Emotional Activities in Computer-mediated Communication: Facial Electromyography Response and Emoticon Use during Instant Messaging

Keywords:
Emoticon, Computer-mediated Communication, Instant Messaging, Facial Electromyography, Facial Muscle Activity

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Abstract

In this study, we use electromyography data of the orbicularis oculi and zygomaticus major as indices of positive emotions to analyze facial muscle activities in computer-mediated communication. We find a difference in frequency of facial muscle activities, influence from stimuli, and other aspects under varied instructions on emoticon use. Results suggest that richness of nonverbal methods is a key factor that affects emotional activities in computer-mediated communication. Although we collected data from two counties, we could not find any significant difference between them. Instead, we found that participants from the two countries have some patterns of emoticon use in common. We believe that, in certain situations emoticon use and facial activities in computer-mediated communication can show commonality between countries on a certain level.

1. Introduction

Interpersonal communication involves not only information from words or messages but also from facial expressions and gestures. However, when we perform computer-mediated communication (CMC) by smart phone or PC, most of the time, these nonverbal behaviors cannot be communicated (Perry, 2010). To do this, users employ some new and simple, but easy-to-use methods. Emoticons are one of these methods. They can be used in most computer and smart phone software. Although emoticons have been discussed from various perspectives in previous studies, we still do not know how they correlate with our facial expressions. One of the purposes of our study is to confirm whether the use of emoticon has influence on facial expression. Similar to the facial expressions that we might make during a phone call, our facial expressions still manifest even when we cannot see each other in CMC. Nowadays, in the information society, the innate methods like facial expression and computer mediated methods like emoticon will be both functional in many occasions in our communications. We assumed the emoticon use might have influence on facial expressions in a direct or indirect way. The other purpose of our study is to confirm whether CMC users from different countries have different way of using nonverbal methods. As the result, correlation between emoticon use and facial expressions is confirmed. However, we found more similarity than difference in emotional expression between countries in CMC.

2. Material and methods

Facial electromyography (fEMG) has been used as a tool for inferring affective states in media-related studies; it has proven to have advantages over other methods. For example, fEMG has been used in studies of emotional responses to television commercials; results indicate that it can be more accurate and sensitive than self-report measures (Hazlett & Hazlett, 1999). A study of user experience with mobile phones proved that subtle emotional changes could be detected by fEMG measurements (Mahlke & Minge, 2006). Other research indicates that facial activities caused by unconscious stimuli can also be detected by fEMG measurements (Dimberg & Thunberg, 2000). These advantages can be very useful for CMC study, because when performing CMC, facial activities are less obvious and more difficult to recognize than in face-to-face situations. Under the circumstances, self-report or visual methods like Facial Action Coding System (FACS) might not be as efficient as fEMG measurements.

On the other hand, discriminating among different emotions is an important application of fEMG measurements, too (van Boxtel, 2010). Explanations for these connections between elementary emotions and specific facial muscle actions can be found in a study based on FACS (Cohn et al, 2006). Thus, using fEMG measurements to record specific emotional responses is feasible (Larsen et al, 2003).

Another reason for using fEMG in CMC study is about the emoticon use in instant messaging (IM) and e-mail. According to Xu et al. (2007), emoticons can help form an impression of the sender's personality and emotional state. This opinion is supported by study of gender differences in impressions about emoticon use (Constantin et al, 2002). Furthermore, other studies suggest that the use of emoticons is not only for enjoyment but can also provide users with rich information (Huang et al, 2008; Thompsen & Fougler, 1996). Therefore, for people who are used to CMC, emoticons might be a reliable method for sending and reading emotional cues. Possibly, the emotional activities appear in this process can be detected by fEMG measurements.

Similar to facial expressions, emoticons can be classified by the emotions they convey. However, emoticon has features fundamentally differ from facial expression. According to recent studies, emoticons with positive meanings like "happy," "humorous," or "enjoyable" are used more than negative ones (Huffaker & Calvert, 2005; Derks et al, 2008); even the expressions of teasing or sarcasm carries positive meaning in most cases (Wolf, 2000). Therefore, for CMC study, conducting research focused on positive emotional activities seems necessary. In many facial activity studies using fEMG, the orbicularis oculi and zygomaticus major were indices of positive emotions (Kimura et al, 2013; Lang et al, 1993; de Wied et al, 2006; de Wied et al, 2009). The activities of the zygomaticus major are especially reported to be sensitive to positive emotions (Witvliet & Vrana, 1995). We conducted a small-scale experiment as a pilot study; collected fEMG data during chats on IM and ensured activities of the two muscles could be correctly recorded.

