How to Evoke Empathetic Experience and Deepen Impression: The role of profile pictures in social media

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ABSTRACT

Profile pictures are perceived as a form of social identity and individuals often engage in similar categorization processes. Profile pictures in social media represent virtual identities in online social networks and embody personal impression. The influence of profile picture styles on empathy plays an important role in the design and user experience of social media. However, the potential impact of profile pictures with different image styles (e.g., cartoon faces, real faces, or non-face images) on the perception of users in social media is still unclear. To investigate this impact, a controlled laboratory experiment (48 participants) and an ecological online experiment (184 participants) were conducted. Results show that participants' empathic experience for users choosing cartoon faces or real faces as profile pictures are greater than that for users choosing non-face images. Besides, participants performed better in identity recognition for users choosing real face or non-face images than those choosing cartoon faces. Increasing empathic experience was associated with the degree to which users choosing profile pictures are categorized as ingroup members. Users of social media often make social categorizations (i.e., ingroup/outgroup categorization) based on the social identities expressed by their profile pictures. Our results also showed that increasing empathic experience was associated with the degree to which users choosing profile pictures are categorized as ingroup members.

Introduction

A profile picture is the image that represents a social media account in all its interactions across a platform; e.g., it is always displayed next to the account name on posts, comments and mentions. Most people use facial images as profile pictures to represent their identities on social media, as a face contains and conveys rich information, including gender, age, and race, etc.[1]. However, many users do not want to use their real face images as profile pictures on social media for some reasons, such as privacy protection, dissatisfaction with their appearance, etc. Instead, some non-real face images, such as cartoon-style face images meet users' needs for customizing their virtual identities. These cartoon-style images are usually generated by applying stylization algorithms to real-face images, which even increase expressiveness and attractiveness[2].

With the rapid growth of social networking sites (SNSs) in the past decade, it has dramatically changed the way people socialize, from face-to-face social interactions to online activities through computers or smartphones in virtual communities[3]. The communication devices of SNS have gradually shifted from personal computers to mobile terminals, making it easier for people to establish online connections. Due to the difficulties of face-to-face communication during the COVID-19 pandemic, online social networking has become the main way to maintain social relationships. At the same time, SNSs also increase users' willingness and possibility to establish social relationships with strangers. In online social networking, profile pictures provide important visual information which are chosen by SNS users to present themselves; this information plays an important role in forming the first impression of strangers, as well as social categorization evaluation from other users.

In recent years, researches on how avatars affect the users' social cognition have attracted increasing attention [8, 10, 12, 18–20, 25]. Some studies found that in social events, the use of an avatar can greatly affect the first impression that others may have of the users; e.g., a study showed that people who used sexualized avatars were always considered less physically attractive, less socially attractive, and less competent to complete tasks[4]. Other studies showed that avatars also significantly affect the trust in online markets[5] and mobile social commerce[6]. The choice of avatars may also affect interpersonal relationships in online social networking; e.g., changing a Facebook profile picture to dyadic photos has a positive effect on satisfaction of

partners' romantic relationship[7].

Considering that social categorization processes are based on visual features (e.g., facial cues, body cues) and top-down factors (e.g., social identity, stereotypes)[8], and individuals have a stronger empathic experience and deeper impression of others who are evaluated as the in-group members[9–13], it is interesting to see how profile pictures of real faces, non-real faces and non-face images differ in social categorization on social media, and how they affect empathy and identity memory.

In view of the above question, our goal in current research is to investigate the influence of different profile picture styles (real and non-real faces, non-face images) on the core abilities of social cognition: the ability to understand the emotional feelings of others and the ability to recognize identity. We explore the empathic and memorial effects of three image styles on users' cognition of the profile pictures; i.e., we use the landscape image style as the representative of non-face images and compare it with two styles of face images (real faces and cartoon faces). In this paper, we present a controlled offline study (Experiment 2) and an ecological online study (Experiment 2) to explore the influence of profile pictures with these three image styles on user's empathic experience and identity memory.

We make the following contributions in this paper. First, we investigated both the subjective evaluation of empathic experience and the cognitive performance of identity recognition in the user experience of social media. The results imply that the image style of profile pictures differentiates the process of influence on empathic experience and identity recognition. Secondly, our study introduces social categorization theory to explain the effect of image style on users' empathy and identity recognition in social media. Thirdly, we tested findings based on a strictly controlled laboratory experiment in Experiment 2 and simulated a situation of real social software usage in Experiment 2, which had good ecological validity, and the results of the study may directly bring insights to social media interaction studies.

Related work

In this section, we first provide a brief overview on the impact of profile pictures in social media. Next, we summarize previous works on empathy and identity recognition in social media.

The impact of profile pictures in social media

Users' choice of profile pictures in social media is an important way for users to present and construct themselves as avatars in virtual space, and profile pictures also play an essential role in establish users' personal appearance. Virtual affective avatars have been used for the treatment of people with social disorders[14]. Using dyadic photos as Facebook profile pictures also has a positive effect on partners' relationship satisfaction[7].

In the field of human-computer and human-robot interactions, the design of personas, which are fictitious, specific, concrete representations of target users, has been widely studied. A study suggested that people have a lower level of empathy and memory for illustrations compared to photographs[15]. However, people's ability to remember and empathize with action figures has no significant difference with real face images[16]. An experiment with 149 participants tested how the use of different image styles affects the user perceptions of personas[17]. In this study, personas whose pictures have seven degrees of stylistic representation of realism, from No Picture (NP) to Real Photo (RP), were presented to participants. This study found that pictures with higher realism can increase the participants' perceived clarity, completeness, consistency, credibility and empathy for personas.

Empathic experience and identity recognition in social media

People may establish social relationships with many new friends online. The effect of profile pictures on social cognition may affect the ability of users to remember new friends and understand their feeling, which further affects the quality and maintenance of these new social relationships. Empathy broadly refers to the ability to understand the feelings of others, and it is an emotion or a sensory state which may be the main motivator of prosocial behavior such as altruism and cooperation[18–21]. Empathy and identity recognition are central to successful social interaction. Recognizing the identity of other persons is an important ability in social interaction. In various information from different modalities, such as faces, voices, names, and biographical information, faces are widely used to distinguish individual's identity[1, 22, 23]. A study investigated users' capacity to identify their friends on social media from face images[24]. In this study, participants were asked to recall their friend's name using the friend's photo from Facebook. The results showed that on average participants could only accurately name 72.7 % of their Facebook friends, which is lower than the estimated percentage of whom participants knew in the real world. This study implies that people cannot accurately recall the identities of their online friends even when users are in contact with their online friends in the real world.

