Exploring the Influence of Profile Picture Styles on Empathy and Identity Recognition in Social Media

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***Abstract*—Empathy and identity recognition are two core social interaction factors that greatly affect efficiency and effectiveness. The selection of a profile picture in social media is crucial as it serves as a visual representation of virtual identity. It not only reflects the user's personality but also influences the level of empathy and identification that others feel toward them. However, the potential impact of profile pictures with different styles (e.g., real faces, cartoon faces, and landscape images) on empathy and identity recognition is still unclear. To explore its effects, a controlled laboratory experiment and an ecological online experiment were conducted. Participants were shown a picture each time, informed to imagine interacting with the person using it as his/her profile picture, and instructed to rate an item from the basic empathy scale (BES) based on it. After rating all pictures, users then completed an identity recognition task. Results show that participants' empathy scores for users with cartoon or real face profile pictures are greater than those with landscape profile pictures. In addition, participants performed better in identity recognition for users with real face or landscape images as profile pictures than for those with cartoon face profile pictures. Moreover, users of social media often make social categorizations (i.e., in-group/out-group categorization) based on the social identities expressed by their profile pictures. Our results also indicate that the affective empathy scale rating score was positively associated with the degree to which users of the corresponding profile pictures were categorized as in-group members.**

***Index Terms*—Empathy, identity recognition, profile picture, social categorization, social media.**

I. Introduction

THE advent of social networking sites (SNSs) in recent decades has significantly altered the manner in which individuals engage in social interactions [1]. Compared to traditional face-to-face socializing, social media has not only facilitated long-distance communication but also increased people's willingness to form social bonds with strangers. A survey [2] shows that by October 2023, the number of social media users worldwide has reached 4.95 billion, which is equivalent to 61.4% of the total global population. There are fifteen social media platforms that have at least 400 million users, including Facebook, WhatsApp, and Instagram, and the top-ranked Facebook has 3.03 billion monthly active accounts [2]. Moreover, users across various countries have disparities in social media preferences. For example, WeChat is the dominant social media platform in China, boasting 1.327 billion monthly active accounts worldwide, of which more than 1.1 billion users are from China [3]. In social media, users have virtual identities and use them to access information, exchange opinions, share photos and videos, and so on. The user usually needs to choose a profile picture to represent his/her virtual identity, which is an essential component of his/her personal information. It is a representative image of the social media account as the user interacts on the platform, usually displayed alongside the account name in a post or comment.

Profile pictures have various styles and can be broadly classified into two categories: face pictures and nonface pictures. Many people tend to choose real faces as profile pictures because they can convey rich information, including gender, age, race, and so on [4]. Some users alternatively choose nonreal faces, such as cartoon faces, as their profile pictures for privacy reasons or due to dissatisfaction with their appearances. These cartoon images are usually generated by applying stylization algorithms on real-face images, which even increases expressiveness and attractiveness [5].

As a representation of a user's virtual identity, the impact of profile pictures on users' online social cognition has received increasing attention [6], [7], [8], [9], [10], [11], [12], [13]. A user's choice of profile picture can greatly affect other people's first impressions of the user. For instance, a study showed that people who used sexualized profile pictures were always considered by females to be less physically attractive, less socially attractive, and less competent to complete tasks [14]. In addition, it also significantly affects the trust in online markets [15], mobile social commerce [16], and interpersonal relationships within online social networks; e.g., changing a Facebook profile picture to a dyadic photo has a positive effect on the partners' romantic relationship satisfaction [17].

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Among the many factors related to social cognition, the degree of empathy and identity recognition is crucial in enhancing the efficiency and effectiveness of social interactions. Empathy [18] refers to the capacity to comprehend the emotional sentiments of others, and identity recognition [19] refers to the ability to identify individuals accurately. According to existing studies on social categorization [7], [8], [20], [21], [22], when an individual is assessed by others as an in-group member (meaning that they believe that you belong to the same group as they do [23]), he or she will receive stronger empathy from others and will make a deeper impression on others, thereby leading to better identity recognition. However, to the best of our knowledge, there remains a lack of evaluations concerning the impact of various profile picture types on empathy and identity recognition, coupled with a scarcity of analysis regarding the underlying causes.

In this article, we focus on analyzing how different profile picture styles, including real faces, nonreal faces, and nonface images, differ in social categorization on social media and how they influence empathy and identity recognition. Inspired by prior research [24], [25], [26], we selected landscape images to represent nonface pictures in our study. In addition, we also aim to investigate the potential influence of social categorization on the association between profile picture styles and empathy. Both an online ecological experiment and a controlled laboratory experiment were carried out. Participants were shown a single image at a time, asked to imagine themselves interacting with an individual using that image as his/her profile picture, and then evaluate an item from the modified basic empathy scale (BES) [27] based on their perception of it. Following the evaluation of all images, participants proceeded to complete the identity recognition task. Our results indicate that participants exhibit higher levels of empathy toward users with cartoon or real-face profile pictures than those with landscape profile pictures. In addition, participants exhibited superior performance when recognizing the identity of people with real face or landscape images as their profile pictures compared to those with cartoon face profile pictures. Furthermore, social media users frequently classify others into in-group or out-group members according to the social identities that are conveyed through their profile images. Our results suggest that there was a positive correlation between the affective empathy scale rating and the degree to which users of the corresponding profile pictures were categorized as in-group members. The main contributions of this article are as follows.

