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Conveying Emotions Through CMC: A Comparative Study of Memoji, Emoji, and Human Face

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Abstract

Emojis and avatars are widely used in online communications, but their emotional conveyance lacks research. This study aims to contribute to the field of emotional expression in computer-mediated communication (CMC) by exploring the effectiveness of emotion recognition, the intensity of perceived emotions, and the perceived preferences for emojis and avatars as emotional expression tools. The following were used as stimuli: 12 photographs from the Yonsei-Face database, 12 Memojis that reflected the photographs, and 6 iOS emojis. The results of this study indicate that emojis outperformed other forms of emotional expression in terms of conveying emotions, intensity, and preference. Indeed, the study findings confirm that emojis remain the dominant form of emotional signals in CMC. In contrast, the study revealed that Memojis were inadequate as an expressive emotional cue. Participants did not perceive Memojis to effectively convey emotions compared with other forms of expression, such as emojis or real human faces. This suggests room for improvement in the design and implementation of Memojis to enhance their effectiveness in accurately conveying intended emotions. Addressing the limitations of Memojis and exploring ways to optimize their emotional expressiveness necessitate further research and development in avatar design.

Key words: Computer Mediated Communication (CMC), Memoji, Emoji, Avatar, Emotion

1. INTRODUCTION

Emotional expression is fundamental in human social interaction (Aldundante et al., 2018), as emotional information impacts the way people understand each other (Pessoa, 2009). In face-to-face (F2F) communication, we share emotions through nonverbal cues such as facial expressions (Haxby et al., 2002), gestures (Stekelenburg & de Gelder, 2004), or vocal pitch (Heilman et al., 1984). From those, facial expression is the main universal nonverbal communication method to convey emotions (Ekman & Friesen, 2003).

In our technologically advanced age, most of our social communication is not F2F, but rather non-face-to- face, i.e., computer mediated communication (CMC). Now, various CMC platforms such as Instant Messaging and social networking service (SNS) has become the major form of communication that people use in a daily basis. In this mode of communication, it is difficult to utilize the cues that we have traditionally used to express emotion. This lack of nonverbal cues has led communication between people to be easily misunderstood (Kiesle et al., 1984).

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As so, people have looked for figurative representations to help and supplement emotional expression in CMC.

One commonly used emotion expression cue in CMC is emoticons, often referred as emojis (Tossell et al., 2012). The term emoticon comes from the combination of the words 'emotion' and 'icon' and refers to a graphical representation of a facial expression that is inserted next to a text message (Kaye et al., 2017). Initially, emojis were simply an arrangement of typographical symbols (e.g., :-) or ^_^), but with the advancement of graphic technology, today's emojis are available in various graphical styles and are available in both still image and animated forms. As of 2020, there are a total of 3,304 different types of still emojis registered in Emojipedia (http://emojipedia.org/). The majority (88.89%) are representations of human facial expressions (Rodrigues et al., 2018).

According to Kaye et al. (2017) the two core functions of emojis are (i) to express emotion and (ii) to ambiguity in messages. This study aims to explore the first function, emoji's ability to express emotions. Graphical emojis are now widely used to express and convey emotions in CMC, but paradoxically, little is known about how emotions are recognized in emojis compared to other modes of emotional expression, including facial expressions (Cherbonnier & Michinov, 2021). This is because most of the existing research on emotional communication has focused on the effectiveness of recognizing emotions from facial expressions represented in photographs or videos. Brechet's (2017) study comparing real face photos to face drawings found that participants were better at recognizing emotions in face drawings. On the other hand, a study by Oleszkiewicz et al. (2017) found no significant difference in emotion recognition between real face photos and graphic emojis. The results of these comparative studies are mixed, and the lack of clear-cut findings suggests that further exploration is needed in effective emotional cues in CMC.