3. Main study

3.1. Participants

Our participants comprised 52 college students (age range of 21～25 with 0.693 as standard deviation). 24 of them were from Japan (12 females and 12 males), and 28 of them were from China (16 females and 12 males). Experiments were conducted in both countries, and participants were all local residents; none had long-term overseas experience in the other country. All the participants had had prior experience of CMC and emoticon use.

3.2. Stimuli and procedure

Participants were asked to perform this experiment in pairs. Each member of a pair sat simultaneously in different rooms, and each room was equipped with an Internet-accessible computer. Participants were asked to watch a short video (as stimuli for positive emotional activities) with Japanese or Chinese subtitles and then have a chat about their experiences related to that video with the participant in the other room for 10 minutes. These videos were all comedic from the situation comedy named *Friends* described some simple stories which our participants might also have experienced in their daily life. From nine videos used in the pilot study, we selected three because their fEMG data was found to be relatively obvious and stable. The video-chat procedure was repeated three times in the experiment, and we changed the three videos' playback order each time to avoid bias caused by interests or experiential differences.

In the first video-chat procedure (Part 1), no particular instruction about emoticon use was given (the "no-instruction" condition), and participants could use emoticons as they wished. For the second procedure (Part 2), participants received instructions to use emoticons more than three times (the "amplified-use instruction" condition); however, when or where to use them was decided by the participants. In the third procedure (Part 3), participants received instructions to inhibit emoticon use (the "inhibited-use instruction" condition). The fEMG activities of these three parts were recorded by Mwatch type 101 (WADA Aircraft Technology) and two pairs of Ag/AgCl surface electrodes (4 mm in diameter). Figure 1 showed an image of the attached electrodes for each muscle. The electrodes were attached one pair each for zygomaticus major (lower left in Figure 1) and orbicularis oculi (upper right in Figure 1). The fEMG activity was amplified 8000 times and filtered (50 Hz to 500 Hz). Data collection was conducted at a sampling rate of 1000 Hz. We also used screen capture software to record all actions on computers to check every occurrence of emoticon use afterward.

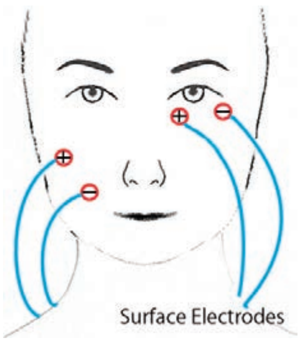

Figure 1. An Image of the Attached Surface Electrodes for Each Muscle

We used LINE in Japan, and WECHAT in China. We purposely used two different kinds of IM software because they were each widely used in one country, but not in the other. We wanted to obtain data reflected situations close to CMC in daily life. There were many kinds of emoticons and other similar methods such as "Stamp" in LINE and "Biaoqing" in WECHAT. These methods were widely used by many people in both countries. However, not all of them could be used from both countries, and some of them were with extremely complex meanings which might bring unpredictable influence to data analysis. Thus, we had to prevent the use of some methods and control the emoticons to ensure no strange or particularly complicated ones could be used.

For the convenience of waveform observation and calculation, we transferred all fEMG data to integrated EMG (iEMG) data (300 ms time constant). And to make our data comparable between individuals, all iEMG data was transferred into %iEMG data, which were proportional to an adequate baseline value (baseline %iEMG value =100%). At some level, this standardization also enabled direct comparison of the two muscles' activities. Because our experiment was basically conducted on computers, there should have been less distribution and influence from low-frequency artifacts. However, to ensure data's comparability; six samples showed unusually high values were removed, leaving 22 from Japan (12 females and 10 males), and 24 from China (14 females and 10 males) as the total number of participants.

4. Data analysis and results

4.1. Overview of fEMG data

All our participants used more than three times in Part 2, and most of them used emoticons in Part 1. In general, more emoticons were used in Part 2. Therefore, we believe that emoticon use was well controlled. Beyond that, most emoticons (431 times in 485) had positive meanings such as "happy," "exciting," and "satisfaction," etc. Other emoticons used to show "sarcasm," "confusion," and "apology" also showed some positive meanings.

No significant difference in %iEMG data was found among general (undifferentiated as to Part 1, 2, or 3) videos or chats by group comparison. And after observation of the fEMG curve, we noticed that stronger fluctuations appeared while watching videos. Comparative results of mean %iEMG values revealed a significant difference between general chats and videos ($t = -2.390$, $df = 550$, $p < .05$).