1) We investigated the influence of the profile picture styles on empathy and identity recognition. Our findings provide guidance for social media users to obtain a more favorable experience on online social networks.
2) The social categorization theory was innovatively introduced to explain the influence of profile pictures on empathy and identity recognition, which indicates that being perceived as an in-group member tends to result in better emotional empathy.
3) In terms of experimental design, we conducted rigorous laboratory experiments (experiment 1) and online experiments of high ecological validity (experiment 2). By combining both of them, we obtained reliable and generalized conclusions.

II. Background and Related Work

A. Empathy on Social Media

Empathy broadly refers to understanding the feelings of others, and it is an emotion or a sensory state that may be the main motivator of prosocial behavior such as altruism and cooperation [9], [10], [11], [28]. It can be broadly classified into two categories [18]: 1) *affective empathy*, which represents an affective response to others' emotional states; and 2) *cognitive empathy*, which represents the cognitive understanding of others' emotional states [27], [29], which is necessary for our daily lives and work [30]. The connection between empathy and online social interaction, an important form of social interaction, has also received great attention. Waytz and Gray found that online interaction has both advantages and disadvantages for empathy, depending on whether it allows for a deeper understanding of people's thoughts and feelings [31]. A one-year interval longitudinal study revealed that adolescents' use of social media increased their capacity for both cognitive empathy and emotional empathy [32]. However, excessive use of social media, also known as social networking addiction, can have a negative impact on empathy [33]. To the best of our knowledge, existing works have not analyzed the effect of social avatars on empathy.

B. Identity Recognition on Social Media

Recognizing (remembering) other people's identities is also an important ability in social interactions. Among the various modalities of information such as voices, names, and biographical information, faces are widely used to distinguish individual identity [4], [34], [35]. A study investigated people's ability to identify their friends on social media based on profile pictures that use face images [36]. Participants were asked to recall their friend's name using the friend's photo from Facebook, and the results showed that, on average, participants could only accurately name 72.7% of their Facebook friends. The question of which type of social avatar is more beneficial for achieving better identity recognition requires further exploration.

C. Social Categorization & Its Influence on Empathy and Identity Recognition

Social categorization includes the initial perception and categorization of in-group and out-group members [7], and it has implications for empathy and identity recognition [20], [21]. Tarrant et al. [22] conducted experiments to investigate the effects of social categorization on the experiences of empathy with 370 participants. As predicted, participants reported stronger empathic experiences for a student who described belonging to an in-group compared to an out-group university. Bernstein et al. found that face recognition performance was better for targets categorized as in-group members despite the

fact that perceptual expertise was equivalent for in-group and out-group faces [37]. Profile pictures can also be used for social categorization. For example, on Weibo (Chinese microblogs), fans often use photos of their favorite idols as their profile pictures, which is essential for fans to identify in-group members from out-group members [38]. Based on the above research, our work also aims to explore the impact of the social categorization induced by profile pictures on empathy and identity identification.

III. Methods

Two experiments were conducted to investigate how empathy and identity recognition are influenced by the image styles of profile pictures. Two face image styles (real faces and cartoon faces) and one nonface image style (landscapes) were used as visual stimuli. Previous studies often use landscape pictures as a control group to compare with other types of pictures, including facial images [39], [40]. Inspired by previous research [24], [25], [26], we chose landscape pictures, which are commonly used as nonfacial profile pictures, as the third style of stimuli. In Sections IV-A and V-A, we present details of the stimulus images used in each experiment.

Both 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 rights and the welfare of the subject are adequately protected; the potential risks are outweighed by the potential benefits. Both experiments were performed in accordance with the relevant named guidelines and regulations. 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.

A. Overview

In *both experiments*, participants were informed to suppose that each image they see is their friend's profile picture on social media and imagine getting alone with him/her. Then, each time an image was presented, the participants rated their empathy based on their perception of the image. After the rating tasks, participants were asked to complete an identity recognition task by responding to whether a profile picture appeared before, in which half of the profile pictures were presented in the rating tasks, and another half of the profile pictures were new images that the participants never saw before.

B. Differences Between Experiments 1 and 2

Experiment 1 was performed in an offline experimental environment, where stimulus presentation time and other irrelevant variables were rigidly controlled.

Experiment 2 simulated everyday social media usage by making the following main changes to experiment 1.

1) Participants can complete the experiment on their smartphones by accessing an online platform through website links instead of participating in person in the laboratory.
2) The stimulus presented to the user is a screenshot of their familiar social media app's profile pages, with a profile picture in the top left corner of it.
3) Instead of using a fixed amount of time, participants can decide for themselves the presentation time of stimuli.
4) Considering that real online relationships with friends on social media usually undergo a longer time span, the time interval between learning and recognition was extended to 24 h in experiment 2.

In addition, we measured preferences and social categorization in *experiment 2* to explore whether the impact of profile pictures on empathy and identity recognition is related to these two variables.

TABLE I
Measurement Items for Empathy

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

Note: Items 1–6 are used to measure cognitive empathy, while items 7–12 are used to measure affective empathy. Items 1, 5, 6, 8, 9, and 10 are reverse scored.

C. Measurement

1) Measurements of Empathy: A modified BES [27] was used to evaluate the empathy of participants on different profile picture styles. Prior to the experiment, we asked participants to imagine that the displayed picture was a friend's profile picture on social media. Following this, they rated empathy by responding to one of the items from the BES after envisioning interaction episodes. The BES contains 12 items, half assessing cognitive empathy and the other half assessing affective empathy. We modified the measure used in the current study by replacing the words "people" and "friends" with third-person pronouns, i.e., "he/she" and "him/her" (see Table I).