The investment on emotional cues in CMC has progressed that the application of facial graphics also extended to avatars, which are computer-generated characters that represent the user in online interactions (Nowak & Fox, 2018). Avatars have become prominent in our lives: from being used for human-computer interactions (Heyselaar et al., 2017) to virtual team communication (Van Der Land et al., 2015), it can be induced that avatars are commonly used in a communicative manner. Avatars are acknowledged to have remarkable facial expressions that help convey emotions (Antonijevic, 2008; Koda et al., 2009) where even facial mimicry in both avatar-avatar and human-avatar settings are found as effective (Suda & Oka, 2021). Now, avatars have become highly diverse as many companies created their own avatars. A few examples bought from Suda & Oka (2021) would be Bitmoji by Snap (https://www.bitmoji.com/), Facebook Avatar by Facebook (https://www.facebook.com/help/278747370042382), LINE avatar by LINE (https://linecorp.com/ja/pr/news/ja/2020/3427), Memoji by Apple (https://support.apple.com/en-us/HT208986), and MetaHuman by Epic Games (https://www.unrealengine.com/en-US/digital-humans). Of avatar platforms, Memoji directly captures the facial features through the camera of the device, which allows it to generate rich facial expressions. Indeed, Memoji users feel that the Memoji best expressed them (Herring et al., 2020).

Like emojis, although studies have found that avatars are capable and thus is a unique way of communicating emotion, there is lack of research on the efficiency of emotion recognition with avatars. In this paper, we specifically focus on Apple's Memoji to determine its rich emotional conveyance as it claims. From what the authors know, only a recent study done by Park & Suk (2022) have researched its emotion recognition, which found that Memojis were less efficient in communicating emotions than photography. Consequently, it would be noteworthy to compare the two modes of graphical expression with the original form of emotion expression, human face. The purpose of this study lies in investigating the emotion recognition effectiveness of tools utilized as emotional expression cues in CMC, which has become the center of human social communication. In the identification of emotional expression, it is important to consider emotional intensity, as the intensity of facial expressions partially explains the accuracy of emotion recognition (Wells et al., 2016). Lastly, an additional point of interest lies in perceived preferences, as it raises the question of whether the most effective emotional cue is also the most preferred by its users. Taken together, we aim to contribute to the field of emotional expression research in CMC by exploring the effectiveness of emotion recognition, the intensity of perceived emotions, and perceived preferences for emojis and avatar as emotional expression modalities. Here, facial expressions will be used as a standard reference point as it has been extensively reviewed in previous literature.

We believe that it is reasonable to assume that emojis may be the easiest to recognize features that convey emotion because they have less information to process than faces or avatars, due to their simplified characteristics (Cherbonnier & Michinov, 2021). Therefore, we expect that the quality and intensity of emotion recognition will be highest for emojis, followed by avatars, and finally real human photos. Finally, since the appearance of avatars and human photos are personalized and are highly subjective, we expect that emojis designed as universal cues will be most preferred out of the three.

This study was conducted with the following hypotheses:

H1. The quality of emotion recognition will be the highest for emojis, followed by avatars, and finally real human photos.

H2. The intensity of perceived emotion will be the highest for emojis, followed by avatars, and finally real human photos.

H3. Emojis will have the highest preference compared to avatars and human photos.

2. METHOD

2.1. Design

This study was conducted with the approval of Yonsei University, in compliance with the guidelines and regulations of the university institutional review board (IRB no. 7001988-202307-HR-1755-03) for the method. A full within-subjects study was conducted to compare emotion recognition, perceived intensity of emotion, and perceived preference. There were three conditions in this study: Photo, Memoji, and Emoji.

2.2. Participants

The required sample size calculated with G*Power indicated a sample size of 45, based on α = .05, power = 0.95, with a moderate effect size of 0.25. We recruited 147 participants by posting an online survey on the Yonsei Psychology recruiting database, Yonsei Sona System. Excluding the dropout rate and insincere responders found from screening, a final sample of N = 130 participants (43 male, 87 female), who were mainly undergraduate psychology students of Yonsei University took part in this study. The total mean age was 21.03 years old (*SD* = 2.05; range = 18-29). All participants voluntarily participated in this experiment and received course credit for participating in the study.

