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# *An Analysis of Simple Lines and Emotions in Chinese Population: Concave for Happy, Convex for Sad*

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***Abstract:*** There has been an abiding interest in how faces convey emotions. The facial information related to the emotion can be processed from the face independently of the context. The purpose of this study was to investigate whether concave and convex lines could convey emotional meaning to Chinese participants. A total of forty Chinese university students participated in the study and completed an implicit association test. Participants were required to match basic lines (concave, convex, straight) with or without eye dots to emotion words ("happy" or "sad"). Results showed participants associated "happy" more quickly with concave lines and "sad" more quickly with convex lines compared to other lines. This provides preliminary evidence that simple lines can communicate emotions. However, differences in response times were not statistically significant. Adding eye shapes also did not significantly impact response speeds or change line-emotion associations. More research is needed to systematically test how basic shapes and facial features convey distinct emotions across cultures.

***Keywords:*** emotion perception, facial expression, implicit association test, concave lines, convex lines

## 1. Introduction

People have always been interested in how emotions are communicated through facial expressions. Research has shown that the visual features of a facial expression can be processed separately from the context and that these features can be broken down into simpler elements. Extensive prior research has demonstrated that specific facial components play a vital role in recognizing emotions from visual facial cues. The shape and position of eyebrows in particular are critical for interpreting emotions, with angled brows conveying negativity and arched brows expressing positivity. The shape and position of eyebrows in particular play a critical role in interpreting emotions from facial cues [1]. Specific eyebrow shapes like angled, down-turned brows convey negative emotions while arched, upturned brows express positivity. Beyond distinct eyebrows, the simple roundedness or angularity of basic shapes also impacts perceived emotions. People tend to judge rounded, curved shapes as happier and sharp, angular shapes as more negative [3]. This indicates basic lines and forms may also convey emotional meaning. In addition to distinct facial features like eyebrows and abstract shapes, eye shapes likely play an integral role in processing facial expressions holistically and interpreting emotions. Studies show the eyes grab attention rapidly and allow people to interpret social cues and the intentions of others [2]. This eye perception effect indicates that the

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presence, position, and form of eyeshapes may significantly influence how other facial features are processed when making emotion judgments.

In addition, cross-cultural research has demonstrated that culture influences how people perceive and judge emotional expressions. Studies show East Asian cultures tend to focus more holistically on the entire face when recognizing emotions, while Western cultures zero in on specific facial features like the eyes or mouth [4]. For example, Easterners look more at the nose area compared to Westerners when identifying facial expressions [5]. Cultures also differ in the extent to which they rely on context versus facial cues alone to interpret emotions. Masuda et al. [6] found that Japanese participants incorporated contextual information more than Americans when judging emotions. This aligns with analytic versus holistic processing biases across cultures. Finally, cultural norms shape emotional expression and perception. A study by Matsumoto et al. [7] showed that Japanese exhibit more muted expressions compared to Americans for some emotions, adhering to cultural display rules. Research also indicates Easterners perceive emotional intensity in faces differently than Westerners depending on expression type [8].

However, less research has examined whether simple lines and shapes convey specific emotions and if eye shapes impact this perception. It also remains unclear if these effects are consistent across cultures with different processing biases. The current study aimed to address these open questions. The study predicted participants would more easily associate concave lines with "happy" and convex lines with "sad" based on prior findings. The study also explored whether adding eye shapes would increase processing time, given the importance of eyes for facial recognition [9]. However, as East Asians tend to process faces more holistically, it was left open whether eye shapes may not alter perception for Chinese participants. This study tested these competing hypotheses regarding simple shapes, eye shapes, and cultural factors in emotion perception.

## 2. Method

### 2.1. Participants

The participants were 40 undergraduate students (13 males, $M_{age}$ = 19.89 years, $SD_{age}$ = 0.94, $range_{age}$ = 19-22 years) from UIC who volunteered for the 25-minute experiment. They were recruited via an informational questionnaire. Prior to beginning, all participants provided informed consent as approved by the UIC Ethics Committee. They received small gifts and benefits for participating. All recruits followed identical procedures for informed consent, participation, and compensation.

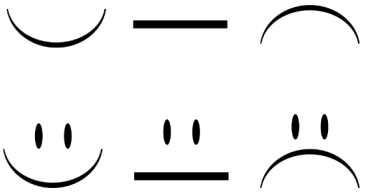

Figure 1: The visual stimuli showed to the participants.