Participants were required to rate how well the item matched their feelings on a seven-point Likert scale (1 = "strongly disagree," 7 = "strongly agree") about friends who appeared as profile pictures on social media, and an item was rated for only one image in each condition. Half of the items were scored positively (higher scores indicate stronger empathy), and the other half were scored negatively (lower scores indicate stronger empathy).

2) Measurements of Identity Recognition: The measurement of how profile pictures affect identity recognition is a kind of signal detection. Signal detection measures participants' ability to distinguish between signals and noise. Here, "signals" refer to profile pictures presented during the learning phase, and "noise" denotes pictures that were not previously shown.

We used sensitivity (d') and accuracy to evaluate the performance of the identity recognition task. The d' is calculated by subtracting the z score that corresponds to the false-alarm rate from the z score that corresponds to the hit rate ($d' = Z_{\text{hits}} - Z_{\text{false-alarms}}$) [41]. Hit rate refers to the probability of correctly identifying an old item, while false-alarm rate refers to the probability of incorrectly identifying a new item as old. We also calculated the accuracy of the recognition task by dividing the sum of hits and correct rejections (correctly identifying new items as new) by the total number of all stimuli. Compared to the accuracy, the d' value is independent of participants' response bias [42]. Higher d' and accuracy indicates higher recognition of a certain style of profile pictures.

D. Data Analysis

1) Experiment 1: One-way repeated multivariate ANOVAs (MANOVAs) were conducted using the empathy scores (cognitive and affective empathy) and the identity recognition task results (accuracy and sensitivity) as dependent variables to testify the effect of profile picture style (real faces, cartoon faces, and landscape images). The Greenhouse–Geisser correction was applied when the sphericity hypothesis was violated. Additionally, we used the Pearson correlation coefficient to find out the relationship among empathy scores, emotional arousal and valence, and the performance of the recognition task.

2) Experiment 2: One-way MANOVAs were employed to check the profile picture style effect on empathy and identity recognition. All multiple comparisons were adjusted through least significant difference (LSD). Additionally, we used the Pearson correlation coefficient to find out the relationship among empathy scores, emotional arousal and valence, recognition task performance, as well as social categorization and preference scores from experiment 2.

3) Analyses of Integrated Data in Both Experiments 1 & 2: We note here that the independent variables (the style of the profile picture) and the measurements of dependent variables (empathy and identity recognition) were the same for both experiments, but the material and the experimental procedure were different: In experiment 1, 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. We combined data from both experiments for analysis to further explore the stability of the effect of profile picture style on empathy and identity memory, as well as analyze how it is affected by factors such as stimulus size. (We note here that this analysis is based on the condition that the independent and dependent variables were the same for both experiments.) For the empathy scores, we took into consideration the different stimulus scales between the two experiments and 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 identity recognition performance, the differences between the two experiments were not only the stimulus size but also the length of the time interval between learning and recognition. We expected the recognition task to be less difficult in experiment 1 (with large stimuli and a short time interval) than in experiment 2 (with small stimuli and a long time interval). Therefore, 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 was conducted for further analysis.

IV. Experiment 1

A. 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 randomly selected from a public dataset.[1] 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 face transformation application[2] with a consistent cartoon style. Since cartoon faces and real faces differ in intensity and expressiveness of different emotion types [43], all the faces in this study were neutral expressions to avoid the influence of these differences. Sixty landscape images were downloaded from the Internet and randomly divided into two sets. To increase the diversity of stimuli, 12 images (half male faces and the other half female faces; for landscape images, they were randomly divided into two sets) were selected from the images of each style and presented to each participant for empathy rating. Another 12 images were randomly selected as new stimuli for the identity recognition task.

B. Participants

The number of sample sizes required in the experiment was calculated by exploratory parameter estimation using G*Power 3.1 (Version 3.1.9.7) [44] with a moderate effect size $f = 0.25$, $\alpha = 0.05$, and power $= 0.8$. Thus, the estimated sample size was 28 for repeated measures ANOVA. To ensure a balanced presentation sequence of the three image styles and considering that young people are the predominant users of social media [45], we recruited 48 participants (18 males and 30 females), which exceeds our estimated sample size of 28, with an average age of 20.91 years (SD $= 0.71$).

C. Design and Procedure

We used a single-factor within-subjects experimental design with three levels: real face images, cartoon face images, and landscape images. All stimuli were programmed through Python 3.1 and presented on the computer screen. The whole experiment procedure was modified according to the face recognition paradigm widely used in previous studies [46], [47]. The experiment consisted of two parts: a rating task (including

[1] https://www.seeprettyface.com/mydataset.html#yellow
[2] https://cloud.tencent.com/product/ft