In the main study we found no significant correlation between the number of emoticons used and %iEMG data from the zygomaticus major ($r = -0.05$, $p > .05$) or the orbicularis oculi ($r = 0.03$, $p > .05$). Neither did we find significant difference in %iEMG values of chats among instructions. Thus, we assume that it is not a simple mechanism that more emoticon use cause stronger facial muscle activities.

4.2. The influence from emoticon use to facial expressions

4.2.1. The effect caused by emoticons as direct stimuli

First, we have to verify the possibility that emoticons themselves could be direct stimuli. Emoticons are graphical icons with emotional information; thus, it is possible that emotional activity may be caused by watching them.

We calculated the mean %iEMG values in time, i.e., from the participants' opening of the emoticon list to their click on an emoticon and compared these data with the mean %iEMG values of the corresponding chats. When the list was opened, it blocked participant's view of reading messages. The %iEMG data showed information more related to the effect caused by watching emoticons but not messages. Under the circumstance, the effect of emoticons as direct stimuli could be testified. The data from two muscles showed the same result. There were 256 times that emoticon use received higher values than mean %iEMG values; however, 229 times it received lower values. Nearly half of emoticon use indicated lower values than mean %iEMG values.

We also analyzed data of receiving emoticon side. When emoticons were received with messages, participants could see messages and emoticons simultaneously even without obvious eye movements. Thus, it was difficult to select the moment when only emoticons were watched. However, we noticed that sometimes emoticons were sent without messages (46 times in total). Under the circumstance, the effect caused by watching emoticons can be testified. We calculated the mean %iEMG values in time, i.e., from the moment emoticons were received to the start of typing messages for reply. Except for a few times (3 times in total) that two muscles showed different results, same tendency was showed by two muscles in most of time. There were 19 times that higher values than mean %iEMG values appeared; however, 24 times it received lower values.

Based on the data showed above, we cannot claim that as direct stimuli, emoticons promote emotional activities when participants were watching them. Additionally, as mentioned in 3.1, we could not find significant correlation between the number of emoticons used and %iEMG data. Thus, emoticon stimuli are at least not the greatest factors related to facial muscle activities.

4.2.2. The effect caused by video stimuli

In main study, significant responses by the two muscles appeared when watching videos. Thus, we can consider the video stimuli were functional. We believe they could have stronger influence on facial activates than emoticons as stimuli.

However, it is necessary to confirm whether the influence from video stimuli continued to be functional in chat parts.

Because videos and chats were on different timelines, we could not directly compare %iEMG value in each part of the experiment. We used mean %iEMG value instead and calculated the simple linear correlation of the mean %iEMG value between videos and chats. Table 1 presents the results.

Table 1 r-Values of Mean %iEMG in Every Part

	r-values of mean %iEMG		
	Part 1	Part 2	Part 3
All samples	.497**	.593**	.360*
JP samples only	.574**	.633**	.395
CH samples only	.612**	.568**	.406*
	r-values of mean %iEMG		
	Part 1	Part 2	Part 3
All samples	.639**	.692**	.376**
JP samples only	.675**	.684**	.428*
CH samples only	.538**	.718**	.433**

*p<0.05; **p<0.01; NS = Non-significant
JP = Japan, CH = China

Statistical significance of correlation between video and chat parts was found in almost all cases (r = 0.36 ～ 0.72). It emerged from both muscles and both sets (Japan and China) of participants. Thus, we can presume that positive emotional activities caused by stimuli did not disappear after watching videos. These emotions and the subsequent facial activities also continued to emerge from chats. Beyond that, this correlation was lower in Part 3 than in Parts 1 and 2 in both countries. Higher correlation revealed that, in Chats 1 and 2, the emotional activities our participants had were closer to the ones directly caused by video stimuli. Thus, we can consider a possibility that the emotions directly or indirectly caused by video stimuli, could be expressed more easily when emoticons were allowed to be used.

However, this was not the only indication we obtained. We also noticed that although in most cases r-values were higher in Part 2 than in Part 1; the difference between Parts 1 and 2, and Part 3 was far more significant. As mentioned in 4.2.1, the number of emoticons used is not the main reason for facial activities. Perhaps this relates more to the richness of nonverbal methods. Because using emoticons was the only way of making nonverbal communication in our experiment, the richness of information would differ much among instructions. Therefore, it is highly possible that the differences in r-valus relates to the difference of communication methods.

