



Beyond the basic six, static, and WEIRD: Exploring the range of emotions conveyed by facial expressions[☆]

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ABSTRACT

Investigating the range of emotions conveyed through facial expressions has been a central focus of emotion research, yet most studies have concentrated on basic six emotions and static expressions within WEIRD populations. This research extends the scope by investigating how a wider range of emotions can be expressed through both dynamic and static facial expressions in a non-WEIRD context, specifically among Chinese individuals. In Experiment 1, we compiled a list of 536 emotion words based on previous research, from which 28 emotion words were carefully selected based on high typicality, low similarity ($N = 61$), and frequent association with facial expressions ($N = 105$). In Experiment 2, 64 Chinese participants posed facial expressions of these emotions, while an additional group of participants ($N = 782$) rated their perception of these expressions. Our findings revealed that 14 emotions were effectively conveyed through dynamic facial expressions, while 10 emotions were conveyed through static facial expressions. Notably, a dynamic advantage was observed in the recognition of 23 out of the 28 emotions, driven primarily by the dynamic features of the expressions rather than the specific facial configurations unique to dynamic expressions. These findings emphasize the importance of embracing diversity and considering a comprehensive range of dynamic facial expressions from non-WEIRD populations in future studies, ultimately advancing our understanding of emotion expression and perception.

Facial expressions serve as powerful indicators of emotions and are essential for effective human communication. Early research emphasized six “basic” emotions—anger, disgust, fear, sadness, surprise, and happiness (e.g., Ekman, Levenson, & Friesen, 1983; Ekman, Sorenson, & Friesen, 1969; Elfenbein & Ambady, 2002; Matsumoto, Yoo, & Fontaine, 2008). Yet, dozens of recent studies have challenged this limited scope, identifying a broader range of emotions associated with facial expressions, including amusement (e.g., Hejmadi, Davidson, & Rozin, 2000; Shiota, Campos, & Keltner, 2003), awe (e.g., Shiota et al., 2003), pride (e.g., Tracy & Robins, 2004, 2008), shame (e.g., Tracy & Matsumoto, 2008; Tracy, Robins, & Schriber, 2009), and embarrassment (e.g., Keltner, 1996; Keltner & Buswell, 1997). Large stimulus sets—such as the EU-Emotion stimulus set (O’Reilly et al., 2016) and Geneva Multimodal Emotion Portrayals (Bänziger, Mortillaro, & Scherer, 2012; Bänziger & Scherer, 2010)—now include over ten emotion categories (for review, see Krumhuber, Skora, Küster, & Fou, 2017). These advances prompt a fundamental question: How many distinct emotions

can facial expressions reliably convey?

Researchers have typically addressed this question from two complementary perspectives: emotion production and emotion perception. In emotion production studies, both spontaneous and posed expressions have been examined. Spontaneous expressions are elicited through mood inductions—such as images, film clips, memory recall, scripted interactions, and real-life events—and are then recorded and coded (e.g., Coan & Allen, 2007; Fang, Sauter, Heerdink, & Van Kleef, 2022; Fernández-Dols & Crivelli, 2013; Quigley, Lindquist, & Barrett, 2014; Reisenzein, Studtmann, & Horstmann, 2013; Siedlecka & Denson, 2019). For example, the facial expressions of pride and shame displayed by Olympic athletes after victories or losses have been systematically analyzed (Matsumoto & Willingham, 2009; Tracy & Matsumoto, 2008). Yet eliciting a full range of emotional states in a single laboratory study remains challenging (Coan & Allen, 2007; Siedlecka & Denson, 2019). Posed paradigms, in contrast, offer greater experimental control: participants receive emotion definitions or vignettes and are instructed to

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enact each emotion facially (sometimes with minimal hand gestures; Elfenbein, Beupré, Lévesque, & Hess, 2007; Fang et al., 2022; Shiota et al., 2003). Cordaro et al. (2018) conducted the most extensive study of this type, examining expressions for 22 emotional scenarios across participants from China, India, Japan, Korea, and the United States. Their scenarios included critical context around emotion concepts. However, because many of their categories originated from multimodal work, including body posture and vocalizations (Keltner, Sauter, Tracy, & Cowen, 2019; Sauter, 2017), it remains unclear which emotions are typically expressed through facial cues. Moreover, while they documented both shared and culture-specific muscle movements for each emotion, they did not assess whether these facial expressions were recognizable to observers.

In emotion perception studies, participants attempt to map facial displays onto emotion concepts—whether through forced-choice terms (e.g., Elfenbein et al., 2007), narrative matching (e.g., Cordaro et al., 2020), or open-ended labels (e.g., Crivelli, Russell, Jarillo, & Fernández-Dols, 2017; Haidt & Keltner, 1999). Cordaro et al. (2020) again pushed these boundaries by developing eighteen prototypical facial–bodily expressions grounded in empirical Facial Action Coding System (FACS) descriptions (Ekman & Friesen, 1978). Eight American posers received muscle-by-muscle instructions to configure each state, and observers were provided four options to choose the intended emotions. The results showed that observers across nine cultures recognized all eighteen categories at well above chance levels (but see Kollareth et al., 2023). However, these highly exaggerated, static displays may not capture the subtle variability of everyday expressions (Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019). Large-scale internet-mining studies have further gauged labeling consensus across dozens of naturalistic faces (Cowen & Keltner, 2020). Nevertheless, without self-reports from those who produced the expressions, their intended emotional meanings remain speculative.

Focusing exclusively on either the production or perception risks oversimplifying the variability of both processes and may overestimate the range of emotions that facial expressions can reliably convey. To provide a more accurate assessment, we propose an integrative approach: an emotion is “conveyable through facial expressions” only if it is produced by a sufficient sample of encoders, represented by non-stereotypical facial expressions, and consistently recognized by a sufficient sample of decoders. The present study applies this framework to identify which emotions can be reliably conveyed through facial expressions.

1. The dynamic advantage

While most research on facial emotions has predominantly focused on static images (Cordaro et al., 2020; Cowen & Keltner, 2020; Ekman et al., 1969), real-life facial expressions unfold over time (Krumhuber, Kappas, & Manstead, 2013; Krumhuber & Scherer, 2011; Tcherkassof, Bollon, Dubois, Pansu, & Adam, 2007). Dynamic features, such as motion direction, quality, and speed, carry rich social information beyond static facial configurations (Kamachi et al., 2013; Sowden, Schuster, Keating, Fraser, & Cook, 2021). Studies often report a “dynamic advantage”, where dynamic expressions are recognized more accurately than static ones (Krumhuber, Skora, Hill, & Lander, 2023; Recio, Schacht, & Sommer, 2013; Wehrle, Kaiser, Schmidt, & Scherer, 2000).