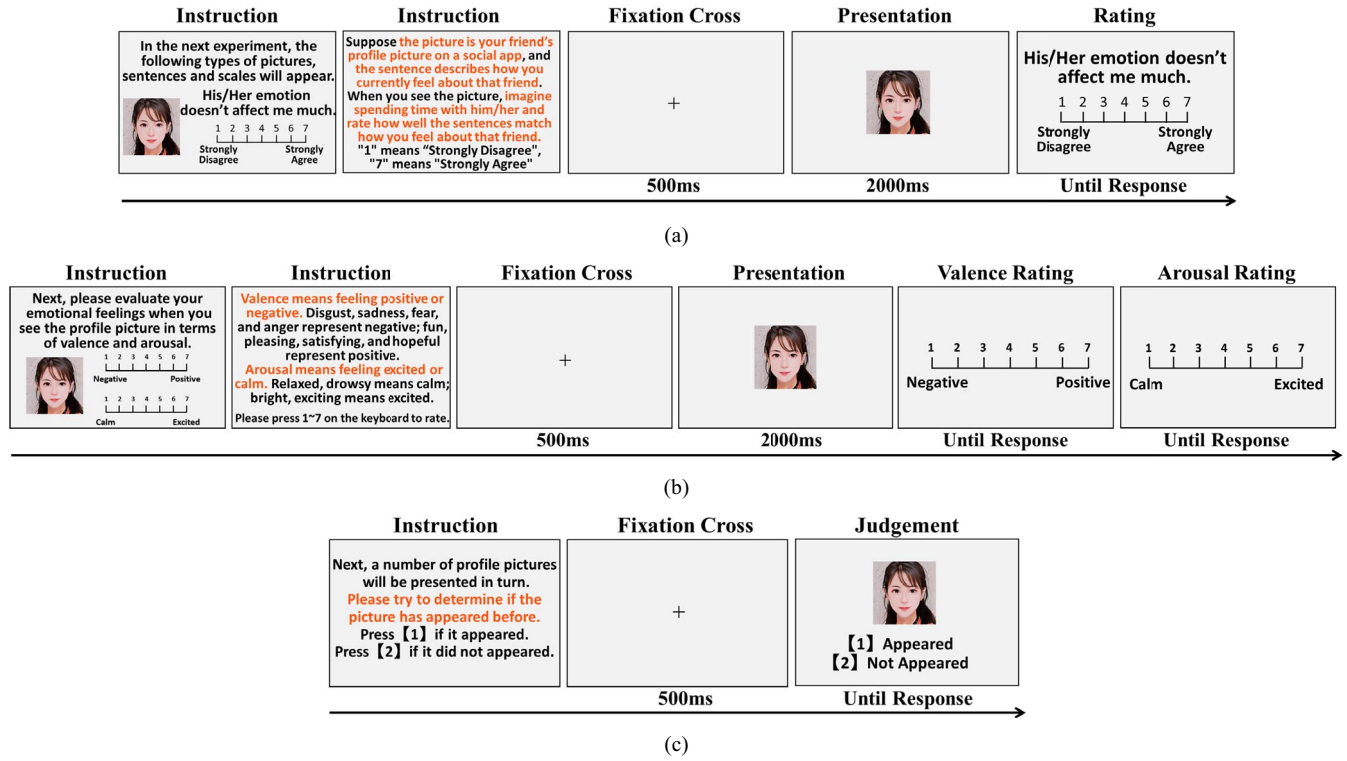

Fig. 1. Flowchart of experiment 1. (a) Flowchart of the empathy rating: participants were asked to complete the empathy rating task based on the profile pictures presented. (b) Flowchart of the emotional valence and arousal rating: participants were asked to evaluate their emotional valence and arousal. (c) Flowchart of the recognition part: participants were asked to respond whether or not the profile picture appeared before.

empathy rating and valence & arousal rating) and a recognition task (see Fig. 1). At the start of each part, participants were provided with a page of instructional slides.

The first part was the rating task, which was a questionnaire-based survey. In *empathy rating*, the participants saw three types of profile pictures (landscape, real face, and cartoon face), imagined interacting with the users of these profile pictures, and then rated an item (randomly selected and nonrepeating) from the BES scale after each profile picture. Each trial began with a central fixation for 500 ms, then an image appeared in the center of the screen for 2000 ms, followed by a sentence from the BES with the seven-Likert scale ranging from strongly disagree (1) to strongly agree (7). The fixation for the next trial appeared only after participants pressed the key. 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. In *emotional valence & arousal rating*, each trial began with a central fixation for 500 ms, and participants were presented with a series of images that they had seen in the first part before, with each image lasting for 2000 ms. Then, participants were asked to evaluate their feelings from the perspective of emotional valence and arousal when they saw these profile pictures and choose a number between 1 and 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. The sequence of image presentation was the same as the empathy test.

The second part, featuring the identity recognition task, was given to the participants right away after the first two rating tasks were finished. Seventy-two images (in three styles of profile pictures) were presented to the participants one by one. Among them, 36 images appeared in the first two tests, and 36 images were newly selected from the material. Participants were asked to judge as accurately as possible whether each image appeared before. Next, each trial began with a central fixation for 500 ms, followed by an image in the center of the screen until participants pressed "1" (appeared) or "2" (did not appear) on the keyboard.

V. Experiment 2

A. Creation of Stimuli

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 would use social media in their daily lives, we chose the profile page screenshots (see Fig. 2) of a widely used social app, WeChat, which is familiar to all participants, as the stimuli. The profile pictures on the screenshots were from experiment 1, which included three styles: real faces, cartoon faces, and landscapes. If a face picture was chosen for the profile picture, the gender displayed on the profile page would match the gender of the face

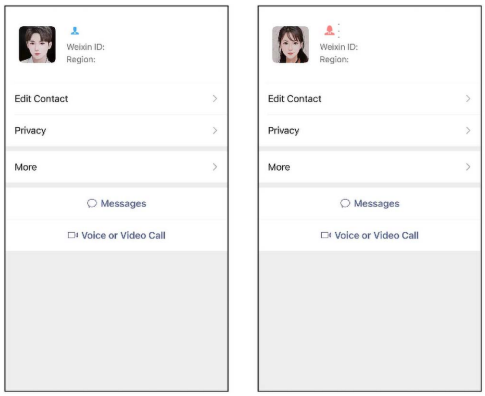

Fig. 2. Examples of profile pages with cartoon face stimuli used in experiment 2. For each page, a 60×60 pixels profile image was located at the top left of the page. The name, id, and region were blurred to avoid possible confounding effects.