4.2.3. Difference in facial muscle activities among instructions

In our experiment, participants could not see each other. They could not conduct self-presentation or impression management by facial expressions. Thus, we can assume that if facial activities occurred, especially the obvious ones, most of them were caused by their emotional activities at those moments. As mentioned above, the emotional activities in chats were affected by video stimuli on a certain level, and no significant difference in %iEMG data was found among the three videos. Thus, if there were no other important factors existed, the facial muscle activities should not show significant difference among instructions. However, differences were found in the frequency of facial muscle activities.

When performing calculations, we wanted to select relatively obvious peaks from the electromyography curve, and then calculate their number and the time gaps between them. Most relatively obvious peaks can be confirmed by observing the electromyography; however, to select these peaks in a more explicit, objective, and unified way, we did not use the observation way as a main method. Instead, we set a series of mathematical definitions and programmed them to ensure the peaks that we wanted could be automatically selected. We assumed the %iEMG value of n (ms) was a peak we wanted. We set the definition as follows:

(1) *%iEMG (n) = max %iEMG value in 1001 ms from (n − 500) to (n + 500)*

(2) *Max %iEMG value appeared only once in 1001 ms from (n − 500) to (n + 500)*

(3) *%iEMG (n) > mean (%iEMG) value of the chat*

(4) *%iEMG (n − 50) > %iEMG (n − 100) > %iEMG (n − 150) > %iEMG (n − 200) >…> %iEMG (n − 400) > %iEMG (n − 450) > %iEMG (n − 500)*

(5) *%iEMG (n + 50) >%iEMG (n + 100) > %iEMG (n + 150) > %iEMG (n + 200) >…> %iEMG (n + 400) > %iEMG (n + 450) > %iEMG (n + 500)*

This definition does not seem strict enough; however, it was sufficiently functional for our purposes according to the results. Because we used %iEMG data in this selection, most curves were smooth, and only relatively dramatic muscle activities could cause obvious peaks. Thus, for any obvious peak to appear and disappear in as short a time as under 1001 ms was nearly impossible. We also tested using longer or shorter time definitions, such as 501 ms and 2001 ms, but obtained no better results. Beyond that, %iEMG data was accurate to six decimal places, thus the appearance of a repeated value in a short time should be very rare. Although considered a very rare case, if several peaks appear in 1001 ms, part of the values we wanted can be excluded by definition. To avoid influence from rare cases, we compared the result of processing with the electromyography curve. Most selected peaks were obvious enough to be confirmed from observation. At least, every obvious peak confirmed from the electromyography curve was selected by this method. Therefore, we believe that the peaks were well defined. Figure 2 is an example of %iEMG curve in 5 s (%iEMG range of 100%～300%). We can confirm an obvious peak at about 2.1 s from it.

To analysis the frequency, we used the number of peaks to calculate how many times peaks appeared in 1 minute (times/min value). As Table 2 shows, the times/min values were higher and closer to the values of video parts in Chats 1 and 2 than in Chat 3. To confirm influence from instruction and country factors, we conducted analysis of variance (ANOVAs), finding the effect from instruction significant on the zygomaticus major ($F(2, 88) = 14.442$, $p<.01$) and the orbicularis oculi ($F(2, 88) = 6.768$, $p<.01$). No significant effect of country factor was found on the zygomaticus major ($F(1, 44) = 1.066$, $p>.05$) or on the orbicularis oculi ($F(1, 44) = 0.20$, $p>.05$). After multiple comparisons by Scheffe, significant differences between Chats 1 and 3 and between Chats 2 and 3 were found in both muscles. However, no significant difference was found between Chats 1 and 2.

As for time gaps in chats, these values were an average of approximately 27 to 40 s. Significant facial muscle activities appearing at this frequency are acceptable results. No extremely short time gap was found in each sample's data. Thus, we believe that data of the peaks selected from chats are reliable.