This advantage, however, appears inconsistent across studies. Several investigations have failed to replicate the dynamic advantage (Fiorentini & Viviani, 2011; Gold et al., 2013; Jiang et al., 2014; Widen & Russell, 2015), while others suggest that its magnitude depends on the recognizability of static expressions (Dobs et al., 2018; Krumhuber et al., 2023). When static expressions are hard to recognize—whether due to subtle emotional intensity (Ambadar, Schooler, & Cohn, 2005; Bould & Morris, 2008), ambiguity (Hess & Kleck, 1990; Orłowska et al., 2018; Zloteanu et al., 2018), or complex mental states like interest or disapproval (Back, Jordan, & Thomas, 2009; Dukes, Clément, Audrin, &

Mortillaro, 2017)—dynamic cues provide temporal information that enhances recognition. In contrast, when static expressions are easily interpretable, the dynamic advantage diminishes.

Preliminary evidence further suggests that the dynamic advantage may vary according to emotion type. The six basic emotions—including happiness, anger, disgust, fear, sadness, and surprise—are theorized as evolutionarily prepared affect programs with universal expressions (Ekman, 1992; Ekman & Cordaro, 2011). Other emotions, such as embarrassment, hubris, may lack such stereotyped prototypes and therefore depend more heavily on contextual and temporal information for accurate recognition. Consistent with this view, Nelson and Russell (2014) found that while dynamic expressions of embarrassment and hubris were recognized more accurately than their static counterparts, basic emotions and positive pride showed no such improvement. Similarly, Richoz et al. (2024) reported comparable recognition rates for dynamic and static expressions of basic emotions. Yet conflicting findings exist: Fujimura and Suzuki (2010) observed a dynamic advantage for happiness and fear but not for anger, sadness, or surprise (Gold et al., 2013; Johnston, Mayes, Hughes, & Young, 2013). The inconsistency of these results leaves unclear whether the dynamic advantage is consistently moderated by the basic six versus other emotion distinction.

In the present study, we aimed to elicit both static and dynamic facial expressions across a wide range of emotions to assess how many distinct emotions each format reliably conveys. We also sought to determine which emotions exhibit a dynamic advantage in recognition, and whether this advantage is influenced by the basic six versus other emotion distinction.

2. Universality debate and WEIRD bias

Foundational work on emotional facial expressions has largely sampled WEIRD—Western, Educated, Industrialized, Rich, and Democratic—populations, fueling debate over whether facial signals are universal or culture-specific (e.g., Ekman & Cordaro, 2011; Elfenbein & Ambady, 2003; Gendron, Crivelli, & Barrett, 2018; Jack, Garrod, Yu, Caldara, & Schyns, 2012; Keltner, Tracy, Sauter, & Cowen, 2019). Early studies suggested that facial expressions depicting the six basic emotions are highly similar across cultures (e.g., Ekman, 1973, 1998; Izard, 1971). That is, individuals from diverse cultural backgrounds exhibit comparable facial muscle movements (e.g., frowning when angry, smiling when happy) associated with particular emotions, as well as attribute similar emotions to particular patterns of facial muscle movements. However, recent studies have increasingly unveiled cultural variations in facial expressions of emotion (Chen & Jack, 2017; Elfenbein, 2013; Elfenbein et al., 2007; Elfenbein & Ambady, 2002; Fang et al., 2022; Fang, Van Kleef, & Sauter, 2019; Jack et al., 2012; Jack, Blais, Scheepers, Schyns, & Caldara, 2009; Jack, Sun, Delis, Garrod, & Schyns, 2016). For instance, Cordaro et al. (2018) discovered that even for basic emotions like anger, the action units (AUs) activated during facial expressions varied significantly across five countries, with only a 23% overlap in AUs shared by all countries. Similarly, Fang et al. (2022) demonstrated that the facial expressions of anger and disgust produced by Dutch participants were more distinct compared to those of Chinese participants. These findings highlight the importance of examining facial expressions of emotion within their specific cultural contexts.

To move beyond this WEIRD bias, our study focuses on a large non-WEIRD sample from China, representing approximately 17.2% of the global population (Worldometer, n.d.). By integrating both production and perception of facial expressions within this sample, we aim to reveal the range of emotions conveyed through static and dynamic expressions, while also identifying the corresponding facial muscle movements associated with each emotion.

3. The present research

This research was designed to address three key objectives: first, to

explore the range of emotions conveyed through static and dynamic facial expressions in a Chinese sample, and their corresponding facial AUs; second, to investigate which emotions exhibit a dynamic advantage in recognition—that is, which emotions are recognized more accurately in dynamic expressions compared to static ones; and third, to explore whether this dynamic advantage is moderated by the distinction between basic six and other emotions.

To achieve these goals, we conducted two experiments, as illustrated in Fig. 1. In Experiment 1, we generated an extensive list of candidate emotion terms from the literature and then used norming studies of typicality, semantic distinctiveness, and channel association (e.g., voice, face, body, touch) to select 28 labels that are both representative and commonly communicated via the face. Experiment 2 recruited 64 Chinese participants to pose facial expressions for each target emotion, guided by standardized definitions and evocative scenarios. We opted for posed rather than spontaneous displays to ensure clear, consistent signals—as facial expressions serve both expressive and communicative functions (Cordaro et al., 2018; Elfenbein et al., 2007; Jakobs, Manstead, & Fischer, 1999, 2001)—and to avoid potential suppression of spontaneous emotional displays in laboratory or collectivist-culture settings (Friesen, 1972; Jakobs et al., 2001; Matsumoto, 1990). A separate group of 782 observers then completed a forced-choice task, matching each still image and video clip to its intended emotion label.

4. Experiment 1

To identify emotional terms commonly associated with facial expressions, we began by compiling an extensive list of emotion words through a literature review, then assessed the typicality and similarity of these terms, followed by an evaluation of the expression channels (e.g., voice, facial expressions, body movements, touch) for each emotion. We report the methods used to determine sample size, data exclusions, manipulations, and measures in accordance with JARS (Appelbaum et al., 2018).

4.1. Stage 1.1: compiling emotion words

To gather a comprehensive list of emotion words, a thorough review of research on emotions in both Eastern and Western cultures up to 2021 was conducted. This review encompassed searches using keywords such as “emotion, emotion word, facial expression, face, database, culture” in several databases, including EBSCO, PsychINFO, Google Scholar, Web of Science, and CNKI (China National Knowledge Infrastructure). Through these searches, a wide range of literature reviews, meta-analyses, and studies focusing on emotion vocabulary and facial expressions were collected.

To further enrich the list, we included emotion words commonly experienced by Chinese individuals. These words were sourced from

emoticons on WeChat—a popular instant messaging application in China—and from self-reports provided by six native Chinese research assistants. Each WeChat emoji is accompanied by a descriptive label; we focused on face-related labels and excluded ambiguous labels (e.g., “emm”, “dizzy”) or those denoting non-emotional status (e.g., “sleepy”, “bye bye”). This additional step ensured that the final list captured the nuanced emotional repertoire specific to contemporary Chinese culture, beyond what was reflected in the existing academic literature. Notably, the literature search had already identified the majority of emotion words ($N = 579$), with this supplementary step adding only a small number of additional terms ($N = 19$).