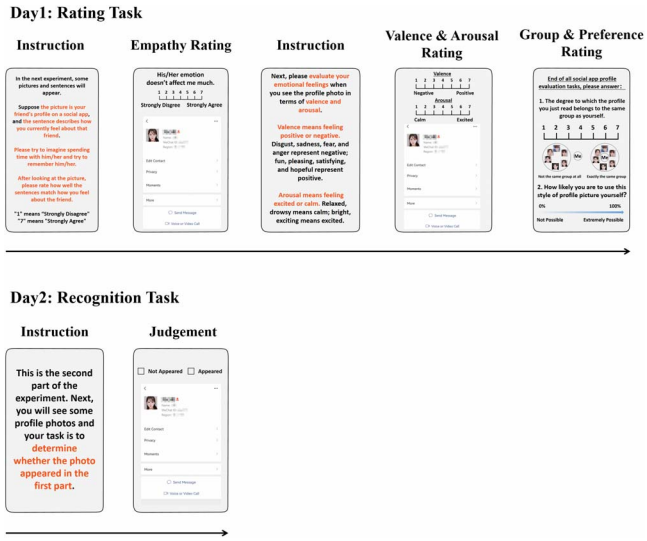

Fig. 3. Flowchart of experiment 2. The top row is the flowchart for the rating tasks that participants were asked to complete on the first day, including empathy rating, emotional valence & arousal rating, and group & preference rating. The bottom row is the flowchart for the recognition task that participants were asked to complete on the next day. The interval between the rating and recognition tasks was at least 24 h.

in the picture. If a landscape image is selected as the profile picture, the gender displayed on the page will be randomly divided into male and female equally. The profile pictures in experiment 2 were the same as those used in experiment 1, but the size was reduced to 60×60 pixels.

B. Participants

Using the same sample size estimation method as in experiment 1, we calculated the required sample size in experiment 2 to be 159. Given that young adults are the main group of social network users [45], we recruited 184 participants (79 males, 105 females) with an average age of 22.18 years ($SD = 3.83$), which is larger than the sample size required for the experiment. They were randomly divided into three groups: 63 participants (27 males, 36 females) assigned to the cartoon face group, 60 participants (27 males, 33 females) assigned to the real face group, and 61 participants (25 males, 36 females) assigned to the landscape image group. Data from 11 participants were excluded from the follow-up analysis because they did not complete the identity recognition tasks.

C. Design and Procedure

To make the experiment resemble a real-world experience, experiment 2 (see Fig. 3) used the single-factor between-subjects experimental design with three levels: real face images, cartoon face images, and landscape images. Twenty-four images (12 from male accounts and 12 from female accounts) were selected in each of the three styles and presented on profile pages. To minimize potential confounding effects, all information on the profile page, such as name, ID, and region, was blurred, with the exception of gender details. Consequently, 72 profile pages were created and used in this experiment.

Experiment 2 consisted of two parts. The first part consisted of three rating tasks, which were respectively used to measure the following responses from participants: 1) empathic response to the profile picture users; 2) emotional feelings to the profile pictures; and 3) social categorization of profile picture users and preference of using the pictures. The second part is the recognition task. Participants were asked to judge whether the profile pictures appeared in the first part. To simulate how individuals recognize new friends in real social media, participants were asked to conduct the recognition task the next day to investigate the long-term memory of profile pictures.

In the first part, we presented 12 mobile social application profile pages to participants according to profile picture types. We instructed them to suppose that the profile pictures were from their WeChat friends and imagine interacting with their friends. During the rating empathy task, items from the BES and the emotion (valence & arousal) rating scale (same as in experiment 1) appeared one at a time and sequentially on the top of the screen. Participants were asked to rate the question using the seven-Likert empathy scale that evaluated the participants' empathy with the person using that type of image as the profile picture. After the participants rated the 12 profile pictures randomly matched to 12 items of modified BES, they rated their emotional feelings about each profile picture in terms of valence and arousal. Last, participants completed a group and preference rating by answering two questions: 1) *the degree to which the profile you just read belongs to the same group as yourself* (group rating). Participants were asked to rate this question on a seven-point Likert scale. A score of 1 means that the participant is "not the same group at all" as the profile picture user, and a score of 7 means that the participant is "exactly the same group" as the profile picture user. 2) *How likely you are to use this style of profile image yourself* (preference rating). Participants were also asked to rate this question on a continuity scale from "not possible" (0) to "extremely possible" (100%).

Participants were required to complete the second part after 24 h. They were shown 24 images (including 12 images that

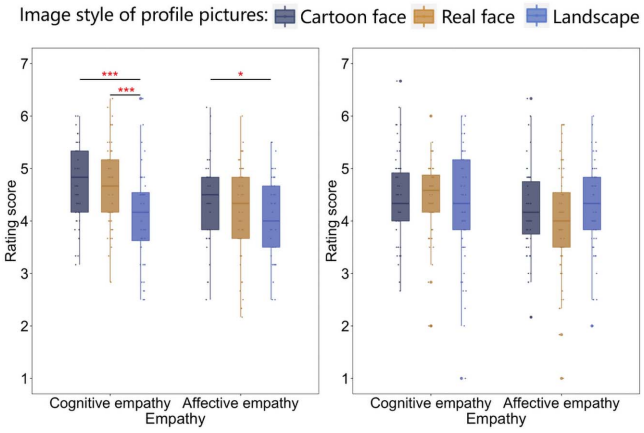

Fig. 4. Boxplots of the scores of cognitive empathy and affective empathy for the three styles of profile pictures in experiment 1 (left) and experiment 2 (right).