Profile pictures, which are figurative representations of the users, reflect the users' preferences[25–27]. A profile picture can be the object of ingroup/outgroup categorizations. For example, on Weibo (microblog in China), many fans use photos of their favorite idols as profile pictures. The profile pictures of fans are the basic condition for fans to identify ingroup and outgroup members. The initial perception and categorization of ingroup and outgroup members are social categorizations, which are

influenced by the bottom-up processes based on visual features and top-down factors. These social categorizations influence empathy and identity recognition, which are the core processing in social cognition[9–13].

After nearly a decade of development, online social networking has gradually shifted from personal computers to smartphone-based mobile devices, and people can easily establish connections through social media applications. Many friends on social media may rarely or never meet in the real world. Different from the previous researches, our research focuses on how profile pictures in social media are affecting empathic experience and identity recognition, as well as whether the effect is relevant to social categorization based on users' perception of profile pictures.

Methods

The goal of our research is to investigate how empathetic experience and identity recognition are influenced by the effect of the image style on users' perception of profile pictures. Profile pictures of two face image styles (real faces and cartoon faces) and non-face image style (landscape images) are used as visual stimuli. Participants were informed to suppose that the image they see is their friend's profile picture on a social media and imagine getting alone with him/her. Then each time an image was presented, the participants rated their empathic feeling based on perception on it. After the rating task, participants were asked to complete an identity recognition task by responding whether the profile picture appeared before, in which half of the profile pictures were presented in rating tasks, and another half of the profile pictures were new images that participants never saw before.

We conducted two experiments. Experiment 2 is to test whether different image styles of profile pictures in social media are different in inducing empathic experience and identity recognition in an offline experimental environment, where the presentation time of stimuli and other irrelevant variables are controlled. Experiment 2 better simulated the situation that people use social media in their daily lives, by making the following changes to Experiment 2: (1) profile pages in a social media was designed with which participants can complete an online experiment on their smartphones; (2) instead of a fixed amount of time, participants can decide for themselves the presentation time of stimuli; and (3) considering that the real online relationship with friends in social media usually undergoes a longer time span, in Experiment 2, the time interval between learning and recognition was extended to 24 hours. In addition, to explore whether the impact of profile pictures on empathic experience and identity recognition is related to people's preferences for profile pictures and social categorization based on profile pictures, we measured these two variables (i.e., preferences and social categorization) in Experiment 2.

All experiments were approved by the Institution Review Board of Tsinghua University (Project Number: 20220110). The IRB has reviewed the proposed use of human subjects in the above-mentioned project. The right and the welfare of the subject are adequately protected; the potential risks are outweighed by potential benefits. All experiments were performed in accordance with relevant named guidelines and regulations. All subjects signed the experimental informed consent before the experiment.

Creation of stimuli

The stimuli consisted of three styles of images as profile pictures: real face images, cartoon face images and landscape images Sixty frontal photographs of Asian male and female faces were found from Internet. All these face pictures were 500×500 pixels and only contained the face and shoulders, without face covers and other ornaments, such as glasses and earrings. Accordingly, the cartoon face images were transformed from these 60 real face images using a commercial Face Transformation Application with a consistent cartoon style. Since cartoon faces and real faces differ in intensity and expressiveness of different emotion types[28], all the faces in this study were neutral expressions in order to avoid the influence by these differences. In addition, 60 landscape images as non-face stimuli were found from the Internet and randomly divided into two sets.

In Experiment 2, to increase the diversity of stimuli, 12 images (one half were male faces and the other half were female faces; for landscape images, they were randomly divided into two sets) were randomly selected from 60 images of each style and presented to each participant for empathic experience rating. Another 12 images were randomly selected as new stimuli for the identity recognition task. Since the purpose of Experiment 2 was to further verify the effect of profile pictures on empathy and identity recognition in a scenario that more closely resembled how people use social media in their daily lives, we created the stimulus materials for Experiment 2 (see Fig. 1) by designing profile pages in social media. Using the material from Experiment 2, we created profile pages of 12 females and 12 males. If the profile pages used face images as profile pictures, the gender of the page accounts depended on the gender of the faces. If the profile pages used landscape images, half of the page accounts were randomly selected to be female accounts and the other half to be male accounts. The profile pictures were the same as those used Experiment 2, but the size was reduced to 60×60 pixels.
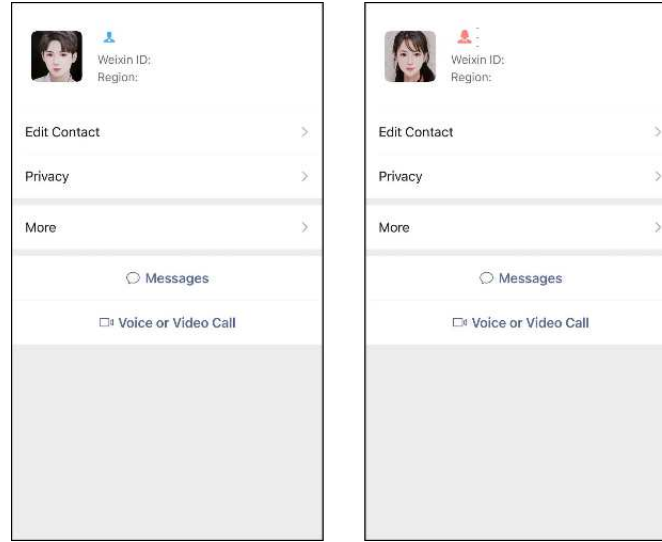
Figure 1. Examples of profile pages using cartoon face stimuli used in Experiment 2.

Measurement

Measurements of Empathic Experience

The definitions of empathy can be subdivided into two classes: one is an affective response to other's emotional state (affective empathy) and the other is the cognitive understanding of other's emotional states (cognitive empathy)[29,30]. Twelve items, half assessing cognitive empathy and the other half assessing affective empathy, modified from Basic Empathy Scale (BES)[29], were used to evaluate the empathic experience of participants on different styles of profile pictures. Participants were required to rate how well the items matched their feeling on 7-point Likert scale (1 = "strongly disagree", 7 = "strongly agree") about friends who appeared as profile pictures on social media. Half of the items were scored in a positive way (the higher score indicates stronger empathic experience) and the other half were scored in a negative way (the lower score indicates stronger empathic experience).

In our study, we instructed participants to "suppose that the picture is your friend's profile picture in a social media, and the sentence describes how you currently feel about that friend", and an item was rated for only one image in each condition. Therefore, we modify the measure used in the current study by replacing the word "people" and "friends" with third-person pronouns, i.e., "he/she" and "him/her" (see Table 1).