In total, we compiled 598 emotion words, including 460 Chinese words and 138 English words. To ensure accurate translation of English emotion words into Chinese, a standard translation/back-translation procedure was employed. Among the English words, 126 were directly translated and 12 were split into two Chinese words, with 74 of the resulting words overlapping with existing Chinese words. After removing duplicates, the word list contained 536 emotion words (see OSF link for details: https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc).

4.2. Stage 1.2: assessing emotion typicality and similarity

In order to refine the emotion word list, the pool of 536 emotion words was carefully assessed by the first and last authors, both of whom were native Chinese speakers. Their aim was to identify words that demonstrated higher emotion typicality and lower similarity. For instance, “amusement” was recognized for its higher emotion typicality, while “beautiful” demonstrated lower emotion typicality. As a result, “amusement” was included whereas “beautiful” was excluded. Furthermore, in light of their notable similarity, “happiness” was chosen over “joy”. With the overarching goal of maximizing the inclusion of emotion words, the authors arrived at a set of 159 carefully selected emotion words. It should be noted that a high proportion of emotion words in Chinese describe external expressions (Ng, Cui, & Cavallaro, 2019).

To further refine the compilation of emotion words, a group of participants were recruited to evaluate the similarity between pairs of emotion words. If we were to combine any two words from a pool of 159 emotion words, we would obtain a total of 12,561 word pairs. Considering that the majority of these word pairs would have very low similarity (e.g., “happiness” and “embarrassment”), three research assistants (including the first and second authors), all native Chinese speakers, identified emotion word pairs that could potentially be confusing (e.g., “pride” and “proud”, “anxiety” and “unease”). Based on the pairing results from the three assistants, we ultimately obtained 174 word pairs. These pairs were randomly divided into two groups, with the order of the words within each pair (A–B, B–A) further reversed, resulting in four subsets for evaluation.

4.2.1. Participants

To ensure high inter-rater reliability, we recruited approximately 30 participants to rate each word pair (Bjornsdottir & Rule, 2017; Rule, Bjornsdottir, Tskhay, & Ambady, 2016). A total of 61 Chinese participants ($M_{\text{age}} = 20.66$, $SD = 2.26$; 45 females, 16 males) were recruited from a university in China. They were all university students and were of similar education level and socioeconomic status. They received CNY ¥7.5 as compensation for their participation. The study received ethical approval from the university ethics committee, and all participants provided informed consent prior to their involvement.

4.2.2. Procedure

The task was conducted on a Chinese online questionnaire platform (<https://www.wenjuan.com/>). Participants were assigned randomly to one of the four subsets, and the presentation order of the word pairs was randomized. Participants were instructed to evaluate the level of

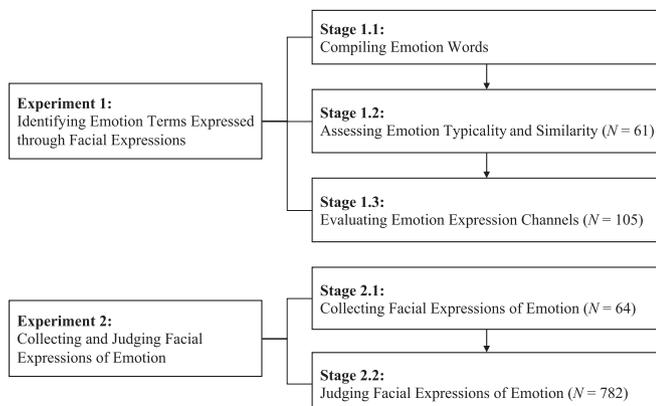


Fig. 1. The framework of the present research.

similarity between the two emotion words using a Likert scale ranging from 1 (*extremely dissimilar*) to 9 (*extremely similar*).

4.3. Results

For word pairs with an average similarity rating greater than or equal to 5, only one emotion word was retained. Since an emotion word may appear in multiple word pairs, we selected the word with a lower similarity to other emotion words. In situations where there was a discrepancy in retaining emotion words between word pairs (e.g., retaining the emotion word “A” in word pair 1 due to a similarity rating smaller than 5, while removing it in word pair 2 due to a similarity rating greater than 5 and higher similarity with other emotion words), the decision was made by the last author. Consequently, we obtained a total of 99 emotion words (see Table S1).

4.4. Stage 1.3: evaluating emotion expression channels

From the 99 selected emotion words, we further identified the emotions most commonly conveyed through facial expressions compared to other communication channels such as voice or body movements. To accomplish this, we recruited a group of participants to assess the expression channels for these emotions. The 99 emotion words were randomly divided into two subsets for evaluation. However, four emotion words (shock, anger, disgust, and regret) were inadvertently omitted initially. Consequently, we recruited a separate group of participants to evaluate the expression channels specifically for these four emotion words.

4.4.1. Participants

To ensure high inter-rater reliability, we recruited approximately 30 participants to rate each emotion word (Bjornsdottir & Rule, 2017; Rule et al., 2016). A total of 105 Chinese participants ($M_{age} = 20.52$, $SD = 2.42$; 80 females, 25 males) from a university in China, completed one subset from the three subsets. They were all university students and were of similar education level and socioeconomic status. Participants received CNY ¥15 as compensation for their participation.

4.4.2. Procedure

The task was conducted using the Qualtrics survey platform (<https://www.qualtrics.com/>). Participants were first presented with an emotion word, its definition in the *Modern Chinese Dictionary* (Institute of Linguistics, Chinese Academy of Social Sciences, 2016), and a situation that could elicit the particular emotion. Subsequently, participants were asked to rate the valence (ranging from -4 , indicating *extremely negative*, to $+4$, indicating *extremely positive*) and arousal (ranging from 1, indicating *extremely low arousal*, to 9, indicating *extremely high arousal*) associated with the emotion. Finally, participants were asked to select one or more options from voice, facial expressions, body movements, verbal language, touch, art, solely internal experience, and other (with the option to provide their answer) to indicate how they typically express the given emotion. The order of emotion words was randomized.

4.5. Results and discussion

For each emotion word, we calculated the mean valence, mean arousal, and the selection rate for each expression channel. The selection rate for a specific expression channel associated with an emotion word was determined by dividing the number of participants who chose that channel by the total number of participants who judged the emotion word. Detailed results can be found in Supplementary Table S1. To limit the number of emotion words down to a controllable level, emotion words with a selection rate equal to or greater than 85 % for the facial expression channel, and higher than other expression channels, were included in the current research. Additionally, we included all basic emotions (anger, disgust, fear, happiness, sadness, and surprise; Ekman,

1992), as well as neutrality. Table 1 presents the 27 emotion words that met the aforementioned criteria, along with their corresponding valence, arousal, and selection rates for each expression channel.