2.3. Stimuli

We created an online survey with Qualtrics to present 30 stimuli: 12 photographs, 12 Memojis, and six iOS Emojis. It is known that there are six basic human emotions: anger, disgust, fear, happiness, sadness, and surprise (Ekman & Friesen, 1971). These basic emotions are distinctive and universal in nature which allows them to be communicated and understood across cultures. Thus, all stimuli were created based on the six basic human emotions. See Fig. 1 for all stimuli used in this study.

Photo. A total of 12 photos were used. One male model and one female model was randomly chosen from the Yonsei-Face database. Six photographs of each of a single male and female modes were used. The chosen models' ethnicity was Asian with similar in age with the participants. This was because individuals are better at recognizing emotions in the facial expressions of in-

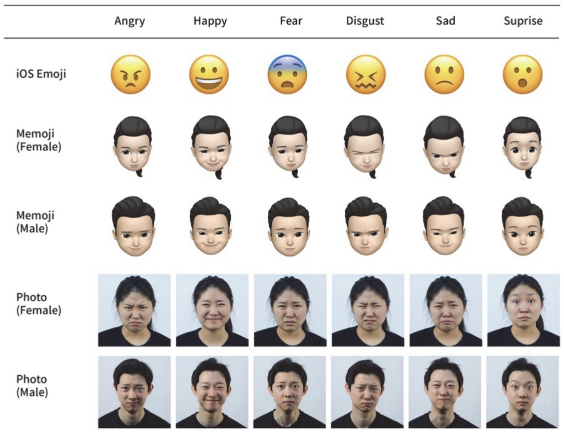

Fig. 1. Image of all stimuli used in this study

group members compared to outgroup members (Young & Hugenberg, 2010). Photo stimuli were all photo-shopped into 5.0 cm × 5.0 cm in size.

Memoji. A total of 12 Memojis were created. We first created the physical appearance of the Memoji very similar to the models. The generated Memojis were cross-checked so that they resembled the models from the Yonsei-Face database. Then, the photos of the selected models were put up on screen, while an iPhone with Memoji creator opened was set up on a stand making it possible for the Memoji creator to recognize and mimic the exact facial expression of the photo stimuli. The core functionality of Memoji lies around real-time facial recognition and machine learning, enabling precise replication of the user's facial features. Meaning, we produced the facial expression of Memojis from the Yonsei-Face database, which had previously been verified for emotional accuracy. Last, the screen shots of the Memoji's mimicked facial expressions were took and were all photoshopped into 5.0 cm × 5.0 cm in size. All the Memojis were made with iPhone 14 operated with iOS 16.5.

Emoji. A total of six iOS emojis were used. iOS emojis were chosen as they are considered morecaesthetic, and clearer than Android emojis (Rodrigues et al., 2018). Emotion- specific emojis were chosen according to the previous study by Cherbonnier & Michinov (2021), Rodrigues et al., (2018) and Franco & Fugate (2020). Emojis common to all three studies were priotized (happy, surprised, anger); then for selection of sadness and fear, the emojis were common for Cherbonnier & Michinov (2021) and Rordrigues et al. (2018) was chosen. Last, for disgust emoji, we adopted the same emoji used by Cherbonnier & Michinov (2021) as they were pre-tested for validation. Emoji stimuli were also photoshopped into 5.0 cm × 5.0 cm in size.

2.4. Measures

Screening was first done by asking participants to evaluate the stimuli itself, (i.e., 'Is this a real human face?') where 1 = yes and 2 = no. If participants did not meet 50% of the screening questions correctly, they were excluded from analysis.

Emotion recognition. Emotion recognition was measured with the paradigm used by Cherbonnier & Michinov (2021). The participants were asked to choose the corresponding emotion that the stimuli depicted in a list of 14 emotions, including the six basic emotions and filler adjectives, which were secondary emotions. Each emotion was coded by 0 (not recognized) or 1 (recognized). The difference we took in our study was that while Cherbonnier & Michinov (2021) added the recognition scores to a total of 6, as we did not compare gender differences, we averaged the recognition score, resulting in a recognition score of a range of 0 to 1.