The data above suggest that when emoticons could be used, the frequency of emotional

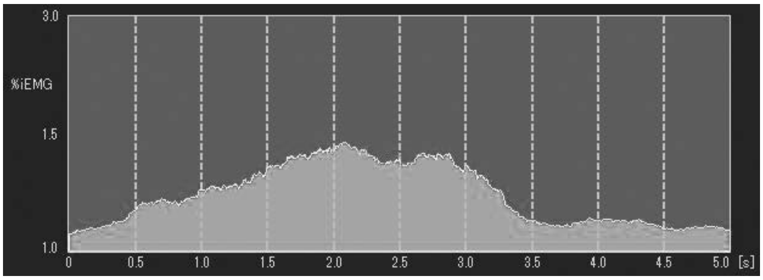

Figure 2. An Example of %iEMG Curve in 5 s

Table 2 Mean Value of Times/Min Value and Time Gaps

		Zygomaticus major					
		video part 1	video part 2	video part 3	chat part 1	chat part 2	chat part 3
Japan	times/min	1.81	1.93	2.02	1.20	1.21	0.94
	time gap	15563.67	14600.68	13423.42	34252.50	29153.65	34973.80
China	times/min	2.09	1.96	2.03	1.05	1.07	0.95
	time gap	11978.30	13094.85	12406.49	35291.60	36151.26	39945.98

		Orbicularis oculi					
		video part 1	video part 2	video part 3	chat part 1	chat part 2	chat part 3
Japan	times/min	1.70	1.89	1.78	1.12	1.13	0.88
	time gap	15251.09	13828.46	14800.87	31454.69	27073.38	39995.57
China	times/min	1.71	1.57	1.62	1.13	1.06	0.91
	time gap	14801.00	18285.64	15844.95	31099.21	27991.60	38809.27

activities was higher and closer to the condition of the videos. Thus, at least, it is highly possible that the instructions (whether emoticons could be used or not) have influence on emotional expressions, and the use of emoticons might be a key factor caused these differences.

4.3. The commonality of emotional activities between countries in CMC

4.3.1. Comparison of data from the two countries

To confirm whether significant differences in emoticon use and facial activities exist between the two countries, we conducted calculation and comparison. However, we obtained no data showed such differences.

First, we analyzed data of facial activities from both countries. We could not find significant difference in %iEMG data between two countries by group comparison on zygomaticus major ($t = 0.054$, $df = 44$, $p > .05$), nor on orbicularis oculi ($t = 0.115$, $df = 44$, $p > .05$). And none of the analyses we made in 4.2 showed any difference between countries. Therefore, it is highly possible that when strong emotional stimuli appear in CMC, users' facial activities show commonality on a certain level. Although there were differences in timing and intensity of muscle activities among individuals, none of them could show any pattern varied between countries.

Secondly, we compared data of emoticon use between the two countries. Emoticon use is not a physiological method like facial expression. Thus, there should be no physiological commonality in using them. However, we obtained no data showed significant difference between the two countries. We confirmed 9 times of emoticon use on average from Japanese samples, and 11.96 times from Chinese samples. Chinese participants used more emoticons on average; however, the numbers were very close. No significant difference in the numbers of emoticon used could be found by group comparison between the two countries ($t = 1.382$, $df = 44$, $p > .05$). We also conducted analysis about the meaning of emoticons used in chats. We confirmed 8.5 times of positive meaning on average from Japanese samples, and 10.2 times from Chinese samples. No significant difference could be found by group comparison ($t = 1.382$, $df = 44$, $p > .05$). The emoticons showed other meaning like "sarcasm" and "confusion" were also found in both countries. Thus, we consider that the commonality may not only exist in facial expressions, but also in emoticon use.

4.3.2. The context in which emoticons were used

If we want to confirm the commonality of emotional activities in CMC, We need to know the context in which emoticons were used. We confirmed the messages used before and after each emoticon use, tried to discover whether patterns existed in these messages.

We found three patterns appeared many times in both countries. And as mentioned in 4.2.1, there were also emoticons used alone without messages. We consider it as an independent pattern, too. There were 402 times of emoticon use related to them. One of the patterns appeared mostly when participants shared their experiences. Especially when they had a chat about their particular experiences other people might not know. There were 195 times of emoticon use related to this pattern. Under the circumstance, most emoticons were used to show positive emotions; however, some of them were with meanings of "puzzled", "shy", "cautious", etc. The second pattern was confirmed on the occasion that participants had same opinions with each