Table 1: Measurement items for empathic experience

No.	items	type	response
1	I find it hard to know when he/she is frightened.	Cognitive[a]	Negative[b]
2	When he/she is feeling 'down' I can usually understand how he/she feels.	Cognitive	Positive[b]
3	I can usually work out when he/she is cheerful.	Cognitive	Positive
4	I can usually realize quickly when he/she is angry.	Cognitive	Positive
5	I am not usually aware of his/her feelings.	Cognitive	Negative
6	I have trouble figuring out when he/she is happy.	Cognitive	Negative
7	After being with him/her who is sad about something, I usually feel sad.	Affective[a]	Positive
8	I don't become sad when I see him/her crying.	Affective	Negative
9	His/Her emotion doesn't affect me much.	Affective	Negative
10	Seeing him/her who has been angered has no effect on my feelings.	Affective	Negative
11	I tend to feel scared when I am with him/her who is afraid.	Affective	Positive
12	I often get swept up in his/her feelings.	Affective	Positive

Table 1.

[a] ∗∗∗ "Cognitive" means the item measured cognitive empathy; "Affective" means the item measured affective empathy.

[b] ∗∗∗ "Positive" means the item was scored in a positive way; "Negative" means the item was scored in a negative way.

Measurements of Identity Recognition.
The measurement how profile pictures affect the Identity recognition is a kind of signal detection. The signal detection theory can be used to determine two possible stimuli and where the participants can distinguish between signals and noise. The hit rate (the probability of responding yes on signal trials) and the false-alarm rate (the probability of responding yes on noise trials) fully describe performance on a yes/no task[31] and the accuracy equals to the sum of hit and correct rejections divided by the total number of all stimuli.

In recognition tasks, d' has been used to determine the degree of discrimination, usually called sensitivity (d'), between signal (old item: the profile pictures have been learned) and noise (new item: the profile pictures have not been learned). The d' is determined by the distance between signal and noise, and is calculated by subtracting the z score that corresponds to the false-alarm rate from the z score that corresponds to the hit rate ($d' = Z_{hits} - Z_{false-alarms}$).

Participants

The sample size in Experiment 2 was based on exploratory parameter estimation using the G*Power 3.1 (Version 3.1.9.7)[32] with a moderate effect size $f = 0.25$, $\alpha = 0.05$ and power = 0.8, and the estimated sample size was 28 for repeated measures ANOVA. To counterbalance the presentation sequence of three image styles, we recruited 48 participants (18 males, 30 females) with an average age of 20.91 years ($SD = 0.71$).

In Experiment 2, based on the same parameter estimation of Experiment 2, the estimated sample size was 159 for a fixed effect, one-way ANOVA. We recruited 184 participants (79 males, 105 females) with an average age of 22.18 years ($SD = 3.83$) from an online survey platform in August 2021, and randomly divided them into three groups: 63 participants (27 males, 36 females) assigned to the cartoon face group, 60 (27 males, 33 females) assigned to the real face group, and 61 participants (25 males, 36 females) assigned to the landscape image group. Data of 11 participants were excluded from the follow-up analysis because they did not complete the identity recognition tasks.

All participants in our study had normal or correct-to-normal vision, and they were provided with a consent form to review and sign before participating in the experiment. They earned an appropriate reward upon completion of the experiments.

Design and Procedure
Experiment 1
The whole experiment process was conducted on personal computers using the Python platform. The experiment was mainly composed of three parts (Fig. 2). At the beginning of each part, an instruction slide was showed to each participant. The first part was a questionnaire-based survey experiment, which collected responses from participants about empathy, emotion and recognition responses for each profile picture style. To measure empathetic experience, the participants were presented with a series of profile pictures with each picture followed a sentence describing about the empathetic feelings. Each trial began with a central fixation for 0.5s, then an image appeared for 2s, following a sentence from Basic Empathy Scale with 7-likert scale ranging from strongly disagree (1) to strongly agree (7). The participants were asked to imagine a scene that chatting online with friends who use these images as their profile pictures in their social media and then to rate the sentences respectively. Images of three types of profile pictures were presented in different blocks (12 images for each block) in a counterbalanced order across participants and images were presented randomly within blocks. After each profile picture, a sentence that randomly selected but not to be repeated from 12 sentences of the Basic Empathy Scale was presented.

The second part was emotional valence and arousal rating. The participants were presented with a series of images with each image last for 2s and then disappeared. Participants were asked to evaluate their feelings from the perspective of emotional valence and arousal when they saw these profile pictures and chose a number between 1-7 (1 = "extremely positive", 7 = "extremely negative" for emotional valence rating; 1 = "not intense at all", 7 = "extremely intense" for emotional arousal rating) according to the degree of their feelings. In this part, the sequence of appearance of images was the same as the empathy test.

The last part is identity recognition, 72 images (in three styles of profile pictures) were presented to the participants one by one. Among them, 36 images had appeared in the first two tests, and 36 pictures were newly selected from the materials. Participants were asked to judge as accurately as possible whether the image had appeared before.
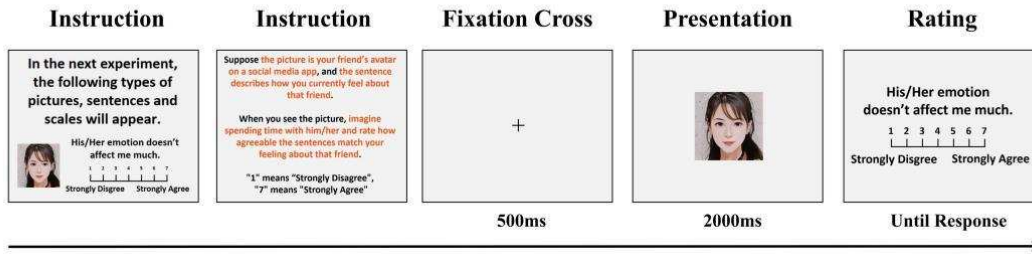
Experiment 2
In order to make the experiment more like a real-world experience, Experiment 2 (Fig. 3) used the single-factor between-subjects experimental design with three levels: real face images, cartoon face images and landscape images. In Experiment 2, we selected 24 images (12 from male accounts and 12 from female accounts) in each of three styles and presented them in a profile page of social media application form. Except for that gender information in the profile page, the information of name, id, and region were blurred for avoiding possible confounding effects. Consequently, 72 profile pages were created and used in this experiment.