Intensity. Intensity was also measured as how Chebonnier & Michinov (2021) has done, where participants answered one item asking them to indicate how strongly the stimulus represents the emotion it was conveying. A 7-point Likert scale was used to measure intensity, where 1 = very low intensity to 7 = very high intensity).

Perceived preference. Perceived preference of stimuli was measured by the five-item preference scale originally made by MacKenzie & Lutz (1989). In this study, we use the Korean translated version by Kim & Hwang (2020). Participants responded to five sets of questions, using a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree).

2.5. Procedure

The present study was built on Qualtrics and was distributed as a form of survey. Participants first read and accepted the participant information and informed consent. Then they saw each graphical stimulus, while the order of the graphical stimulus presentation was randomized. With viewing the stimuli participants had to answer seven items: one screening, one emotion recognition, one intensity of emotion, and five perceived preference. In total, participants saw 30 stimuli. After participants had finished seeing all the 30 stimuli, they filled three demographics questionnaire items: age, gender, and Yonsei Sona System ID for credit. The survey was made of total 243 items, where completing the whole experiment took about 40 minutes.

3. RESULTS

All statistical analyses of the data were performed using JASP (Jeffreys's Amazing Statistics Program) software. Repeated measures analysis of variance (RM ANOVA) was performed with experimental condition as the within-subjects factor.

3.1. Emotion Recognition

The overall *F*-test identified that there were statistically significant differences in emotion recognition between the experimental conditions, $F(2, 258) = 550.85$, $p < .001$, $\eta_p^2 = .81$. Bonferroni post-hoc comparisons revealed that emojis were better recognized in the following order: iOS emoji, followed by photo, and then Memojis, which is visualized in Fig. 2. See Table 1 for mean and standard deviations.

To see if specific emotions elicit different responses, relative post-hoc comparisons were completed. The results showed that individual emotions had a significant effect, $F(5, 774) = 210.25$, $p < .001$), with happiness ($M = 0.81$, $SD = 0.01$) and surprised ($M = 0.78$, $SD = 0.01$) being the most recognizable emotion and fear ($M = 0.17$, $SD = 0.01$) being the least recognizable. The interaction between stimulus and emotion was also significant, $F(10, 1548) = 49.94$, $p < .001$). Post-hoc analy-

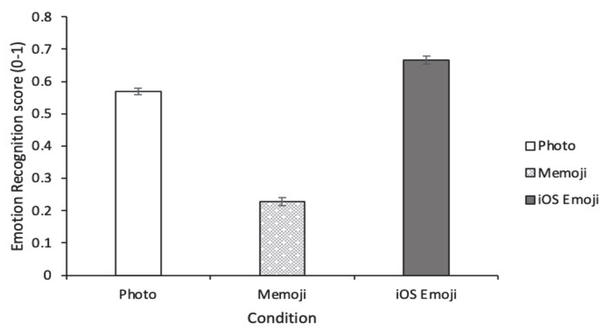

Fig. 2. Mean of emotion recognition scores for photo, Memoji and iOS emoji. Error bars reflect standard errors

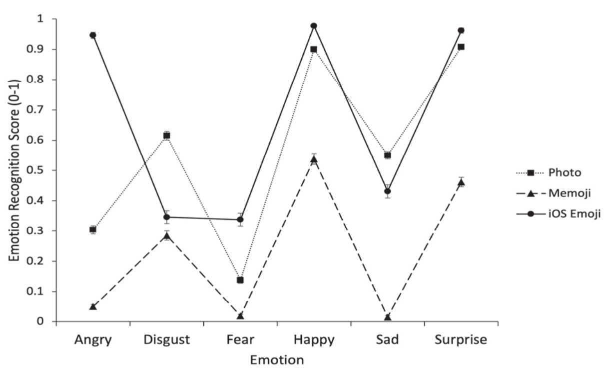

Fig. 3. Mean of emotion intensity ratings for photo, Memoji and iOS emoji by speciifc emotions. Error bars reflect standard errors