5. Experiment 2

We initially identified a preliminary set of 27 emotion words in Experiment 1. However, upon careful examination, we recognized that the Chinese translation for the emotion word “disgust” — “厌恶” — was more closely associated with moral disgust rather than physical disgust (Yoder, Widen, & Russell, 2016). To account for the potential differentiation between moral and physical disgust proposed by previous research (Rozin, Lowery, & Ebert, 1994; Widen, Pochedly, Pieloch, & Russell, 2013), we decided to include the Chinese translation “恶心” (translated as “grossed out”) to specifically capture the concept of physical disgust. As a result, we expanded the emotion set to a total of 28 emotions for Experiment 2.

In Experiment 2, one group of participants posed facial expressions for each of the 28 emotions, and a separate group of participants rated their perceptions.¹ The objectives of this experiment were threefold: (a) to investigate which emotions can be effectively conveyed through static or dynamic facial expressions, along with their corresponding facial AUs, (b) to determine which emotions exhibit a dynamic advantage in recognition, and (c) to explore whether this dynamic advantage is moderated by the distinction between basic six and other emotions.

5.1. Stage 2.1: collecting facial expressions of emotion

5.1.1. Participants

Due to the time-consuming and labor-intensive nature of collecting facial expressions of emotions, previous studies have typically limited the number of participants to fewer than 30 (Cordaro et al., 2018; Elfenbein et al., 2007; Van der Schalk, Hawk, Fischer, & Doosje, 2011). In our study, we aimed to recruit a minimum of 50 participants for each emotion. A total of 67 Chinese participants were recruited as encoders from a university in China. Data from three participants were excluded due to video camera malfunction, an extended residency in Japan, and refusal to authorize the use of the recordings. As a result, the final sample consisted of 64 participants ($M_{age} = 19.89$, $SD = 1.98$; 34 females, 30 males), all non-performance major university students with similar socioeconomic status.

Notably, the emotion “grossed out (恶心)” was included after initial data collection from a group of 37 participants. We subsequently contacted these participants, and 23 agreed to perform the grossed-out expression. Consequently, we had 50 participants posing grossed-out expressions and 64 participants posing the other 27 expressions of emotion. Participants received CNY ¥30 as compensation. The study received ethical approval from the university ethics committee, and all participants provided written informed consent prior to their participation.

5.1.2. Procedure

The setup for capturing facial expressions is illustrated in Fig. 2. Participants were seated on a comfortable chair, positioning their backs against a matte white wall and facing directly towards the camera. They were instructed to avoid makeup, glasses, or jewelry, and to ensure that their hair did not obstruct their faces. Additionally, each participant wore either their own or a provided white T-shirt.

¹ We also recruited a separate group of participants to evaluate the neutral faces of the encoders in terms of personality traits (e.g., dominance and trustworthiness). As these judgments were not the primary focus of the present research, details regarding these evaluations can be accessed through OSF at https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc.

Table 1
Valence Ratings (SDs), Arousal Ratings (SDs), and selection rates for each expression channel of 27 emotions.

Emotion	Valence	Arousal	Voice	Facial Expressions	Body Movements	Verbal Language	Touch	Art	Solely Inner Experience
Anger (气愤)	-1.47 (2.13)	6.73 (1.51)	0.47	0.77	0.43	0.87	0.20	0.03	0.20
Anxiousness (焦急)	-2.05 (1.35)	7.08 (1.28)	0.43	0.86	0.65	0.65	0.19	0.03	0.08
Awe (令人惊叹)	1.54 (1.17)	6.24 (1.71)	0.76	0.86	0.54	0.81	0.14	0.08	0.03
Bitter Smile (苦笑)	-2.32 (1.00)	5.00 (1.58)	0.24	0.97	0.18	0.18	0.00	0.00	0.11
Chuckle (偷笑)	0.14 (1.40)	5.35 (1.42)	0.54	0.95	0.49	0.14	0.11	0.00	0.00
Confusion (困惑)	-0.95 (1.20)	5.19 (1.37)	0.22	0.89	0.27	0.59	0.03	0.05	0.05
Contempt (轻蔑)	-2.32 (1.02)	4.82 (1.37)	0.29	0.92	0.29	0.50	0.03	0.00	0.08
Discouragement (气馁)	-2.43 (1.09)	4.38 (1.60)	0.19	0.89	0.46	0.54	0.08	0.03	0.14
Disgust (厌恶)	-1.87 (1.72)	6.10 (1.54)	0.20	0.87	0.20	0.83	0.23	0.03	0.17
Distress (苦恼)	-2.32 (1.00)	5.00 (1.58)	0.24	0.89	0.38	0.57	0.05	0.00	0.14
Excitement (兴奋)	2.84 (1.00)	8.50 (0.88)	0.95	0.95	0.95	0.87	0.76	0.05	0.00
Fear (恐惧)	-2.70 (1.53)	7.00 (1.31)	0.81	0.76	0.68	0.43	0.32	0.11	0.11
Grief (悲痛)	-3.14 (1.53)	7.14 (1.42)	0.57	0.89	0.54	0.65	0.46	0.24	0.14
Grievance (委屈)	-1.93 (1.28)	5.61 (1.94)	0.37	0.92	0.39	0.58	0.24	0.05	0.08
Happiness (开心)	3.01 (0.98)	7.29 (1.61)	0.87	0.89	0.79	0.79	0.66	0.24	0.03
Irresistible Laugh (忍俊不禁)	1.73 (1.24)	5.78 (1.38)	0.49	0.95	0.41	0.43	0.11	0.00	0.05
Irritability (烦躁)	-2.70 (1.43)	6.78 (1.18)	0.43	0.86	0.73	0.70	0.19	0.08	0.11
Listlessness (萎靡)	-3.22 (0.75)	3.49 (1.54)	0.14	0.86	0.62	0.32	0.05	0.16	0.14
Neutrality (中性)	0.00 (0.00)	3.71 (1.87)	0.03	0.32	0.05	0.13	0.00	0.00	0.79
Pleasant Surprise (惊喜)	2.56 (1.28)	7.57 (1.44)	0.84	0.89	0.74	0.76	0.39	0.03	0.05
Sadness (悲伤)	-3.11 (0.99)	5.54 (1.77)	0.30	0.86	0.43	0.59	0.30	0.22	0.16
Shyness (害羞)	-0.16 (1.01)	5.27 (1.56)	0.14	0.92	0.14	0.22	0.11	0.05	0.11
Sinister Smile (奸笑)	-1.51 (1.57)	5.24 (1.28)	0.65	0.89	0.27	0.03	0.03	0.03	0.08
Smile (微笑)	1.86 (1.11)	4.78 (1.84)	0.08	0.00	0.03	0.03	0.05	0.00	0.03
Snicker (坏笑)	-1.29 (1.49)	5.26 (1.54)	0.58	0.89	0.16	0.18	0.03	0.00	0.00
Surprise (惊讶)	0.19 (0.46)	6.05 (1.53)	0.73	0.95	0.41	0.46	0.03	0.00	0.03
Triumph (胜利)	3.05 (0.98)	7.45 (1.41)	0.84	0.87	0.84	0.74	0.63	0.05	0.08

The numbers within brackets indicate standard deviations.