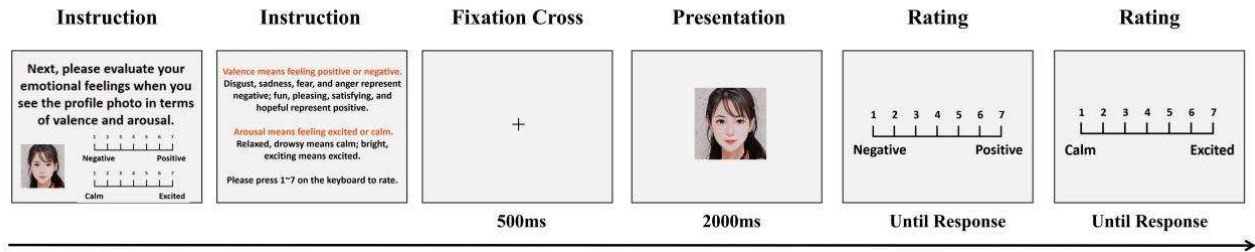Experiment 2 consisted of two parts, each followed three questionnaires which tested the effect of three types of profile pictures respectively. There were three sections in the first part of Experiment 2. The first section was designed to measure
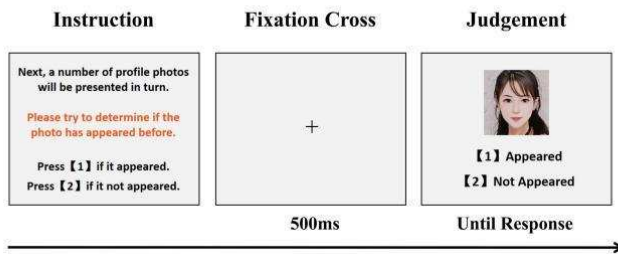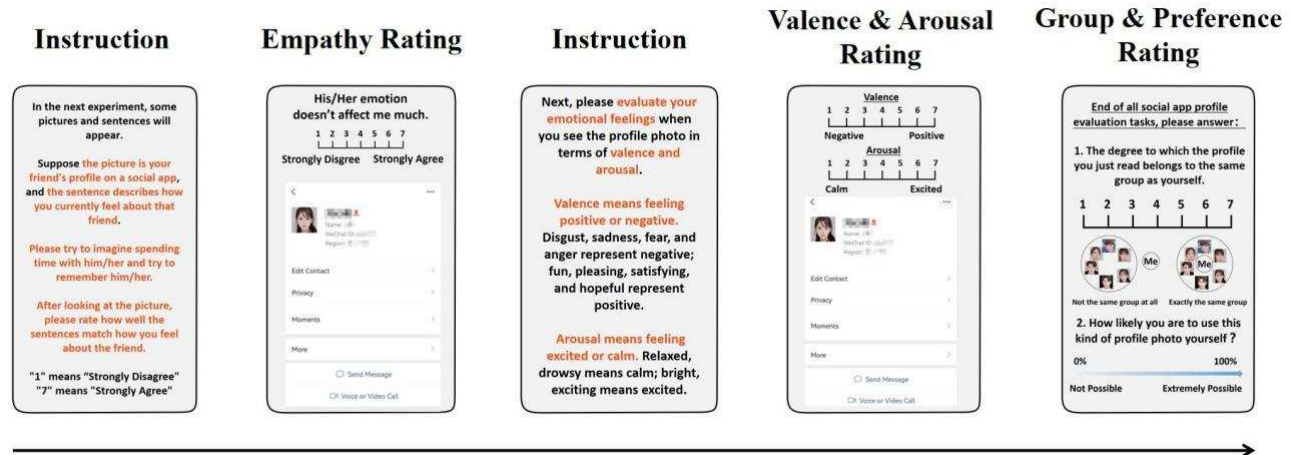
Figure 2. Flowchart of Experiment 2.

participants' empathy and the second section was designed to ask participants to rate emotional valence and arousal of profile pictures. In both sections, corresponding questions were presented. In the third section, participants were asked to rate the extent to which the people using the image as their profile pictures belonged to the same group as themselves (group rating) and how likely (preference rating) they would like to use this image as their profile pictures. The second part is a memory test. Participants were asked to determine whether the screenshots (12 appeared in the first part and 12 new added one) had appeared in the first part. These two phases were completed in two days.

In the first part, we first presented 12 mobile social application profiles to participants according to their group and asked them to assume that these were their friends. Under each profile picture, there was a question from the 7-likert empathy scale (same as in Experiment 1) that evaluated the participant's ability to empathize with the person using that type of image as the profile picture. After that, participants were asked to rate their emotional feelings about the profile in terms of both valence and arousal. At the end of the first part, participants were asked to complete the group rating on a 7-likert scale (1 = "Not the same group at all", 7 = "Exactly the same group"), and the preference rating on a continuity scale from "Not possible" (0) to "Extremely possible" (100%).

After 24 hours, participants were required to complete in the second part. Participants were shown 24 images (including 12 images that appeared in the first part and 12 images that did not appear) in a random order and asked to determine whether the image had appeared in the first part or not.

Day1: Rating Task

Instruction

In the next experiment, some pictures and sentences will appear.

Suppose the picture is your friend's profile on a social app, and the sentence describes how you currently feel about that friend.

Please try to imagine spending time with him/her and try to remember him/her.

After looking at the picture, please rate how well the sentences match how you feel about the friend.

"1" means "Strongly Disagree"
"7" means "Strongly Agree"

Empathy Rating

His/Her emotion doesn't affect me much.

1 2 3 4 5 6 7

Strongly Disagree   Strongly Agree

Instruction

Next, please evaluate your emotional feelings when you see the profile photo in terms of valence and arousal.

Valence means feeling positive or negative. Disgust, sadness, fear, and anger represent negative; fun, pleasing, satisfying, and hopeful represent positive.

Arousal means feeling excited or calm. Relaxed, drowsy means calm; bright, exciting means excited.

Valence & Arousal Rating

Valence
1 2 3 4 5 6 7

Negative   Positive

Arousal
1 2 3 4 5 6 7

Calm   Excited

Group & Preference Rating

End of all social app profile evaluation tasks, please answer:

1. The degree to which the profile you just read belongs to the same group as yourself.

1 2 3 4 5 6 7

Not the same group at all   Exactly the same group

2. How likely you are to use this kind of profile photo yourself ?

0%   100%

Not Possible   Extremely Possible

Day2: Recognition Task

Instruction

This is the second part of the experiment. Next, you will see some profile photos and your task is to determine whether the photo appeared in the first part.