Table 1. Means, standard deviations, and RM ANOVA results

Measure	Photo		Memoji		iOS Emoji		*df*	*F*	η_p^2	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*				
Emotion Recognition	0.57	0.13	0.23	0.14	0.67	0.15	2	550.85	.81	<.001
Intensity	5.15	0.62	3.34	0.66	5.46	0.80	2	772.11	.86	<.001
Perceived Preference	3.05	0.93	3.09	0.96	3.91	1.15	2	65.34	.34	<.001
Residual							258			

Table 2. Descriptive statistics for post-hoc comparisons

Cond	Emotion	*M*	*SD*
Photo	Angry	0.30	0.31
	Disgust	0.62	0.33
	Fear	0.14	0.24
	Happy	0.90	0.22
	Sad	0.55	0.28
	Surprise	0.91	0.20
Memoji	Angry	0.05	0.16
	Disgust	0.29	0.36
	Fear	0.02	0.12
	Happy	0.54	0.42
	Sad	0.02	0.11
	Surprise	0.46	0.36
iOS Emoji	Angry	0.95	0.23
	Disgust	0.35	0.48
	Fear	0.34	0.48
	Happy	0.98	0.15
	Sad	0.43	0.50
	Surprise	0.96	0.19

sis showed that emojis were effective in recognizing emotions in general, yet when closer look was taken to compare emojis and photos, it could be seen that the high recognition scores were specifically due to angry ($p < .001$) and fear ($p < .001$) emotion. For happy, sad, and surprised emotions, no significant differences were found in the recognition score between photos and emoji conditions (all $p > 1.0$). There were also instances where emoji did not perform better than photos, which was disgust ($p < .001$). Meanwhile, Memoji showed a very low performing rate, as clearly visible in Fig. 3. Interestingly, Memoji performed similarly (no significant differences were found) in emotion recognition with fear ($p = .14$) when compared with photos, and disgust ($p = 1.00$) when compared with emojis. See Table 2 for mean and standard deviations.

3.2. Intensity

There were statistically significant differences in intensity of emotions between the experimental conditions, $F(2, 258) = 772.11$, $p < .001$, $\eta_p^2 = .86$. Bonferroni post-hoc comparisons revealed that emotions were reported as intense in the same order as emotion recognition: iOS emoji, followed by photo, and then Memoji, which is visualized in Fig. 4. See Table 1 for mean and standard deviations.

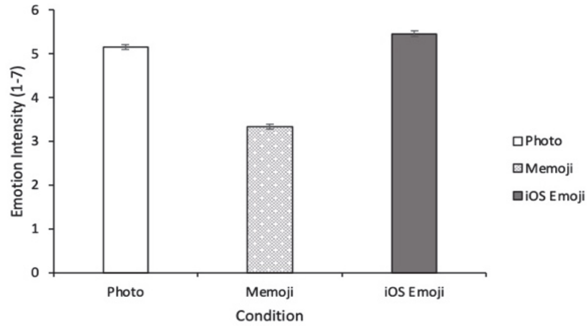

Fig. 4. Mean of emotion intensity ratings for photo, Memoji and iOS emoji by speciifc emotions. Error bars reflect standard errors

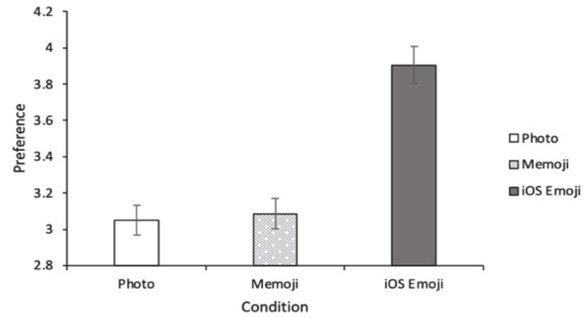

Fig. 5. Mean of perceived preference for photo, Memoji and iOS emoji. Error bars reflect standard errors

3.3. Perceived Preference

There were statistically significant differences in intensity of emotions between the experimental conditions, $F(2, 258) = 65.34$, $p < .001$, $\eta_p^2 = .34$. Bonferroni post-hoc comparisons revealed that iOS emojis as best preferred, as visualized in Fig. 5. There were no significant differences in perceived preference between photo and Memoji. See Table 1 for mean and standard deviations.

