Rice and Love [Rice and Love 1987] who maintained that frequency and duration of messaging have similar effects in both FtF and CMC environments and that both are important predictors of an CMC user's participation in group communication. In addition, these results partially support Walther's [Walther 1992] Social Information Processing Model. According to Walther, CMC users can process all relational cues available and social identity using various media to present and solicit their relational behaviors. Specifically, in relation to this study, CMC users can manipulate nonverbal cues such as duration and frequency of messaging to more favorably present their behaviors and to achieve better impressions from their partners.

Fourth, contrary to the expectations, hypothesis 4 was not supported. That is, impression scores did not significantly increase from the end of the first week to the end of the second week. This finding seems not to support Walther's [Walther 1993a, 1993b] initial hypothesis of gradual impression development in CMC. According to Walther, CMC users can gradually develop impressions of their own partners over time. However, in this study, visual presentation showed that the means at Time 2 were all higher than the means at Time 1 in terms of impression scores in spite of no significant differences between the two occasions in all four experimental groups.

In all, there may be several reasons why the present study fails to completely support Rice and Love's [Rice and Love 1987] and Hiltz and Turoff [Hiltz and Turoff 1978] predictions of the interaction effects and Walther's [Walther 1993a, 1993b] hypothesis of gradual impression development over time in CMC. These may include, are not limited to: (1) Experimental duration: This study only involved a period of two weeks, while most prior CMC studies used a longer period of time such as five weeks. (2) Participants as observers: Participants in this study were only allowed to be "lurkers" rather than participants, while most prior CMC studies allowed participants to participate actively in the list discussions. (3) Composition of participants: There was a very imbalanced toward female group in subject pool in this study, while most prior CMC studies did not involve such a high percentage of females. (4) Experimental tasks: This study only involved one task, while most prior CMC studies used more tasks for participants to discuss with each other. In addition, this study involved an emotional topic in order to stimulate the participants' interests. (5) Research type: This study only involved the manipulation of two independent variables in CMC environments, while most prior CMC studies involved the comparison of FtF and CMC environments. (6) Characteristics of participants: This

study involved participants mostly having CMC experiences, while most prior CMC studies used participants with no CMC experience. (7) Other relevant factors: These may include group sizes and language styles.

Finally, as CMC is becoming more and more widely used, there is an urgent need to study the affects of interactive CMC in different areas, such as e-learning, e-commerce, and e-health. Based on the findings in this laboratory study and Walther's (1992) social information processing model in CMC, the following recommendations are proposed for future research in different interactive CMC environments:

(1) Investigating the effects of frequency and duration of messaging in interactive CMC discussion in different areas, such as education, work, commerce, or health.
(2) Extending the experimental duration to longer periods so that participants can have enough time to develop impressions and relations.
(3) Adding more discussion topics in CMC so that participants will not get bored in the experiment.
(4) Increasing participants' duration of messaging in extended periods of communication.
(5) Using participants from a variety of settings, including educational, industrial, organizational, and personal communications.
(6) Recruiting a more balanced group of males and females in subject pool.

5 Conclusion

Although the findings in this experimental study are exploratory, and further study is needed in interactive CMC environments with different samples, the initial results are promising. The results suggest that frequency and duration of messaging are potentially important variables in CMC group communication; high frequency and long duration can help CMC users achieve more developed impression from their CMC partners. This conclusion is in contrast to the task-oriented model of CMC discussed previously. The authors agree with this conclusion since it can help explain lots of interactive CMC phenomena. Therefore, the present study generally supports one of CMC's two major theoretical models—the social-emotion-oriented model in CMC environments described previously. In other words, all types of CMC users may control the frequency and duration of messaging to achieve desired impression development in various CMC environments. In addition, the results in this study has laid foundations for future research in many popular types of interactive CMC environments, including e-learning, e-commerce, and e-health.

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