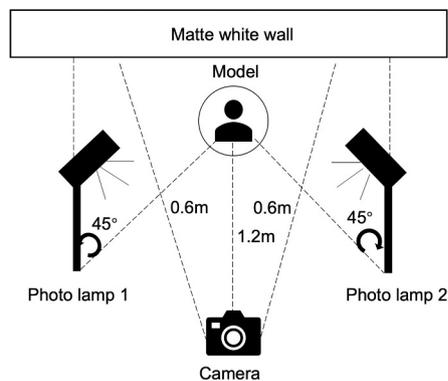


Fig. 2. Illustration of facial expression capture setup.

Facial expressions were recorded using a SONY ZV-1 digital camera set to 1920×1080 pixels at 50fps. The camera was placed approximately 1.2 m in front of the participant, with its height adjusted to the tip of the nose. To ensure even and soft lighting while minimizing shadows, two professional photo lamps were placed at approximately 60 cm away at a 45° angle. Ceiling lights were turned off, and no flash was used. The camera recorded continuously throughout the entire performance.

During the experiment, participants were instructed to sequentially perform facial expressions for 28 emotions, with the order randomized across participants. For each emotion, they were provided with its definition from the *Modern Chinese Dictionary* (Institute of Linguistics, Chinese Academy of Social Sciences, 2016) and a situation likely to elicit that emotion (see Table S2). They were then asked to recall personal experiences related to the emotion and immerse themselves in that emotional state. After this reflection, participants practiced the corresponding facial expression using a mirror. Once ready, they raised their hand and verbally recited the emotion word to facilitate locating the relevant expressions in the subsequent video review. After reciting the word, participants transitioned from a neutral expression to the target

emotion expression. They were instructed to avoid covering their faces, minimize body movements, focus exclusively on their facial expressions. No guidance or feedback regarding facial expressions was provided by the experimenters. After each expression, participants rated the difficulty of performing that specific expression on a scale ranging from 1 (*very easy*) to 9 (*very difficult*).

Following the performance, participants reviewed their recordings using Adobe Premiere Pro 2022 on a laptop. For each emotion, they selected the frame that best represented their intended expression. This approach ensured the chosen frame accurately reflected the participant's intended emotion, minimizing any potential bias from experimenter's selection of prototypical expressions. Once a frame was chosen, participants rated the intensity and clarity of the expression on a Likert scale ranging from 1 (*extremely low/unclear*) to 9 (*extremely high/clear*). If dissatisfied with their expression, participants had the option to request a re-recording and repeat the above process.

5.2. Extraction and standardization of facial expression stimuli

For static expressions, facial images were extracted from video frames selected by the participants. Corresponding dynamic expressions were defined by research assistants, who identified and labeled continuous clips beginning at the onset of minimal facial muscle movement preceding the chosen static frame and extending through the apex of expression. These dynamic segments ranged from 1 to 4 s in duration.

Standardization of facial expression was carried out through batch processing using a Python script. Facial landmarks were identified with the `face_recognition` library (version 1.3.0, <https://pypi.org/project/face-recognition/>), and image and video extraction utilized the `FFmpeg` library (version 4.2.2, <https://ffmpeg.org/>). Manual standardization was performed for cases unprocessable by the script. The region of interest was standardized to encompass core facial features, defined as the vertical distance between the lowest point of the inner brows and the highest point of the lips multiplied by the maximum visible horizontal distance of the cheekbones, fixed at 80,000 pixels. Images and videos were then cropped to a 1000×1000 pixel area centered around these core facial features.

Following this standardization process, we obtained a total of 1778 standardized dynamic/static expressions (28 emotional expressions per participant \times 50 participants + 27 emotional expressions per participant \times 14 participants).

5.3. Stage 2.2: judging facial expressions of emotion

5.3.1. Participants

A total of 1778 static facial expression images and 1778 dynamic facial expression videos were randomly divided into 30 subsets, respectively. Each subset consisted of either 59 or 60 stimuli, encompassing 28 emotions by a range of 33 and 43 encoders. The gender distribution of the encoders was similar across all subsets.

To ensure the robust evaluation of the collected emotional facial expressions, we followed previous research protocols by collecting evaluations from a minimum of 20 participants for each subset (Bänziger et al., 2012; O'Reilly et al., 2016). Once this criterion was met, data collection for that particular subset was concluded. In total, we recruited 808 Chinese participants who participated as decoders in one or more subsets' evaluations. Data from some participants were excluded due to (a) failure to pass the attention check ($N = 41$), (b) repeated completion of the same subset ($N = 2$), (c) emotion recognition accuracy below 3 standard deviations ($N = 2$), or (d) prior participation in the production of facial expressions ($N = 1$). The final sample consisted of 782 participants, with 415 participants ($M_{\text{age}} = 21.60$, $SD = 4.13$; 197 females, 218 males) evaluating static expressions, and 386 participants ($M_{\text{age}} = 20.06$, $SD = 2.46$; 260 females, 126 males) judging dynamic expressions. Notably, 19 participants took part in the evaluation of both static and dynamic expressions, but they did not evaluate the same encoders or emotions in both formats. The majority of participants were university students with similar socioeconomic status, and they received CNY ¥15 or course credits as compensation for their participation. We conducted a simulation-based sensitivity power analysis for generalized linear mixed model (GLMM)—following Kumble, Vö, and Draschkow (2021) and Green and MacLeod (2016)—using an assumed random effect (variance) of 1.0 for both Encoder and Decoder (Kamiloglu, Boateng, Balabanova, Cao, & Sauter, 2021). The R code is publicly available (https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc). Results from 1000 simulations indicated that this sample size could provide 80 % power to detect fixed-effect coefficients of $B = 0.47$ or higher when testing recognition rates against chance at $\alpha = 0.05$.