4. DISCUSSION

This study compared the recognization of emotion, perceived intensity of emotion, and perceived preferences of Memoji and emojis with human facial expression photographs as the baseline. Results from the study demonstrated that emojis are most effective in emotion recognition and are considered carrying the highest emotional intensity, followed by human photos, and finally, Memojis. Such results are in line with previous studies in finding emojis were quite successful at conveying emotions and therefore also reduces ambiguity in CMC (Chebonnier & Michinov, 2021; Dalle Nogare et al., 2023; Fischer & Herbert, 2021). The findings also suggest that, like facial expressions, the intensity of emotion can partially explain the accuracy of emotion recognition in emojis.

Throughout this study, happy and surprised emotions were recognized most accurately than other emotions, while fear emotion was the hardest to identify. This finding is consistent with previous studies reported in the literature, beginning with a study done on children. Oleszkiewicz et al. (2017) found that children were most accurate when identifying happiness and sadness, while disgust and fear was difficult. Happiness emojis are highly recognizable from iOS emojis (Jones et al., 2020), and Cherbonnier & Michinov (2021) designed 'new' emojis that also conveyed happiness very effectively than other mediums, including photographs. Furthermore, similar results were also reported in a reaction time study conducted by Fischer & Herbert (2021). They found that the fastest response times were observed for happiness and anger, followed by surprise, sadness, neutral, and finally, fear. The pattern of results, demonstrating consistent emotion response patterns for both emojis and real human faces, aligns closely with the findings of our study.

The high performance of iOS emojis can be attributed to their greater familiarity, exposure, and widespread usage in social media platforms (Chebonnier & Michinov, 2021). Indeed, iOS emojis are considered the most favorable and clear (Rodrigues et al., 2018). When looking into specific emotions, it could be induced that angry and fear emotion played a role in advantage of emojis' emotional conveyance. It should be noted that angry and fear emojis are slightly different compared to other emojis in the stimuli set in that they have more cues (eyebrows, color) for recognition. This result also fits with the results of Chebonnier & Michinov (2021), where participants were most successful in identifying negative emotions such as disgust and fear. For some emotions (happy, sad, and surprised), emojis showed similar or little differences in effectiveness when compared with photos. Perhaps this is due to happy and surprised emotions being the easiest emotions to capture in overall. Another explanation could be done by how there is low agreement in which emoji represents an emotion category except anger (Franco & Fugate, 2020). The insignificant differences caused in happy, sad, and surprised emojis with photos could differ, or emojis may perform better when used with different emoji faces.

On the other hand, Memoji tends to show low performance in emotion conveyance, intensity, as well as perceived preference. Despite Apple's Memoji claims to be high-performance facial expression replicators (Suda & Oka, 2021), the result of this study implies that the exact mapping still needs development. Memoji being unable to convey emotions are very in line with the results of the study done by Park & Suk (2022), where they specifically found Memojis were capable of only happy, sad, or disgusted emotions, while remaining emotions are uncertain. Park & Suk (2021) explain the cause of Memoji being insufficient as to its typical features being a cartoonist style that may have hindered or biased the emotion conveyance. This is possible as Memojis tend to have big eyes, flawless skin, and rounder facial shape which are attributes to cuteness. If Memojis are considered cute, cuteness can hinder emotion recognition: people may perceive something cute as merely playful, whimsical, or less serious (Jia et al., 2015).

Through examining each emotion recognition scores separately, the current study found that fear and disgusted emotions were the only two emotions that could play similar level of conveyance to other modes of emotion expression. Specifically, participants rated fear Memojis had with no significant differences with fear photography and that disgust Memojis had no significant differences with disgust Emojis. It is noteworthy that at some instances, Memojis could be equally as expressive as photos and emojis. This result did not precisely align with those of the earlier research conducted by Park & Suk (2022) as they found that only happy, sad, and disgusted emotions were effective in Memojis. The divergence in results could be attributed to the diverse stimuli utilized by Park & Suk (2022) in comparison to our study. Their research employed a blend of cultural models, including both Japanese and Caucasian individuals, as stimuli. This diversity in stimuli may have played a role in the differing recognition rates observed, even though both studies involved Korean university students as participants. Again, it is important to note that in general, Memojis still fall short of conveying the intended emotion through facial expressions compared to photos or iOS emojis. Moreover, what essentially affects the Memoji to convey intended emotion remains unclear. Thus, to further acknowledge the emotional expressivity of Memoji, there is need for further research.