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 before in the first part or not.

VI. Result

A. Effect of Image Styles on Empathy

1) Experiment 1: 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 results showed that the cognitive empathy scores 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 higher than that of landscape images ($M = 4.09$, $SE = 0.13$, 95% CI = [3.83, 4.34]), $p_s < 0.001$, and there were no significant differences between that of real faces and cartoon faces, $p > 0.05$. The effect of profile picture style on the affective empathy scores is not significant, $F_{(2.03,45.25)} = 1.11, {\eta_p}^2 = 0.04, p > 0.05$ (see the left of Fig. 4). Participants of experiment 1 showed higher cognitive empathy for 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 the affective experience.

2) Experiment 2: No effect of the profile picture style on the empathy scores (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 Fig. 4). This result suggests that no difference in cognitive empathy and affective empathy was found between the three styles of profile pictures.

3) Analyses of Integrated Data in Both Experiments 1 & 2: Since the effect of the profile picture style on empathy scores was not observed in experiment 2, we combined data from both experiments for analysis to further investigate whether the effect of the profile picture style on empathy is affected by stimulus size. The results of the 2 (stimulus size: large, small) ×3 (image style of profile types: real face, cartoon face, and landscape) MANOVA showed that the main effect of image style and the interactive effect of two factors for cognitive empathy was significant, $F_s > 2.31$, $p_s < 0.039$. The pairwise comparisons for the main effect of image style suggested that participants were more likely to experience higher cognitive empathy when their friends used 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 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 rating scores 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 affective empathy, no effect or interactive effect was found, $F_s < 1.40, p_s > 0.143$, indicating that the participants' affective empathy did not change for their online friends using different styles of profile pictures.

Our results indicate higher empathy scores for face-style profile pictures. Compared to landscape images, individuals generally believed they could more effectively comprehend the emotions of online friends using face images (real or cartoon) as profile pictures. However, this perceived advantage of face-style profile pictures in fostering cognitive empathy diminished when the experiment was conducted on simulated profile pages viewed through participants' mobile phones. The advantage of face images in enhancing empathy, as revealed in our current study, aligns with the findings of the study conducted by Salminen et al. [48], which investigated how image styles affected user perceptions of personas and found that real face images received higher empathy ratings compared to those without pictures. This advantage may be attributed to the eye region in the face image, considering that cognitive empathy refers to understanding others' emotional statements involving cognitive process [29] and highly correlates to perspective taking [49]. It 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) [50], [51]. The attribution of the eye region also explains why the advantage of cartoon face images disappeared in the online experiment, where the size of the cartoon face profile photos used as stimuli was smaller, resulting in a smaller corresponding eye region and lower cognitive empathy rating. Moreover, the results show no difference in empathy scores between real and cartoon faces in either experiment. These indicate that participants' empathy for their friends using cartoon faces as profile pictures was not diminished compared to real face images, suggesting that the top-down process (where personal experience and cognition drive perception) is more important than the bottom-up process (which builds from the sensory information of stimuli, such as different cartoon styles [52]).

B. Effect of Image Styles on Identity Recognition

1) Experiment 1: The results on the sensitivity (d') of identity recognition in experiment 1 (see the left of Fig. 5) revealed a significant effect of the profile picture style

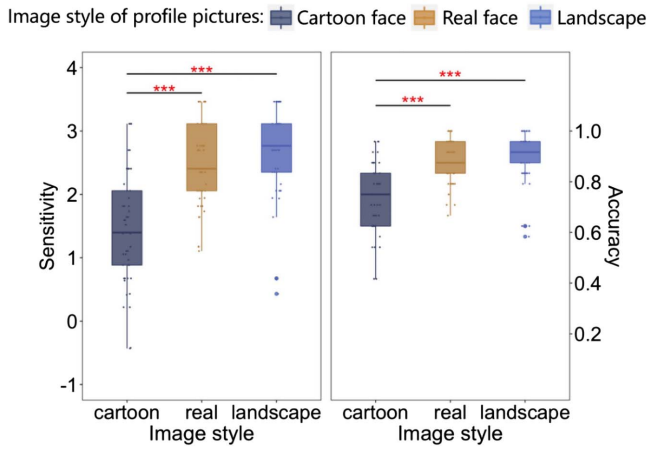

Fig. 5. Boxplots of the sensitivity d' (left) and accuracy (right) of identity recognition performance for three image styles of profile pictures in experiment 1.

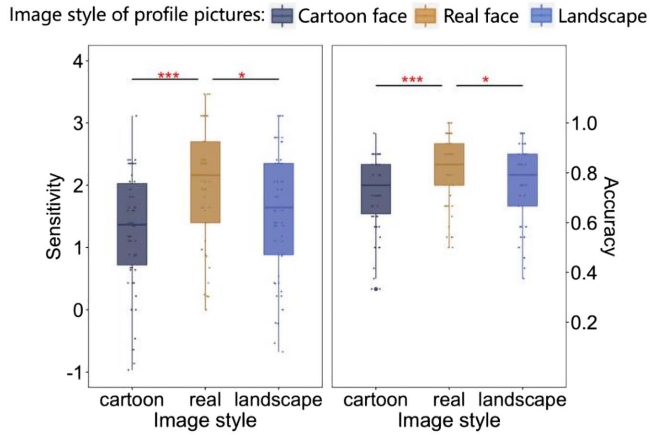

Fig. 6. Boxplots of the identity recognition performance sensitivity (left) and accuracy (right) for the three profile picture styles in experiment 2.