Table 3 Patterns of Emoticon Use

			Japanese				Chinese			
			Chat 1		Chat 2		Chat 1		Chat 2	
Patterns			Zyg	Orb	Zyg	Orb	Zyg	Orb	Zyg	Orb
when sending	1. experience sharing	times of occurrence	36		51		45		63	
		mean of %iEMG	3.53	2.11	3.16	3.54	3.77	3.09	2.91	3.92
	2. agreement expressing	times of occurrence	13		18		19		32	
		mean of %iEMG	4.21	3.80	4.92	4.77	3.56	5.17	3.33	3.95
	3. joke in a brief reply	times of occurrence	11		21		18		29	
		mean of %iEMG	2.81	2.72	3.41	2.68	2.92	3.01	2.70	2.14
	4. emoticon only	times of occurrence	13		7		10		16	
		mean of %iEMG	2.03	1.54	1.31	1.89	2.58	1.88	1.46	1.26
	5. other usages	times of occurrence	7		21		17		38	
		mean of %iEMG	1.43	1.53	1.57	1.41	2.13	1.86	1.47	2.10
when receiving	1. experience sharing	times of occurrence	36		51		45		63	
		mean of %iEMG	3.19	2.70	2.75	2.85	3.31	2.76	3.99	2.69
	2. agreement expressing	times of occurrence	13		18		19		32	
		mean of %iEMG	3.46	4.46	4.16	4.02	2.15	3.22	5.04	2.93
	3. joke in a brief reply	times of occurrence	11		21		18		29	
		mean of %iEMG	2.31	1.81	3.11	2.47	2.88	2.51	2.65	1.74
	4. emoticon only	times of occurrence	13		7		10		16	
		mean of %iEMG	1.47	2.84	1.82	1.32	1.75	2.09	2.01	1.44
	5. other usages	times of occurrence	7		21		17		38	
		mean of %iEMG	1.70	1.32	2.76	1.39	1.21	2.27	1.11	1.12

Zyo = Zygomaticus major. Orb = Orbicularis oculi other. Especially when they chatted "me, too", emoticons were used very often. There were 82 times of emoticon use related to this pattern. It added emotional information into the chats, and made the conversation more dramatic than just saying approval. The third pattern was confirmed when participant made a joke in a brief reply. All the replies confirmed were under 8 words after translated into English. Emoticons with meanings of "exciting" and "sarcasm" were found many times in those replies. There were 79 times of emoticon use related to this pattern. The emoticons used alone without messages were confirmed 46 times. We confirmed more appearance of these four patterns in Chinese samples. However, if we consider the number of Chinese participants was bigger than Japanese, the appearances of these patterns in two countries are possibly closer than data showed. Thus, we believe participants from the two countries have these patterns in common. There were also some other usages of emoticons (83 times in total) could not be categorized or only appeared a few times, like emoticons used in greetings. The overall result was showed in Table 3 (%iEMG range of 111%～517%).

We calculated the mean %iEMG values in each time of sending (time from the beginning of typing messages to the click on the sending button) and receiving emoticons (time from the moment when messages were received to the start of typing messages for reply) of these patterns. These values were compared with mean %iEMG values of the chats in which the patterns appeared. As the result of comparison in situation of sending emoticons, in 255 times (157 times in pattern 1, 56 times in pattern 2 and 42 times in pattern 3), higher values emerged when the first three patterns appeared. In 101 times, we obtained lower values. In only 16 times, higher values emerged when emoticons were used alone without messages. In only 14 times, we obtained higher values in other usages of emoticons. Data of the occasion when receiving emoticons showed a similar result, in 231 times (126 times in pattern 1, 46 times in pattern 2, and 59 times in pattern 3), higher values emerged when the first three patterns appeared. In 125 times, we obtained lower values. In only 19 times, higher values emerged when emoticons were used without messages. In only 9 times, we obtained higher values in other usages of emoticons. Because the result of comparison differed very little between two muscles, in order to give a more accessible image, data showed above was calculated as the average times of data from two muscles. The result revealed that stronger facial activities emerged in first three patterns. It is testified by group comparison of the %iEMG values on zygomaticus major between the first three patterns and last two ones when sending (Japan: $t = 30.563$, $df = 173.618$, $p<.05$; China: $t = 37.423$, $df = 245.727$, $p<.05$) and when receiving messages (Japan: $t = 33.563$, $df = 129.875$, $p<.05$; China: $t = 31.696$, $df = 282.590$, $p<.05$). The difference is testified on orbicularis oculi, too (when sending, Japan: $t = 34.587$, $df = 165.073$, $p<.05$; China: $t = 28.207$, $df = 280.399$, $p<.05$; when receiving, Japan: $t = 11.385$, $df = 196$, $p<.05$; China: $t = 38.264$, $df = 227.721$, $p<.05$). We also compared the time data of the first three patterns with the frequency data (time when peaks appeared) mentioned in 4.2.3. We found at least one time of peak appearance in 117 times of these patterns. Thus, we believe relatively strong facial activities did emerge in these patterns.