### 2.2. Material

PsychoPy software 2022.2.4 (Psychology Software Tools, Inc.) presented the visual stimuli on a high-resolution monitor and recorded participants' responses. Adobe Illustrator created the concave, convex, and straight lines with or without eye dots (see Figure 1). An implicit association test (IAT) assessed the strength of associations between lines and emotion words. The IAT principle is that faster responses indicate easier associations between stimuli and concepts. Slower reactions and more errors occur when associations are difficult due to mismatched stimuli and semantics. Thus,

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IAT reaction times and errors evaluate the strength of connections between visual stimuli and emotions.

## 2.3. Design

The experiment design comprised six distinct IAT tests, each containing four stages. Concave lines were associated with happiness while convex lines conveyed sadness. Pairing concave lines with "happy" represented a congruent trial, while pairing convex lines with "happy" was incongruent. Stages 1 and 2 of each IAT were congruent pairings, while stages 3 and 4 were incongruent pairings. There were two experimental conditions: lines with and without added eye ovals. Tests 1 through 3 used lines without eyes, while tests 4 through 6 included lines with eyes. To control for order effects, the condition order and IAT test order were fully counterbalanced. Chinese participants matched the lines and emoticons to emotion words "happy" or "sad" as phrases. The study utilized the brief IAT method, where participants pressed "K" when stimuli matched the instructed pairing, or "D" for mismatches, responding as rapidly as possible.

Table 1: Stages of each IATs presented to participants.

| | Stage 1 and 2 | | Stage 3 and 4 | |
|---|---|---|---|---|
| | Words | | Words | |
| IAT | Happy | Sad | Happy | Sad |
| Concave–convex | Concave | Convex | Convex | Concave |
| Concave–straight | Concave | Straight | Straight | Concave |
| Straight–convex | Straight | Convex | Convex | Straight |
| Concave–convex with eyes | Concave | Convex | Convex | Concave |
| Concave–straight with eyes | Concave | Straight | Straight | Concave |
| Straight–convex with eyes | Straight | Convex | Convex | Straight |

## 2.4. Procedure

Before starting the experiment, all participants were first required to provide informed consent confirming their voluntary participation. They were presented with details about the study purpose, risks, benefits, privacy protections, and ability to withdraw at any time without penalty. Only after signing the consent form were participants allowed to begin the study procedures.

At the outset, general instructions explained that participants needed to match lines or emoticons (simple lines with eye dots) to specific emotion words "happy" or "sad." For each IAT test, if the experimental stimulus matched the instruction (e.g. concave paired with "happy"), they should press "K." If the stimulus did not match (e.g. convex paired with "happy"), press "D." Speed and accuracy were equally emphasized. After being presented with an example trial pairing "concave" to "happy" and "convex" to "sad", participants were instructed to respond as rapidly as possible. Feedback was provided on each trial, indicating "incorrect", "correct" or "too slow" if responses exceeded 2500ms. There was also a 5s break between each completed IAT test. To ensure adequate trials for reliable data, the procedures of Sriram and Greenwald [10] were followed and 32 stimuli presentations were utilized in each test stage.

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### 2.5. Data Analysis Methods

SPSS 26 (Armonk, NY: IBM Corp.) was used to analyze the data. The method adopted was the same as Greenwald et al. [11]. First the D value for the whole six tests was calculated to see if there are existing differences in RT between congruent and incongruent phrase, then individual D was computed to find out if there are significant differences in line combinations (concave–convex, concave–straight, and straight–convex), with/without eyes condition and their interaction. The details were demonstrated as follows.

In order to get the whole D, the mean RT and standard deviation for four stages of each test were calculated. Then the mean difference between stage 1 and 3, and stage 2 and 4 was calculated. For example, the mean difference between stage 1 and stage 3 was computed for discovering the mean difference between with and without eyes in congruent stage for each IAT. After dividing it by its standard deviation and averaging the two ratios, the result was represented as D. There were six Ds in total.

As for the individual D, the wrong responses needed to be dealt with first. If participants chose a wrong answer, the RT was added 600ms based on the mean of the correct answers in that stage. All the procedures were identical for six IATs presented to the participants. Finally, a 2×3 repeated measures analysis of variance (ANOVA) was used to determine if there are any significant differences in IATs factors and eyes factors. It was also found out if two factors had interaction effect.

## 3. Results

Missing data (<1.5%) were replaced by within-subject mean substitution. Extreme D values were excluded (n=3). The average D-scores showed participants associated “happy” faster with concave lines and “sad” faster with convex lines compared to other lines, indicating basic lines convey emotional meaning. Higher D values illustrated that participants’ responded more quickly in the congruent phase than in the incongruent phase, further indicating that specific words were more easily associated with that line.