($F_{(2,94)} = 72.67, p < 0.001, \eta_p{}^2 = 0.61$). 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 there was 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 Fig. 5, $F_{(2,94)} = 70.48, p < 0.001, \eta_p{}^2 = 0.60$), and there was the same pattern of differentiation in impact between the 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], $p > 0.05$).

2) Experiment 2: The effect of the profile picture styles on the d' of identity recognition (see the left of 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 face ($M = 1.28$, $SE = 0.13$, 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 Fig. 6) was also significant, $F_{(2,170)} = 6.93, p = 0.001, \eta_p{}^2 = 0.08$. The accuracy was higher for real faces recognition ($M = 0.81$, $SE = 0.02$, 95% CI = [0.78, 0.85]) than that 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]), $p_s < 0.039$.

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. When recalling friends with real face images as profile pictures, participants achieved the highest accuracy and d', which means that real face profile images lead to a deeper impression than cartoon faces or landscape images. The identity recognition results for both experiments show that the best performance for recognizing online friends' identities was achieved when using real face profile pictures, indicating that real face profile pictures have a stable advantage over the others. Compared to real face style, cartoon face style was usually depicted by nonrealistic texture with exaggerated or weakened facial features [53], [54]. Using the same cartoon style, facial features tend to deform in the same way, and the facial regions of different cartoon pictures look similar. Participants need to recognize the cartoon character's identity not only by relying on facial features, but also on nonfacial features such as hairstyle and accessories [55].

Note that the recognition accuracy of real face images remains above 80% in both the immediate recognition and the next-day recognition after learning. 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 support that face recognition, including that of cartoon face style, is quite different from object recognition [4], [56], [57]. Due to the difficulty caused by the similarity of the stimuli, the recognition accuracy of the cartoon face style was lower than that of other conditions. However, the impression from face images in long-term memory may be more stable compared to that from landscape images as profile pictures. In addition, the d' of cartoon faces was significantly lower than that of real faces and landscape images. This result could be attributed to the similarity between the cartoon face images used in the experiment, whose distinctive features are not easily discernible, thereby posing a challenge for users to identify them.

C. Correlations

1) Experiment 1: The correlations matrix (see Fig. 7) was computed among data within each profile picture style. The results for cartoon faces showed that the correlations of affective empathy rating score with recognition accuracy [$r(48) = 0.29, p = 0.05$] and d'[$r(48) = 0.31, p = 0.03$] were significant,

	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

Fig. 7. Correlation matrix of coefficient (r) given by the variables of each style of profile pictures in experiment 1. Green indicates a higher, yellow indicates a lower r, and red mark indicates the r is significant, $p < 0.05$.

	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 Categerization	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

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

while the correlation was not significant for real faces and landscape images.

2) Experiment 2: To further investigate whether empathy scores and identity recognition were related to users' preference for the profile picture or in-group classification of the person using the profile picture, we additionally measured and analyzed the preference and social categorization ratings for profile pictures in experiment 2 (see Fig. 8). The correlation metrics were calculated with the entire profile picture dataset containing all three styles. The results suggested that affective empathy was positively correlated with arousal $[r(173) = 0.35, p < 0.001]$, valence $[r(173) < 0.15, p = 0.04]$, and more importantly, with social categorization $[r(173) = 0.24, p = 0.001]$.

Combining the results of two experiments, we found that real faces and cartoon faces induced stronger cognitive empathy, but only real faces had the advantage of identity recognition, which suggests that contextual information plays a crucial role in empathy [20], [22], [58], [59], [60], [61], i.e., for participants in the experiment, whether the person they empathize with was a real or virtual person and whether they were in-group or out-group members determined the level of empathy. Specifically, the rating of social categorization and affective empathy was positively correlated, indicating that participants who rated a higher score in the group task usually got a higher score in the affective empathy scale rating [21], [22]. In addition, the correlation metrics results also revealed that people's preferences for profile pictures were neither significantly correlated to empathy nor to identity recognition performance for their online friends.

For identity recognition in this study, the effect of profile image styles may rely more on bottom-up processing; that is, the form of stimuli, such as cartoon faces and real faces, impacted the identity recognition performance 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 showed that people performed better in recognition for in-group members than for out-group members [37]. However, no significant correlation was observed in the identity recognition performance nor in the rating of social categorization and preference in the current study. The reason may be that the authenticity of face profile pictures (real and cartoon faces) did not lead to changes in people's social categorization toward their friends. Additionally, our results revealed that the affective empathy rating for cartoon faces was positively correlated with the identity recognition performance, indicating that after imagining interactions with a friend using cartoon profile pictures, the participants who got a higher score on the affective empathy scale rating were more likely to show a better identity recognition performance than others. This finding could explain individual differences in empathy and identity recognition for profile pictures using cartoon faces: the more the users agreed that they respond to the emotional state of their online friends who use cartoon profile pictures, the deeper the impression that they have of these friends.