Because these patterns (especially the first three patterns) were found in chats of both countries, to some extent, it explained why we could not obtain any data showing significant difference between countries. In the three patterns, more obvious emotional activities were found from data of both countries. Thus, the context in which emotional activities improved showed commonality at some level.

4.4. Result of the additional experiment

To confirm possible influence from factors varying with time axis change, like fatigue or concentration, a small-scale experiment was conducted as an adjunct. It was basically the same as the main experiment; only the order of no-instruction and inhibited-use instruction was swapped. Correlation of %iEMG data between video and chat showed lower values under inhibited-use instruction on both muscles. To be specific, on zygomaticus major, the r-values were 3.30 under inhibited-use instruction, 4.53 and 5.32 when emoticons were allowed to be used. And on orbicularis oculi, they were 5.25 and 4.87 when emoticons were allowed to be used; significance of correlation could not be found under inhibited-use instruction ($r = 3.58$, $p > .05$). Data of frequency showed lower values under inhibited-use instruction, too. Significant difference of times/min value was found by group comparison between the inhibited-use construction and no-instruction on zygomaticus major ($t = 1.933$, $df = 22$, $p < .05$); and on orbicularis oculi ($t = 2.126$, $df = 22$, $p < .05$). It was also found between the inhibited-use construction and amplified-use instruction on zygomaticus major ($t = 2.692$, $df = 22$, $p < .05$); and on orbicularis oculi ($t = 2.571$, $df = 22$, $p < .05$). No Significant difference was found between no-instruction and amplified-use instruction, not on zygomaticus major ($t = 0.103$, $df = 22$, $p > .05$) nor on orbicularis oculi ($t = 0.087$, $df = 22$, $p > .05$). Data above indicated no evidence of influence from fatigue or concentration. Neither could we find evidence showing such possibilities by electromyography curves observation or getting such report from our participants. Although other variables might exist, our data still showed much evidence supporting our hypothesis.

5. Discussion

The analyses above lead us to a high probability that richness of nonverbal methods is a factor greatly influencing emotional activities. Although we found many differences among instructions, most were between Chat 3 and Chats 1 and 2. The difference we found between Chats 1 and 2 was very small. This result suggests that the number of emoticons used were not strong enough to be an important factor in emotional activities.

Under no-instruction and amplified-use instruction, %iEMG data showed a higher correlation of facial muscle activities between video and chat parts. We believe the emotional activities caused by video stimuli did not simply disappear in chat parts. And they could be expressed more easily when emoticons were allowed to be used (4.2.2). This hypothesis is based on not only our results but also previous studies. According to Walther et al. (2001), when emoticons and text were used together, positive emotion could be communicated more easily, and CMC interpretation improved. Other research provided detailed information for us. Affective evaluation of emoticons seems to be an automatic process that has been analyzed by Event Related Potentials measurements (Comesañaa et al, 2013). In contrast, lack of a nonverbal method caused a more complicated situation when emoticon use was inhibited. Words and messages can also convey emotional information, however, in a verbal way. When participants could not use emoticons in Chat 3, part of the emotional expressions had to be verbally transferred. Words and messages include complicated information. This complication will cause difficulty in discriminating emotional information from other types. As mentioned in previous studies, the lack on nonverbal cues makes the miscommunication of emotion more likely (Perry, 2010; Byron, 2008). Thus, compared with using verbal and nonverbal methods together, this process of transferring nonverbal signals into verbal ones could be less efficient. We believe when messages could be used with a nonverbal method (emoticons), a more direct, less processed way of emotional expression appeared in our experiment.