5.3.2. Procedure

The task was administered using the Qualtrics survey platform (<https://www.qualtrics.com/>). During each trial, participants were presented with either a static or dynamic facial expression and were then asked to: (a) select the emotion category that best matched the displayed expression from a list of 29 options (28 emotions arranged alphabetically by pinyin, plus a "None of the above" option with an open-ended response box); (b) rate the intensity of the emotion on a scale from 1 (*extremely weak*) to 9 (*extremely strong*); (c) rate the clarity of the

emotion on a scale from 1 (*extremely unclear*) to 9 (*extremely clear*); (d) rate the valence of the emotion on a scale from -4 (*extremely negative*) to $+4$ (*extremely positive*); (e) rate the level of arousal elicited by the emotion on a scale from 1 (*extremely low arousal*) to 9 (*extremely high arousal*); and (f) rate the authenticity of the emotion on a scale from -4 (*extremely fake*) to $+4$ (*extremely authentic*). Facial stimuli were displayed at a size of 300×300 pixels at the top of the participant's screen and remained visible until all evaluations were completed.² Dynamic facial stimuli were looped continuously throughout the evaluation period. An example of the survey in English is available at: https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc.

5.4. Results and discussion

Because our primary focus was on emotion categorization accuracy, we report only those findings here. Additional data on other stimulus dimensions (e.g., valence, arousal, and authenticity) are available on OSF at https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc. The following analyses address three objectives in sequence: (a) identifying which emotions can be reliably conveyed by static versus dynamic facial expressions (and their associated AUs), (b) determining which emotions benefit from a recognition advantage when presented dynamically, and (c) examining whether this dynamic advantage varies between basic six and other emotions.

5.4.1. Which emotions can be conveyed through static or dynamic facial expressions?

To investigate the emotions that can be effectively conveyed through static or dynamic facial expressions, we employed two criteria: (a) recognition rates had to exceed chance levels, and (b) recognition rates for the intended emotion (i.e., the emotion intended by the facial expression) needed to be higher than those for non-intended emotions.

To directly assess recognition accuracy, we analyzed each emotion separately for dynamic and static expressions using GLMMs. This approach avoided the complexities associated with fitting a single large model (which would require 56 coefficients: 28 emotions \times 2 presentation formats) and prevented potential convergence issues, while preserving the unique variance structure for each emotion-presentation combination. Given that recognition errors typically occur within the same valence category (see e.g., Kollareth, Esposito, Ma, Brownell, & Russell, 2020), we conservatively set a uniform chance recognition level at 0.10 across all emotions, corresponding to the number of positive emotions in our set (10 positive vs. 16 negative emotions). The logit value of chance level (0.1) served as an offset term in the GLMMs, with Encoder and Decoder as random factors and recognition accuracy (1 = correct, 0 = incorrect) as the dependent variable. Each emotion-presentation combination was analyzed using the following formula: $\text{glmer}(\text{Accuracy} \sim \text{offset}(\text{logit}(0.1)) + 1 + (1|\text{Encoder}) + (1|\text{Decoder}), \text{family} = \text{binomial}(\text{link} = \text{"logit"}))$. This analytical approach, also adopted by Kamiloglu et al. (2021), effectively accounted for variability across encoders and decoders through crossed random effects (Judd,

² Because participants could use any device (e.g., smartphones, tablets, computers) to complete the online evaluations, we did not control the viewing distance or visual angle. Previous studies suggest that facial expression recognition is generally robust to variations in stimulus size and viewing distance (Guo, 2013; Lee, Matsumiya, & Wilson, 2006), likely due to perceptual constancy (Walsh & Kulikowski, 1998). Although some work indicates that stimulus size can influence perceived emotional intensity (Gerhardsson et al., 2015) or affect the evaluation of highly ambiguous expressions (e.g., morphed images; Wang, 2018), we did not find strong evidence that uncontrolled stimulus size substantially impacts emotion recognition accuracy. We note, however, that this lack of control may affect evaluations of ambiguous expressions more than those of clearer ones.

Westfall, & Kenny, 2012). Our results revealed that recognition rates for 17 dynamic and 10 static facial expressions were significantly higher than the 0.10 chance level (see Table 2 for full results and Table S3 for corresponding random effects).

Next, we examined the confusion matrices (Fig. 3) to determine whether the intended emotion achieved the highest recognition rate. This information is denoted by “y” in the “Highest Score” column of Table 2. Notably, 18 dynamic facial expressions and 12 static facial expressions obtained the highest recognition rates for their intended emotions.

By meeting both criteria, our findings demonstrated that observers were able to recognize 14 emotions through dynamic facial expressions, compared to 10 emotions through static facial expressions. These results suggest that dynamic expressions could convey a wider range of

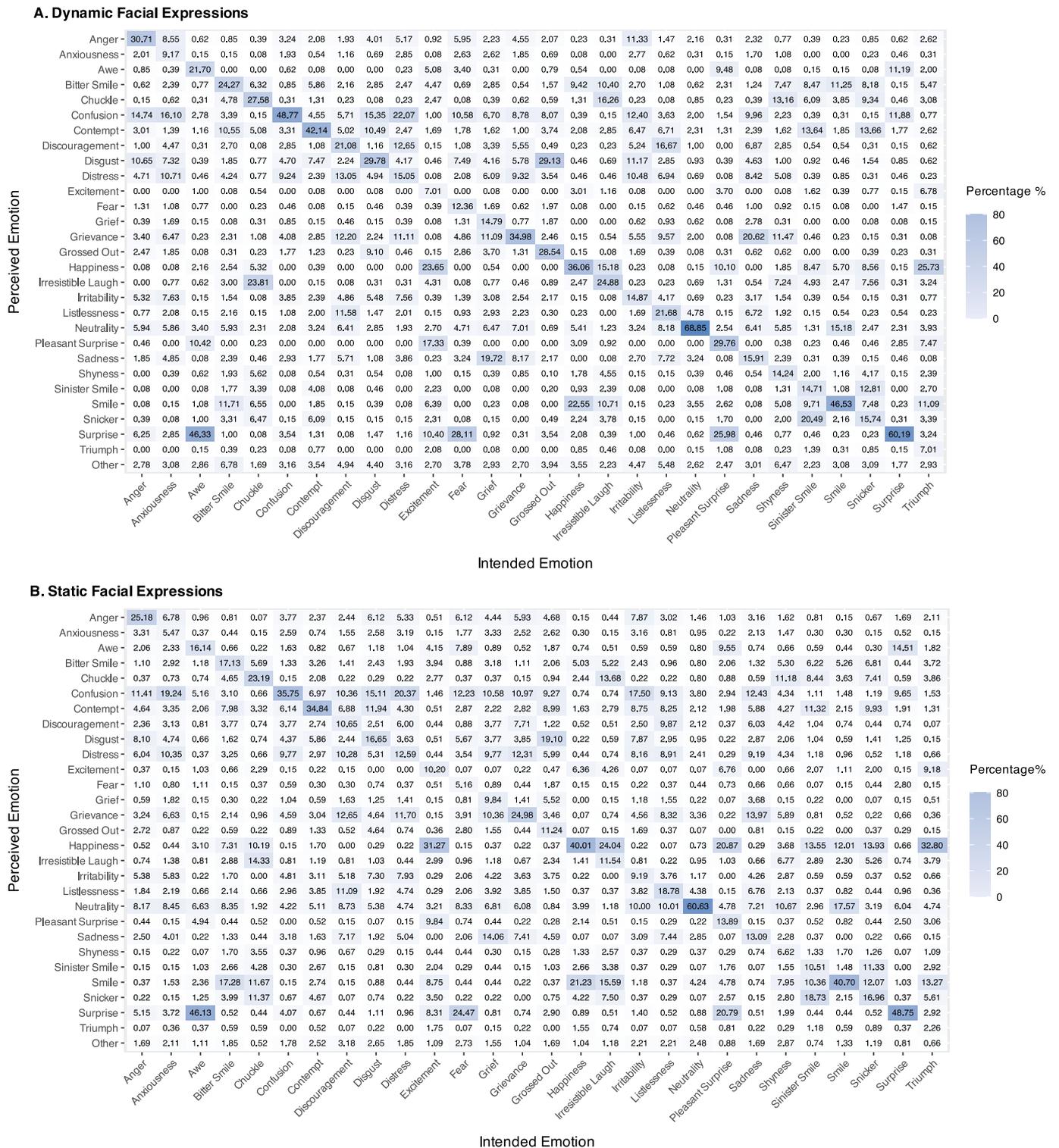
emotions than static expressions.