By analyzing data, results have shown that it was more easily to associate the word happy with concave line (without eyes D = 0.09, with eyes D = 0.16) compared to the straight line (without eyes D = -0.03, with eyes D = -0.01) and convex line. Also, it is more easily to connect sad with convex line. Moreover, RTs were faster in eyes condition, indicating that the presence of eyes can give an overall emotional conveyance, therefore subjects can respond faster when eyes are present. In addition, only in the concave-convex IAT can faster response in congruent phrase than incongruent stage be observed. Both the concave-straight IAT and straight-convex IAT showed an opposite direction.

A two-way repeated ANOVA was conducted after calculating the individual D, using the lines (concave, convex and straight) and with or without eyes as factors. Significant effect was not found for all the three factors: between lines $F(2, 74) = 1.03$, $p > .05$, $\eta_P^2 = 0.01$, the presence/absence of the eyes $F(1, 37) = 0.26$, $p > .05$, $\eta_P^2 = 0.03$ and the interaction between lines and eyes $F(2, 74) = 0.27$, $p > .05$, $\eta_P^2 = 0.01$. Results indicated that although there were some differences when average D was observed, the differences were not significant enough to tell them apart after calculating individual D..

## 4. Discussions

The results of this study provide some preliminary evidence that concave and convex lines can be matched to the specific emotions of “happy” and “sad.” The average D-scores showed participants

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associated “happy” more quickly with the concave lines compared to the straight and convex lines. They also matched “sad” more quickly with the convex lines. This suggests basic lines and shapes can convey emotional meaning, consistent with prior research showing rounded shapes express positivity while angled shapes convey negativity [12]. However, the differences in response times during congruent versus incongruent trials were not statistically significant according to the ANOVA results. This indicates the differences between the lines may not have been salient enough for participants to consistently distinguish between them. The contrast between the curved lines likely needs to exceed a certain threshold before subjects will reliably associate them with discrete emotions. These studies also extend the study by Larson et al. [13], which tested stimuli with the exception of the “V” and a downward-pointing triangle. The results suggest that simple visual stimuli like line segments or combinations of line segments can also be associated with emotions.

Moreover, eyes are usually regarded as containing significantly important emotional cues. Various researches have confirmed how important the eyes are when interpreting the facial expression. Interestingly, adding simple eye-like dots did not significantly influence response times or change associations between the lines and emotion words. It seems that eye shapes would not impact processing of other facial features given their importance in face perception [2]. A possibility is that the eye dots were too small or subtle to modify participants’ interpretations. The location of the eyes relative to the lines may also impact their effect. Further testing is needed on different eye shapes and positions. Also, the direct staring effect might explain this result. Böckler et al. [14] found that the most fundamental way that the eye contact affects us was due to that people could easily perceive it initially, which quickly captured attention faster. Colombatto et al. [15] showed that this phenomenon not only could be applied to eyes, but also could be used to eye-like shapes. Therefore, participants might process the images with eyes quickly and react faster because they gaze the picture directly and images with eyes give subjects a more integrated and pronounced emotional transmission.

More importantly, one potential reason the differences between lines were subtle relates to Chinese cultural factors. Research shows East Asians focus more holistically on the entire face when judging emotions, while Westerners zero in on specific facial features like the mouth or eyes [4]. Chinese participants may thus perceive the lines more gestalt-like rather than focusing on the distinct curved shapes. This could make it harder to elicit strong associations between discrete lines and specific emotions. Additionally, Chinese culture emphasizes emotional moderation and discourage strong displays of emotion [16]. This cultural norm of emotional restraint could make it more difficult for Chinese participants to associate highly exaggerated curved lines with intense emotions like happiness or sadness. More muted curves may feel conceptually congruent.

## 5. Conclusions

This study provided initial evidence that concave and convex lines can convey discrete emotions, with concave associating with “happy” and convex with “sad” for Chinese participants. However, differences in response times between line types were not statistically significant. This suggests the curvature contrast may need to exceed a certain threshold before facilitating reliable emotion associations. The lack of an eye shape effect also requires further investigation regarding position and size. Limitations of this exploratory research include small sample size and trial number, plus potential order effects. Also, the eye shapes may have been too subtle to significantly impact holistic facial processing. Finally, cultural factors likely influenced the perception of exaggerated curvatures as unnatural. Future research should use larger, cross-cultural samples and increased trials to better detect effects. Testing exaggerated curvatures or shapes with motion/color could increase salience. Systematically manipulating eye shape and position could isolate their influence. Comparing reactions to 2D versus 3D stimuli would also be informative. Finally, directly

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comparing Eastern and Western participants would reveal cultural differences in simple shape and facial feature processing during emotion judgments.

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