Judgement
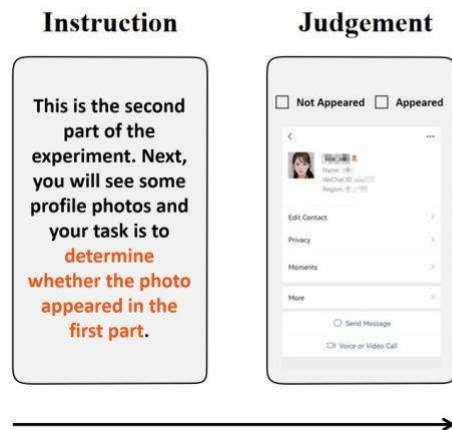
☐ Not Appeared   ☐ Appeared

Figure 3. Flowchart of Experiment 2.

Results

In Experiment 2, one-way repeated multivariate ANOVAs (MANOVAs) were conducted using the scores of empathy (cognitive and affective empathy) and the identity recognition task (accuracy and sensitivity) as dependent variables to testify the effect of image styles of profile pictures (real faces, cartoon faces and landscape images). The Greenhouse-Geisser correction was applied when the Sphericity hypothesis was violated. In Experiment 2, one-way MANOVAs were employed to check the same effect on empathy and identity recognition. All multiple comparisons were adjusted through Least Significant Difference (LSD). Additionally, we used Pearson correlation coefficient (a, k.a. Pearson's rho) to find out the relationship among empathy score, emotional arousal and valence, and the performance of the memory task in Experiments 1 and 2, as well as the social categorization and the preference scores in Experiment 2.

Note that the independent variables (the style of the profile picture) and the dependent variables (empathic experience and identity recognition were the same for both experiments, but the material and the experimental procedure were different: in Experiment 2, the size of profile pictures was 500×500 pixels and the recognition task was performed immediately after learning, whereas in Experiment 2, the size of profile pictures was 60×60 pixels and the same task was completed one day after learning. To further explore the stability of the effect of the image style of profile pictures on empathy as well as on identity memory, and how it is affected by factors such as stimulus size, we combined the data from both experiments for analysis (noting that this analysis is based on the condition that the independent and dependent variables were the same for both experiments). For the empathic experience scores, considering the difference in the size of stimulus between two experiments,

we conducted a 2 (stimulus size: small, large) $\times$3 (image style of profile pictures: real face, cartoon face, landscape) MANOVA with the stimulus size as an additional independent variable. For the performance of identity recognition, the differences between two experiments were not only the stimulus size, but also the length of time interval between learning and recognition. We expected that the recognition task is less difficult in Experiment 2 with large stimuli and a short time interval than that in Experiment 2 with small stimuli and a long-time interval. So, the difference between the two experiments was defined using task difficulty as an additional independent variable. The 2 (task difficulty: small, large) $\times$3 (image style of profile pictures) MANOVA were conducted for further analysis.

Effect of Image Styles on Empathic Experience

In Experiment 2, One-way Repeated MANOVA (Wilks's Lambda = 0.75, $F_{(4,188)} = 7.06$, $p < 0.001$, $\eta_p^2 = 0.13$) revealed a significant effect of the profile picture style on the cognitive empathy scores ($F_{(2,94)} = 14.31$, $p < 0.001$, $\eta_p^2 = 0.23$), and pairwise comparisons found that the cognitive empathy of cartoon faces ($M = 4.74$, $SE = 0.10$, 95% CI = [4.26, 4.94]) and real faces ($M = 4.63$, $SE = 0.11$, 95% CI = [4.40, 4.85]) were stronger than that of landscape images ($M = 4.09$, $SE = 0.13$, 95%CI = [3.83, 4.34]), $p_s < 0.001$, and no differences between that of real faces and cartoon faces, $p > 0.05$ (see the left of Fig. 4). The effect on the affective empathy scores is not significant, $F_{(2.03,45.25)} = 1.11$, $\eta_p^2 = 0.04$, $p > 0.05$, although the pairwise comparison found that the affective empathy of cartoon faces was higher than that of landscape images, $p = 0.019$. However, no effect of the profile picture style on the empathy score (Wilks's Lambda = 0.97, $F_{(4,362)} = 1.39$, $p = 0.238$, $\eta_p^2 = 0.13$) was revealed by one-way MANOVA in Experiment 2 (see the right of the Fig. 4).
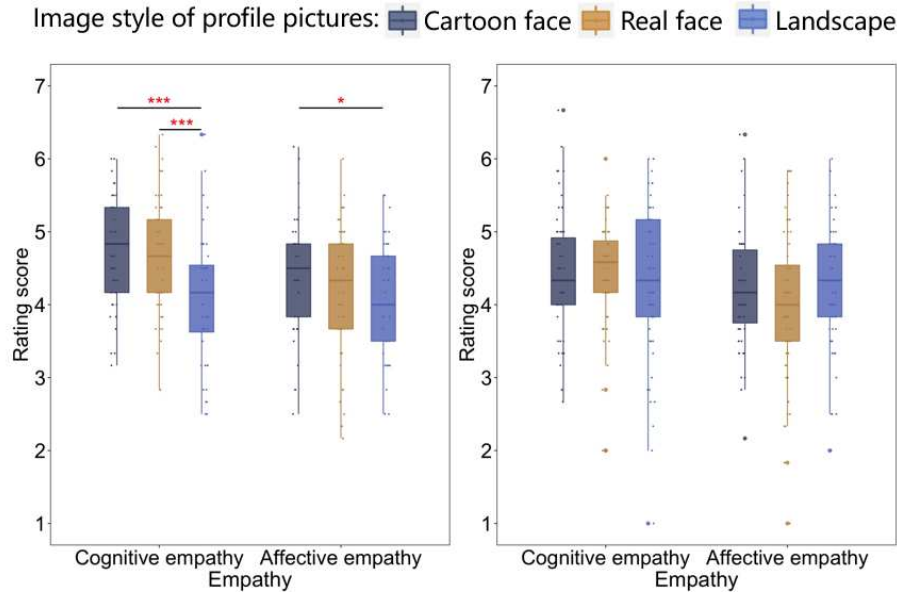

Figure 4. Boxplots of the scores of cognitive empathy and affective empathy for three styles of profile pictures in Experiment 2 (left) and Experiment 2 (right). Here and elsewhere in the article, $*p < 0.05, **p < 0.01, ***p < 0.001$, in multiple contrasts, after LSD corrections.