During videos, our participants had no need to exchange information with others; thus, there was a natural condition with no process of transformation from emotions to words, messages, emoticons, or any other information. Under the circumstances, emotional expressions in facial activities were direct and efficient. We found that when emoticons and messages could be used together, the frequency of facial muscle activities was higher and closer to the frequency of those during videos (4.2.3). We also mentioned in 4.1 that no significant difference in %iEMG data was found among the three instructions by group comparison. Therefore, the differences caused by emoticon use exist in frequency, but cannot be simply reflected by the comparison of mean %iEMG value in general. Compared with words and messages, emoticons are closer to nonverbal methods; thus, transformation from emotion to emoticon is more efficient, and emotional signal recognition is eased. When emoticons could be used, participants' emotions could be expressed easily, and then new emotions could appear one after another. However, during the time when these emotions did not appear or when they did not appear obviously enough, the emotional activities emerged might not be stronger than under inhibited-use instruction. We believe it is the reason why the %iEMG value was not stronger in average than under inhibited-use instruction. It is not a simple mechanism that more emoticon use caused stronger facial activities. We believe it is more related to the efficiency of affective delivery and the process of transformation mentioned above. Of course, not all emotional activities were transformed into verbal or nonverbal information. This depends on the participants' judgments. In our experiment, because strong emotional stimuli (video stimuli) existed, the subjective demand of emotional expression should be enhanced. Thus, the chance of using emoticons became a more valuable and effective way of delivering emotional information. In contrast, under inhibited-use instruction, the inhibitory effects were also enhanced and affected participants stronger than in other situations. Under the circumstances, the complementary effect of verbal and nonverbal methods disappeared; low efficiency of emotional signal recognition could influence their judgments. If it was sensed by participants, part of the emotional expressions might even be canceled. We believe this is also one of the reasons why difference in frequency appeared among instructions.

When our participants used emoticons in context with some patterns, stronger emotional activities appeared much more than under other circumstances (4.3.2). Because this tendency was observed from both sending and receiving occasions, we believe the improvement of affective delivery was a mutual effect on both sides. The %iEMG values of emoticon use in the three patterns were recalculated by using the method introduced in 4.2.1 (mean %iEMG values in time from the participants' opening of the emoticon list to their click on an emoticon). In 191 times, emoticon use received higher values than mean %iEMG values; in 165 times it received lower values. Based on this result, we still cannot claim that as direct stimuli, emoticons promote emotional activities when participants were watching them. However, when emoticons and messages were used together in context mentioned above, evident improvement of emotional activities was confirmed. We selected some chats (150 times) with messages of experience sharing, agreement expressing and jokes randomly from Chat 3. Then the mean %iEMG values during sending and receiving messages were calculated with the methods mentioned in 4.3.2. We compared these values with the ones of Chats 1 and 2 introduced in 4.3.2. Significant difference of %iEMG values on zygomaticus major was found in sending occasions ($t = 11.198$, $df = 498.346$, $p<.05$) and receiving occasions ($t = 13.232$, $df = 463.282$, $p<.05$). Significant difference were found on orbicularis oculi in sending occasions ($t = 9.859$, $df = 482.693$, $p<.05$), but not in receiving occasions ($t = 1.032$, $df = 504$, $p>.05$). However, the mean value of data in Chats 1 and 2 (2.78) was found higher than in Chats 3 (2.56) when receiving. Thus, possibly, the obvious improvement of affective delivery mentioned above could not be caused by using emoticons or messages independently. When verbal and nonverbal methods could be used together, the richness of information improved. We believe it brought efficiency and smoothness to affective delivery.

Furthermore, we obtained no data indicating significant differences of facial activities or emoticon use between countries. We even found certain patterns of emoticon use from two countries in common. Although emoticon use is not an innate method of nonverbal communication, it has functional similarity to facial expressions (Comesañaa et al, 2013). And some social factors—e.g., education level—do not significantly influence facial activities (Cacioppo et al, 1992). We believe that under strong emotional stimuli, emoticon use can show features similar to facial activities.

6. Conclusions

As the conclusion of this study, we consider it is highly possible that richness of nonverbal methods is a key factor affecting emotional activities in CMC. We also believe that in certain situations emoticon use and facial activities in CMC can show features in common between different countries on a certain level. However, because this study is based on samples of Japanese and Chinese college students, results might not generalize to users' conditions in other counties. It is a limitation of this study. As mentioned above, some other nonverbal methods such as "Stamp" in LINE could not be included in this study. It is not because they are not important. Some of them are widely used and may have their own features as nonverbal methods. We believe it is necessary to find a more appropriate way to do research on these methods in future. We also realized that not all people can be influenced by emoticon use on the same level, some people who are not used to CMC or using emoticons may show different result. We believe the discussion of more detailed information like above is necessary in future study.

In our study, we used fEMG measurements to record and analyze emotional activities emerged in CMC. It made the use of two nonverbal methods intercomparable and with calculating practicability. Detailed comparisons were conducted among different instructions, patterns and specific occasions. We believe this method can provide accuracy and logicality to CMC study. As mentioned in the beginning, in the information society, the innate methods and computer mediated ones will be both functional in many occasions. People are getting used to fusing and combining these methods so that they can take full advantage of using them. We believe our study provided a feasible method of analyzing the interaction between these methods. And we wish our works can inspire more research in this area.

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