D. Interview

After the experiment, we also interviewed participants about the effects of different styles of profile pictures on empathy and identity recognition. The majority of the subjects reported that facial images led to better empathy, which is consistent with the results of the experiment. "I think real face images inspire more trust in me, which will enhance my level of empathy for their users." "I think people who use cartoon profile pictures share the same preferences as me and I am more likely to empathize with similar people." Some participants also mentioned that it was the effect of the eyes, "It feels like real people's eyes convey emotions more directly." When asked about the effect of different styles of profile pictures on identity recognition, the participants indicated that the variability between pictures within the style would affect their memorization, "The differences between the cartoon-face images given in the experiment were relatively minor, which increased my difficulty in memorizing their faces," "Compared to the landscape pictures and the cartoon pictures, I was able to access the features that distinguish that face from other faces more quickly when confronted with a real face, which helped me memorize it well."

VII. Discussion

We noted that participants' empathy scores were higher for users with cartoon or real face profile pictures (facial images)

compared to landscape profile pictures. This is probably because the facial images have humanlike characteristics. Humans have animate perception [62] and can distinguish animate and inanimate objects very easily, with humans having the highest animate properties, followed by animals, and finally, inanimate objects [63]. Landscape pictures often contain inanimate objects, which are much less animate than face pictures. Even under conditions of high perceptual load, faces attract more attention than other objects [64]. On the other hand, existing research suggests that the more similar a species is to humans, the more likely it is to trigger human empathy [65].

It is also observed that participants performed better in identity recognition for users with real face or landscape images as profile pictures than for those with cartoon face profile pictures. Several potential cognitive mechanisms may contribute to the result. First, real face and landscape images contain rich visual details, complexity, and familiarity that align with our lifetime experience and statistical knowledge of how people and environments actually appear. This high degree of realism and congruence facilitates robust encoding into memory and subsequent retrieval [66], [67], [68]. In contrast, cartoon face images are simplified, iconic representations lacking many unique identity cues present in real faces and deviate from the typical facial configurations we are accustomed to, potentially disrupting finely tuned face processing mechanisms in the brain and hindering identity encoding and recognition [69]. Second, to control for consistent styling and avoid background interference, we intentionally chose stylized cartoon avatars. However, this approach inadvertently heightened facial similarity among cartoon faces compared to real faces, increasing confusability and impairing discriminability. Additionally, by simplifying and distorting real-world representations, cartoon images introduced visual ambiguity, which may have taxed cognitive resources during encoding and recognition processes [70], [71].

Since all participants of the experiment were from China, we also explored the possible reasons for obtaining the above results in Chinese culture. In terms of empathy, Chinese society is influenced by the "collectivism" and interpersonal relationships are characterized by "emotionality" [72], i.e., people rely on each other in the interaction process and value interpersonal connections. Real and cartoon face images may bring people a more intimate feeling, and therefore get higher empathy scores. In terms of identity recognition, in addition to the reasons mentioned above that real faces and nature pictures contain rich visual details, complexity, and familiarity that align with our lifetime experience, we believe that this result may also be related to the Chinese culture of reverence for nature and the pursuit of harmony with nature [73], a cultural factor that also made the natural landscape images presented in the experiments meaningful to the participants. When the required memory material is linked to people's selves, the memorization effect is more optimal [74], and the identity recognition scores will be higher.

Research results indicate that users with real-face profile pictures tend to get better empathy and identity recognition, so we recommend using real-face images as profile pictures. If users do not want to use them for privacy or other considerations, they can choose the profile picture style according to their needs. For instance, if they wish to elicit better empathy from others, using cartoon face images would be preferable.

VIII. Limitations and Future Work

In this study, we recruited young adults, the most frequent social network users, and focused on the WeChat platform with which they are most familiar. In future work, we hope to broaden the age range of participants further and contribute to enhancing the social experience of all age groups. In addition, we aim to expand our study to encompass users from diverse regions and cultures, along with the social platforms they are most accustomed to using. This expansion will enable us to more comprehensively explore cultural consistencies and differences on a larger scale at a macro level. Moreover, we adhered to the classical methodologies in psychology research and utilized landscape images, a common choice among social network users, as representatives of nonface images. We plan to further diversify the range of profile picture styles to draw more comprehensive conclusions in our future research. Additionally, while the current study primarily relies on subjective ratings and behavioral performance as metrics, we aim to incorporate the analysis of brain activities in future work to uncover the underlying physiological mechanisms. Furthermore, we plan to conduct longitudinal research in which participants will be interviewed again after a period of time to explore whether people's perceptions of profile pictures change over time.

IX. Conclusion

Empathy and identity recognition are two crucial factors that enhance the effectiveness and efficiency of social interaction. In this study, we explore how a user's choice of social network profile pictures influences these two crucial factors. Two experiments were conducted, including a laboratory experiment with strict control of extraneous variables and an online experiment with relatively high ecological validity that is similar to daily life. The experiment results indicate that: 1) for cognitive empathy, the score of profile pictures with real faces and cartoon faces was higher than that for landscape pictures; 2) for affective empathy, the scores did not vary with the style of profile pictures; and 3) for identity recognition, real face profile images led to a deeper impression than cartoon face or landscape images. Moreover, we innovatively used social categorization theory to analyze the above results. Participants who scored higher on the social categorization task usually also scored higher on the emotional empathy scale scores, and they were positively correlated, which suggests that being perceived as an in-group member tends to result in better emotional empathy. Our work reveals the impact of different profile picture styles on empathy and identity recognition, providing insights for users to have a better social experience on online social networks.

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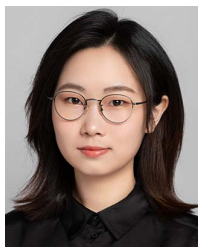

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