Since the effect of the image style of profile pictures on empathic experience was not observed in Experiment 2, to further investigate whether the effect of the image style of profile pictures on empathy is affected by the difference of stimulus size between two experiments, we combined the data from both experiments for analysis, The results of the 2 (stimulus size: large, small) $\times$3 (image style of profile types: real face, cartoon face, landscape) MANOVA showed that the main effect of image style and the interactive effect of two factors for cognitive empathy were significant, $F_s > 2.31$, $p_s < 0.039$. The pairwise comparisons for main effect of image style suggested that participants tended to consider that they would perform higher cognitive empathy for their friends using cartoon faces ($M = 4.58$, $SE = 0.08$, 95%CI = [4.42, 4.74]) and real faces ($M = 4.52$, $SE = 0.08$, 95%CI = [4.36, 4.68]) as profile pictures, than that for landscape images ($M = 4.21$, $SE = 0.08$, 95% CI = [4.05, 4.37]). The following simple effect analysis for the interaction showed that large profile pictures in cartoon face style ($M = 4.74$, $SE = 0.12$, 95% CI = [4.50, 4.63]) elicited higher cognitive empathy ratings than small ones ($M = 4.42$, $SE = 0.11$, 95% CI = [3.85, 4.33]), $p = 0.053$; the same trend was observed for real face condition, but the difference is not significant, $p = 0.14$. For the affective empathy, no effect or interactive effect was found, $F_s < 1.40$, $p_s > 0.143$, indicating that participants'

affective empathy did not change for their online friends using different styles of profile pictures.

Effect of Image Styles on Identity Recognition

The results on the sensitivity (d') of identity recognition in Experiment 2 (see the left of the Fig. 5) revealed a significant effect of the profile picture style, $F_{(2,94)} = 72.67, p < 0.001, \eta_p^2 = 0.61$. The d' of cartoon faces ($M = 1.46, SE = 0.12$, 95% CI = [1.21, 1.71]) was significantly lower than that of real faces ($M = 2.47, SE = 0.09$, 95% CI = [2.28, 2.65]) and landscape images ($M = 2.66, SE = 0.11$, 95% CI = [2.45, 3.87]), $p_s < 0.001$, and no significant difference between that of real faces and landscape images ($p > 0.05$). Similar to the results of the d', there was also a significant effect of the profile picture style on the accuracy of identity recognition (see the right of the Fig. 5), $F_{(2,94)} = 70.48, p < 0.001, \eta_p^2 = 0.60$, and the same difference pattern between three conditions: the lowest accuracy on the cartoon faces condition ($M = 0.73, SE = 0.02$, 95% CI = [0.69, 0.77]), $p_s < 0.001$, and no differences between that of real faces ($M = 0.88, SE = 0.01$, 95% CI = [0.86, 0.90]) and landscape images ($M = 0.90, SE = 0.01$, 95% CI = [0.87, 0.93]), $p > 0.05$.
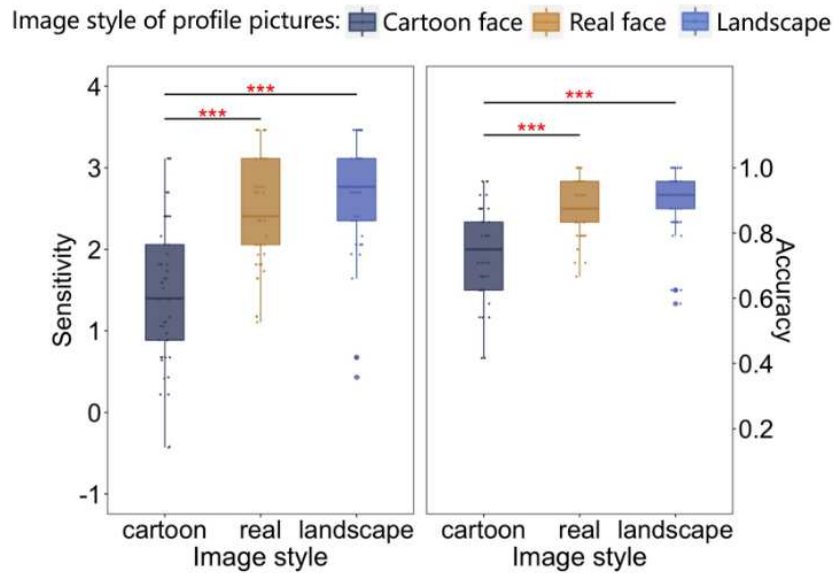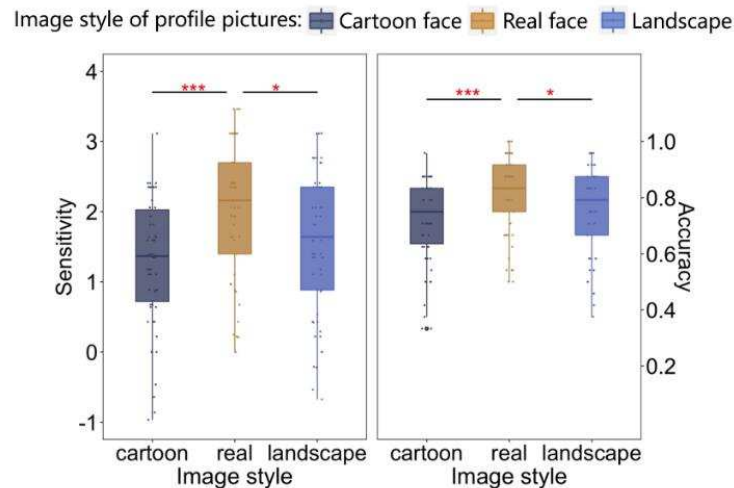

Figure 5. Boxplots of the sensitivity (left) and accuracy (right) of identity recognition performance for three image styles of profile pictures in Experiment 2.

In Experiment 2 (Fig. 6), the effect of the profile picture styles on the d' of identity recognition (see the left of the Fig. 6) was significant, $F_{(2,170)} = 8.06, p < 0.001, \eta_p^2 = 0.09$. The pairwise comparisons showed that the d' of real face style ($M = 2.00, SE = 0.13$, 95% CI = [1.75, 2.25]) was higher than that of cartoon faces ($M = 1.28, SE = 0.13$, 95% CI = [1.03, 1.53]) and landscape images ($M = 1.60, SE = 0.13$, 95% CI = [1.35, 1.85]), $p_s < 0.029$, and there was no significant difference between the d' of cartoon faces and landscape images ($p > 0.05$). The effect on the accuracy of identity recognition (see the right of the Fig. 6) was also significant, $F_{(2,170)} = 6.93, p = 0.001, \eta_p^2 = 0.08$. For real face recognition ($M = 0.81, SE = 0.02$, 95% CI = [0.78, 0.85]), the accuracy was higher for cartoon faces ($M = 0.71, SE = 0.02$, 95% CI = [0.68, 0.75]) and landscape images ($M = 0.76, SE = 0.02$, 95% CI = [0.72, 0.80]), $p_s < 0.039$.