Finally, it seems that most effective emotional cue is also the most preferred by its users, as emojis were significantly preferred by the participants of this study. Again, it may be due to iOS emojis being familiar to the participants as people use it frequently. Nonetheless, it is important to note that the most important characteristic of avatar is that they are online representations of the self, the user (Suda & Oka, 2021). Memoji provides various possibilities in its avatars's visual appearance. However, in this study, to control for confounding variables, only a plain Memoji that replicated the looks of the model was used. As perceived preference ratings for Memoji can be biased due to personification, which tends to fall into subjective ratings, the low score may not exactly explain the exact preference on Memojis's design itself.

Up until now, comparisons of emotion expression were mostly done with emojis and photos. As this study also included avatars, there are some practical implications. First, as some argue, the inferiority of CMC is decreasing (Suda & Oka, 2021): this study found that emojis are perceived as more effective than photos in conveying emotions, suggesting that emojis can provide users with a means to express their emotions with fewer misunderstandings. Second, Memoji facial mapping system and design problems are identified. To minimize misunderstandings when using Memojis, it is crucial for designers to strive for generating emotion expressions that are accurate and easily understandable for the users. As avatars are mainly being used for communication online, this study provides some empirical evidence in the areas where avatars may lack in emotion conveyance. The findings of this study can serve as valuable insights for future avatar designers, enabling them to create avatars with graphical characteristics that effectively convey intended emotions. By incorporating these findings into avatar design, designers can enhance the emotional expression and communication capabilities of avatars, resulting in more engaging experiences for users.

Despite how this study contributed to the CMC literature, the current research only used one model for each gender. Using various models which would result in different Memoji characteristics would have contributed to more diverse results of this research. Likewise, only iOS emojis and Apple Memoji was used as well. It should be interesting to explore more various types of emojis and avatars to further investigate the viability of emotional tool avatars could be. Compared to other forms of avatar platforms, only Apple's Memoji may have performed particularly poorly. As more platforms are adopting their own versions of avatar, their emotion recognizability, intensity, and preference would be all different. Another limitation that should be considered is that there seems to be sociocultural differences in emotion recognition of Memoji. According to a cross-cultural study done by Park & Suk (2022, September), Koreans tended to confuse surprise and fear in Memojis while fear was clearly communicated to Americans. Just like emojis play differently in various cultures, avatars may show different aspects depending on participant's sociocultural background. Lastly, all the stimuli used in this study was static pictures. Dynamic stimuli have proven their value in recognizing emotional facial expressions (Tcherkassof et al., 2007), which makes the static stimuli used in this study more difficult to identify the dynamic features of facial expressions. As many avatar stickers are provided in a dynamic method where they can be processed as a streaming video, future study area would be examining the emotion recognition and intensity within dynamic emotional cues.

5. CONCLUSION

This study contributed to the field of emotional expression research in CMC by exploring the effectiveness of emotion recognition cues. Although emojis as emotional cues have been explored in previous research, they lack in concrete findings. Moreover, this paper incorporated the examination of avatars, which are often seen in online communication nowadays. This research demonstrated that emojis conveyed basic emotions more effectively than Memojis and real human photos. Emojis were also considered to carry more intensity and are preferred compared to photos and Memojis. Memojis tended to score low in all aspects compared to emojis and photos, which demonstrates that Memojis are insufficient to convey emotions. This study confirms that emojis are nevertheless dominant as emotional cues in CMC, and as Memojis are likely cause misunderstanding in emotion conveyance, development in new systems for conveying emotion through avatars are needed for better communication.

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