To uncover AU activation in the 13 dynamic expressions and 9 static expressions (excluding neutrality), we employed FaceReader 9 (Noldus, 2021) to code all instances in which (a) recognition accuracy for the intended emotion exceeded 0.10 and (b) the intended emotion was the most frequently chosen label. This resulted in a total of 434 dynamic and 302 static expressions. FaceReader 9 quantifies 20 AUs (AU1, 2, 4, 5, 6, 7, 9, 10, 12, 14, 15, 17, 18, 20, 23, 24, 25, 26, 27, and 43) on a frame-by-frame basis across six intensity bands: not active – [0, 0.1], A – [0.1, 0.217], B – [0.217, 0.334], C – [0.334, 0.622], D – [0.622, 0.910], E – [0.910, 1]. An AU was considered active at band A or above (intensity ≥ 0.1), and for dynamic expressions, an AU was counted as active if it reached this threshold in any frame. We excluded AU43 (Eye closure) because blinking rendered it universally active. Fig. 4 presents the

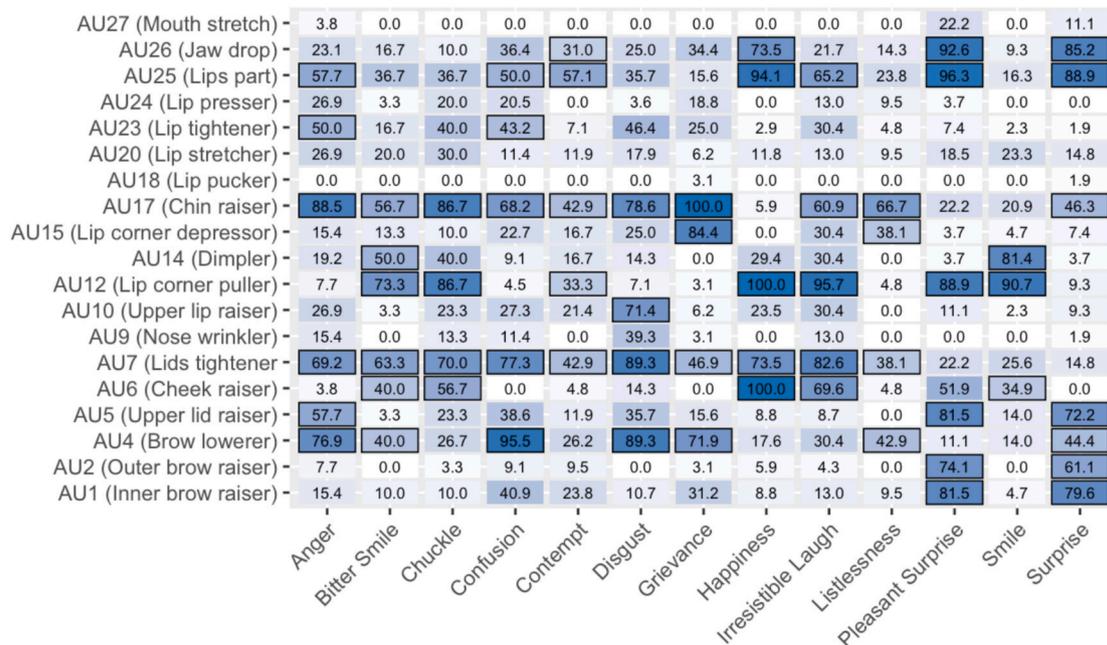
Table 2
Mean recognition rates and GLMMs of dynamic and static facial expressions for 28 emotions.