We additionally analyzed a 2 (recognizing difficulty: low, high) ×3 (image styles of profile pictures: real faces, cartoon faces, landscape) MANOVA by combining data of two experiments to further investigate the maintaining memory of profile picture. Two main effects and an interaction effect on the d' and accuracy were significant, $F_s > 6.87, p_s < 0.002$. The simple effect analysis showed that no significant difference for cartoon faces between two experiments were observed in the d' and accuracy of identity recognition, $p_s > 0.291$, while the $d'(M_{difference} = -1.06)$ and accuracy ($M_{difference} = -0.15$) for landscape images were significantly lower in Experiment 2, $p_s < 0.001$, followed by that for real faces, $p_s < 0.009$. The results suggested that although identity recognition performance of cartoon faces was lower than other two styles of profile pictures, it was relatively stable.

Correlations

Correlational analyses were used to examine the relationship between empathic experience (affective empathy and cognitive empathy), identity recognition (accuracy and d'), emotion (arousal and valence) and other variable measured in Experiment 2.

Figure 6. Boxplots of the sensitivity (left) and accuracy (right) of identity recognition performance for three image styles of profile pictures in Experiment 2

	Cartoon face						Real face						Landscape					
	Af	Co	Ar	Va	Ac	d'	Af	Co	Ar	Va	Ac	d'	Af	Co	Ar	Va	Ac	d'
Affective Empathy	1.00	0.30	-0.24	0.18	0.29	0.31	1.00	0.42	0.08	0.13	0.10	0.07	1.00	0.10	-0.29	0.09	0.04	0.04
Cognitive Empathy	0.30	1.00	-0.09	0.18	0.07	0.09	0.42	1.00	0.10	0.05	-0.04	-0.05	0.10	1.00	0.27	0.33	-0.06	-0.07
Arousal	-0.24	-0.09	1.00	0.38	-0.23	-0.24	0.08	0.10	1.00	0.41	-0.16	-0.16	-0.29	0.27	1.00	0.29	-0.18	-0.16
Valence	0.18	0.18	0.38	1.00	0.09	0.08	0.13	0.05	0.41	1.00	0.12	0.11	0.09	0.33	0.29	1.00	-0.04	-0.03
Accuracy	0.29	0.07	-0.23	0.09	1.00	0.99	0.10	-0.04	-0.16	0.12	1.00	0.99	0.04	-0.06	-0.18	-0.04	1.00	0.99
d'	0.31	0.09	-0.24	0.08	0.99	1.00	0.07	-0.05	-0.16	0.11	0.99	1.00	0.04	-0.07	-0.16	-0.03	0.99	1.00

Figure 7. Correlation matrix of coefficient (r) given by the variables of each style of profile pictures in Experiment 2. Green indicates a higher, yellow a lower r, red mark indicates the r is significant, $p < 0.05$

In Experiment 2, the correlations matrix (Fig. 7) was computed among data within each condition of profile picture styles. The results for cartoon faces showed the correlations of cognitive empathy rating with accuracy ($r(48) = 0.29, p = 0.05$) and d' ($r(48) = 0.31, p = 0.03$) were significant, while the correlation of that were not significant in real faces and landscape images.

	Af	Co	Ar	Va	So	Pr	Ac	d'
Affective Empathy	1.00	0.45	0.35	0.15	0.24	0.13	-0.07	-0.06
Cognitive Empathy	0.45	1.00	0.22	0.12	0.13	0.02	-0.03	-0.01
Arousal	0.35	0.22	1.00	0.46	0.31	0.22	-0.10	-0.09
Valence	0.15	0.12	0.46	1.00	0.28	0.25	-0.06	-0.07
Social Categorization	0.24	0.13	0.31	0.28	1.00	0.62	-0.03	-0.01
Preference	0.13	0.02	0.22	0.25	0.62	1.00	0.06	0.08
Accuracy	-0.07	-0.03	-0.10	-0.06	-0.03	0.06	1.00	0.99
d'	-0.06	-0.01	-0.09	-0.07	-0.01	0.08	0.99	1.00

Figure 8. Correlation matrix of coefficient (r) given by the variables in Experiment 2. Green indicates a higher, yellow a lower r; red mark indicates the r is significant, $p < 0.05$.

To further investigate whether empathic experience and identity recognition were related to users' personal preference for the profile picture or ingroup classification of the person using the profile picture, the preference and social categorization rating for profile picture were additionally measured and analyzed in Experiment 2 (Fig. 8). The correlation metrics were calculated among the whole data of three styles of profile pictures. The results suggested that the affective empathy were positively correlated with arousal ($r(173) = 0.35, p < 0.001$), valence ($r(173) < 0.15, p = 0.04$) and more importantly, the social categorization ($r(173) = 0.24, p = 0.001$).

Discussion

In this paper, we conducted two experiments to investigate whether the image styles of profile pictures affect empathic experience and identity recognition in social media. The first experiment is a controlled experiment in laboratory where

participants sat in front of a laptop and were presented stimuli of fixed time, whereas the second experiment is an ecological online experiment where participants completed the whole procedure using their smart phones without further restrictions. For the empathic experience, participants of Experiment 2 showed higher cognitive empathy to their friends when their profile pictures were images of real and cartoon faces than landscape images, whereas the image styles of profile pictures did not affect affective experience. However, the results for empathic empathy of Experiment 2 were not the same as that of Experiment 2: no difference of cognitive empathy and affective empathy were found between three styles of profile pictures. For the identity recognition, the results of two experiments showed the advantage of real face images in the task where participants were asked to remember the identity of a friend in SNS by presenting different profile pictures and they showed the highest accuracy and d' for recalling friends with real face images of profile pictures.

First, our results indicated a higher empathic experience for face style profile pictures. Compared to landscape images, people tended to think they can better understand the emotions of their online friends who used face images (real faces and cartoon faces) as profile pictures, but this advantage for face style profile pictures in cognitive empathy was weakened when the experiment was conducted on simulated profile pages using participants' mobile phone. The advantage of face images in empathy revealed in our current study was in line with the study conducted by Salminen et al.[17], that investigated how image styles affected user perceptions of personas and found higher perception of empathy for a persona with real face images as compared to no pictures. This advantage may be attributed to the eyes region in the face image, considering that cognitive empathy refers to understand others' emotion statement involving cognitive process[30] and highly correlates to so called perspective taking[33], which refers to the ability to consciously put oneself into the mind of another person to understand what she/he is thinking or feeling and is usually measured by the Reading the Mind in the Eyes Task (RMET)[34,35]. The attribution of the eyes region also explained why the advantage of cartoon face images disappeared in the online experiment, in where the size of the cartoon face profile photo used as stimuli was smaller, resulting a smaller corresponding eye region and lower cognitive empathy rating.

Moreover, the results showed no difference of empathic experience between real and cartoon faces in both experiments. These indicated that participants' empathic experience on their friends using cartoon faces as profile pictures was not diminished as compared to real face images, suggesting that the top-down process (which refers to perception that is driven by personal experience and cognition) is more important than the bottom-up process (which refers to the way it is built up from the sensory information of stimuli, such as the different cartoon style[36]).

Second, our finding showed deepener impression for real face profile pictures.The identity recognition results of both experiments showed that the best performance for recognizing online friends' identity was achieved when using real face profile pictures, indicating a stable advantage of the real face. As compared to real face style, cartoon face style was usually depicted by non-realistic clean texture with exaggerated or weakened facial features[37,38]. Using the same cartoon style, the facial features tend to deform in the same way, which leads to recognize a cartoon character's identity not only relying on facial features, but also more on features unrelated to faces, such as symbolic hair color, hair style and accessories etc.[39]. Because the cartoon face style used in our current study are of the same style, the similarity of these cartoon faces leaded to higher difficulty and lower accuracy in the identity recognition task.

Note that the recognition accuracy of real face images remains above 80% in both the immediate recognition and the next-day recognition after learning, as well as the recognition accuracy of cartoon face images reached 70%, whereas the recognition accuracy rate of landscape images dropped from 90.3% to 75.7%. These results supported that face recognition, including that of cartoon face style, is quite different from object recognition[1,40,41]. Due to the difficulty caused by the similarity of the stimuli, the recognition accuracy of cartoon face style was lower than that of other conditions. However, compared with using landscape images as profile pictures, impression of SNS friends using face images may be more stable in long-term memory.

Next in importance, combination the results of two experiments, we found that real faces and cartoon faces induced stronger cognitive empathy, but only the real faces had the advantage of identity recognition, which suggested that the contextual information plays a crucial role in empathic experiences[9,13,42–45], i.e., for participants in the experiment, whether the person they empathize with was a real or virtual person, and whether they were ingroup or outgroup members determined the level of empathy. Specifically, the rating of social categorization and affective empathy was positively correlated, indicating that the more participants perceived the person using a certain style of profile pictures as a member of the same in-group as them, the more they thought they could be emotionally affected (affective empathy) by the other person. In addition, the results of correlation metrics also revealed that people's preference for profile pictures was not significantly correlated to empathic experience of identity recognition performance for their online friends. To sum up, our results about the relationships between empathic experience, identity recognition, and social categorizations implicated that the processing of the effect of profile pictures on empathic experience and identity recognition may be different.

For identity recognition based on profile pictures in this study, the effect of image styles of profile pictures on it may relied more on bottom-up processing; that is, the form of stimuli, such as cartoon faces and real faces, impacted the performance of

identity recognition in both experiments. Note that this result did not exclude the top-down processing from identity recognition. A typical example of such a processing is the effect of social categorization on identity recognition: previous studies had shown that people performed better in recognition for ingroup members than for outgroup members[46]. However, no significant correlation was observed among the performance of identity recognition, the rating of social categorization and preference in current study. The reason was possible that the authenticity of face profile pictures (real and cartoon faces) did not lead to changes in people's social classification toward their friends. Additionally, our results revealed that cognitive empathy rating for cartoon faces was positively correlated with the performance of identity recognition, indicating that the more the users agreed that they can understand the emotions of their online friends who use cartoon profile pictures, the deepen impression they would have for these friends. This finding could explain individual differences of empathic experience and identity recognition for profile pictures using cartoon faces.

Finally, in this paper, we investigated the impact of profile picture styles on users' empathic experience and identity recognition in social media. To control the variables for a meaningful and clear analysis, we used one style of non-real face profile pictures (i.e., profile pictures of the cartoon face style) and one style of non-face profile pictures (i.e., profile pictures of the landscape image style), because the purpose of our study was to compared them with the real face profile pictures rather than the differences between picture styles. Based on the comprehensive results and insights presented in this paper, maybe we provided some bases for the future work, which would focus on examining other representative styles of non-real face profile pictures (e.g., line drawing, oil painting, etc.) and extensive profile pictures containing more specific information than landscape images (e.g., pictures of animals, objects, symbols and so on). Besides, the measures in current study mainly include the subjective rating and behavioral performance, and the results are comprehensive and reveal interesting findings of profile picture styles on user empathy and identity recognition. Based on our findings, physiological measures of brain activities can be included in the future work to reveal the potential physiological mechanism.

Conclusion

Profile pictures as an important sign of social identity in our daily virtual life which have an effect on human's online behaviours. In this paper, investigated how different styles of the online friends' profile pictures in social media affect participants' virtual social interaction behaviours from the perspective of empathic experience and identification. We conducted a laboratory experiment with strict control of extraneous variables and an online experiment with relatively high ecological validity that is similar to everyday life. In the two experiments, participants were presented with real face cartoon face and landscape profile pictures, and then the participants were asked to rating the items from modified BES which is composed of cognitive empathy (cognitive understanding of other's emotional statement) scale and affective empathy (affective response to other's emotional state) scale to measure their empathy experience, and then the recognition test was used to examine the memory of their online friends' identities. Our results showed that, in terms of cognitive empathy, the score of profile pictures with real faces and cartoon faces was higher than landscape pictures, while this advantage disappeared as the size of the profile pictures became smaller. In terms of cognitive empathy, the scores did not vary with the style of profile pictures but increased as participants classified people using that style picture into in-groups. Identity recognition performance was significantly better with real face profile pictures than that with cartoon face and landscape profile pictures. The results of the two experiments showing different impact of profile picture styles on empathic experience and identification have certain enlightenment for the influence mechanism of profile in social media on people's emotional and cognitive levels, it also shows some light on the interaction between humans and avatars in the future virtual reality social life.

Data availability

The data in this study are available from the corresponding author on reasonable request.

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Author contributions statement

Y-J.L., X.L., C.Z., and S.Z. conceived and designed the experiments. X.L. and N.L. conducted the experiments. X.L. and S.Z. analyzed the results. X.L., C.Z., and S.Z. wrote the original draft. Y-J.L., C.Z., X.L., M.J., S.W., and Z.L. revised the draft. All authors reviewed the manuscript.

Additional information

Competing interests No competing interests exits in the submission of this manuscript, and manuscript is approved by all authors for publication. I would like to declare on behalf of my co-authors that the work described was original research that has not been published previously, and not under consideration for publication elsewhere, in whole or in part.

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