Emotion	Dynamic						Static					
	Mean	B	95 % CI	Z	p	Highest Score	Mean	B	95 % CI	Z	p	Highest Score
Anger (气愤)	0.31	0.86	[0.36, 1.36]	3.35	<	y	0.24	0.73	[0.33, 1.14]	3.54	<	y
Anxiousness (焦急)	0.09	-1.24	[-1.94, -0.55]	-3.51	<	n	0.06	-1.47	[-2.21, -0.73]	-3.88	<	n
Awe (令人惊叹)	0.22	0.57	[0.26, 0.88]	3.58	<	n	0.16	0.22	[-0.07, 0.52]	1.48	0.138	n
Bitter Smile (苦笑)	0.24	0.84	[0.57, 1.11]	6.19	<	y	0.17	0.29	[-0.02, 0.60]	1.83	0.067	n
Chuckle (偷笑)	0.28	1.01	[0.76, 1.27]	7.78	<	y	0.23	0.51	[0.17, 0.85]	2.91	0.004	y
Confusion (困惑)	0.49	2.08	[1.61, 2.56]	8.61	<	y	0.35	1.30	[0.93, 1.68]	6.78	<	y
Contempt (轻蔑)	0.42	1.73	[1.33, 2.12]	8.64	<	y	0.35	1.29	[0.89, 1.68]	6.40	<	y
Discouragement (气馁)	0.21	0.34	[-0.08, 0.76]	1.58	<	y	0.11	-0.30	[-0.67, 0.06]	-1.64	0.101	n
Disgust (厌恶)	0.30	0.97	[0.62, 1.32]	5.40	<	y	0.17	0.22	[-0.09, 0.54]	1.38	0.168	y
Distress (苦恼)	0.15	0.28	[0.02, 0.54]	2.12	<	n	0.13	0.07	[-0.22, 0.36]	0.49	0.624	n
Excitement (兴奋)	0.07	-0.93	[-1.48, -0.38]	-3.33	<	n	0.10	-0.85	[-1.39, -0.32]	-3.15	0.002	n
Fear (恐惧)	0.12	-0.73	[-1.33, -0.13]	-2.40	<	n	0.05	-2.28	[-3.29, -1.28]	-4.45	<	n
Grief (悲痛)	0.15	-0.73	[-1.43, -0.02]	-2.02	<	n	0.10	-0.86	[-1.42, -0.30]	-3.03	0.002	n
Grievance (委屈)	0.35	1.27	[0.87, 1.66]	6.31	<	y	0.25	0.60	[0.22, 0.99]	3.08	0.002	y
Grossed Out (恶心)	0.28	0.68	[0.17, 1.19]	2.59	<	n	0.11	-1.00	[-1.67, -0.33]	-2.91	0.004	n
Happiness (开心)	0.36	1.31	[0.91, 1.71]	6.39	<	y	0.40	1.51	[1.10, 1.92]	7.26	<	y
Irresistible Laugh (忍俊不禁)	0.25	0.67	[0.31, 1.03]	3.67	<	y	0.12	-1.73	[-2.66, -0.80]	-3.64	<	n
Irritability (烦躁)	0.15	0.04	[-0.32, 0.40]	0.23	<	y	0.09	-0.62	[-1.06, -0.19]	-2.84	0.005	n
Listlessness (萎靡)	0.22	0.45	[0.07, 0.82]	2.31	<	y	0.18	0.29	[-0.07, 0.65]	1.58	0.115	y
Neutrality (中性)	0.69	3.23	[2.95, 3.51]	22.89	<	y	0.61	2.78	[2.48, 3.07]	18.38	<	y
Pleasant Surprise (惊喜)	0.30	0.86	[0.43, 1.29]	3.92	<	y	0.14	-0.22	[-0.66, 0.22]	-0.97	0.330	n
Sadness (悲伤)	0.16	-0.15	[-0.60, 0.30]	-0.64	<	n	0.13	-0.20	[-0.59, 0.20]	-0.97	0.332	n
Shyness (害羞)	0.14	-0.37	[-0.84, 0.11]	-1.51	<	y	0.07	-2.03	[-2.93, -1.14]	-4.45	<	n
Sinister Smile (奸笑)	0.15	-0.23	[-0.72, 0.25]	-0.94	<	n	0.11	-1.12	[-1.76, -0.47]	-3.38	<	n
Smile (微笑)	0.47	1.97	[1.65, 2.29]	12.04	<	y	0.41	1.70	[1.42, 1.98]	11.95	<	y
Snicker (坏笑)	0.16	0.17	[-0.17, 0.52]	0.97	<	y	0.17	0.37	[0.09, 0.66]	2.55	<	y
Surprise (惊讶)	0.60	2.69	[2.31, 3.08]	13.65	<	y	0.49	2.02	[1.66, 2.38]	11.13	<	y
Triumph (胜利)	0.07	-2.11	[-3.11, -1.11]	-4.14	<	n	0.02	-1.63	[-2.04, -1.22]	-7.81	<	n

Bold values indicate recognition rates significantly better than the chance level (0.10). Statistical significance was adjusted using the Benjamini–Hochberg procedure (false discovery rate [FDR] < 0.05; Benjamini & Hochberg, 1995). This correction was chosen for its suitability in controlling the error rate when multiple comparisons are made (Pike, 2011; Verhoeven, Simonsen, & McIntyre, 2005).



A. Dynamic Expressions



B. Static Expressions

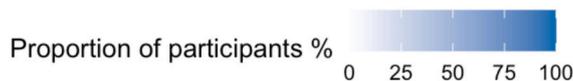
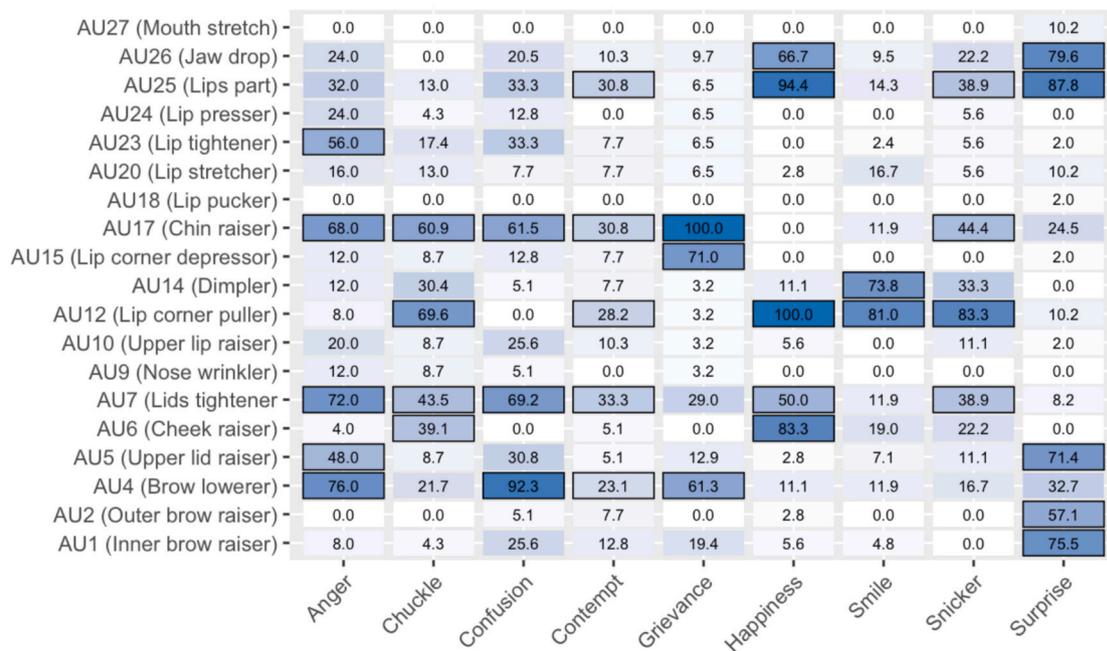


Fig. 4. Activated AUs for 13 dynamic and 9 static expressions of emotion and example expressions. (A). Proportions of activated AUs in the 13 dynamic expressions of emotion. (B). Proportions of activated AUs in the 9 static expressions of emotion. Darker colors indicate a higher proportion of encoders using that AU, while lighter colors indicate a lower proportion. Black borders indicate AUs identified as highly frequent for a given emotion via Monte Carlo simulations. (C). Examples of dynamic and static facial expressions for all 28 emotions. Dynamic clips can be viewed at https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc. Emotions framed with a black border and labeled “DO” (Dynamic Only) are conveyed solely in dynamic format; those labeled “SO” (Static Only) are conveyed exclusively in static format; those framed without a suffix can be conveyed in both formats.

C. Examples of Dynamic and Static Facial Expression with High Recognition Rates

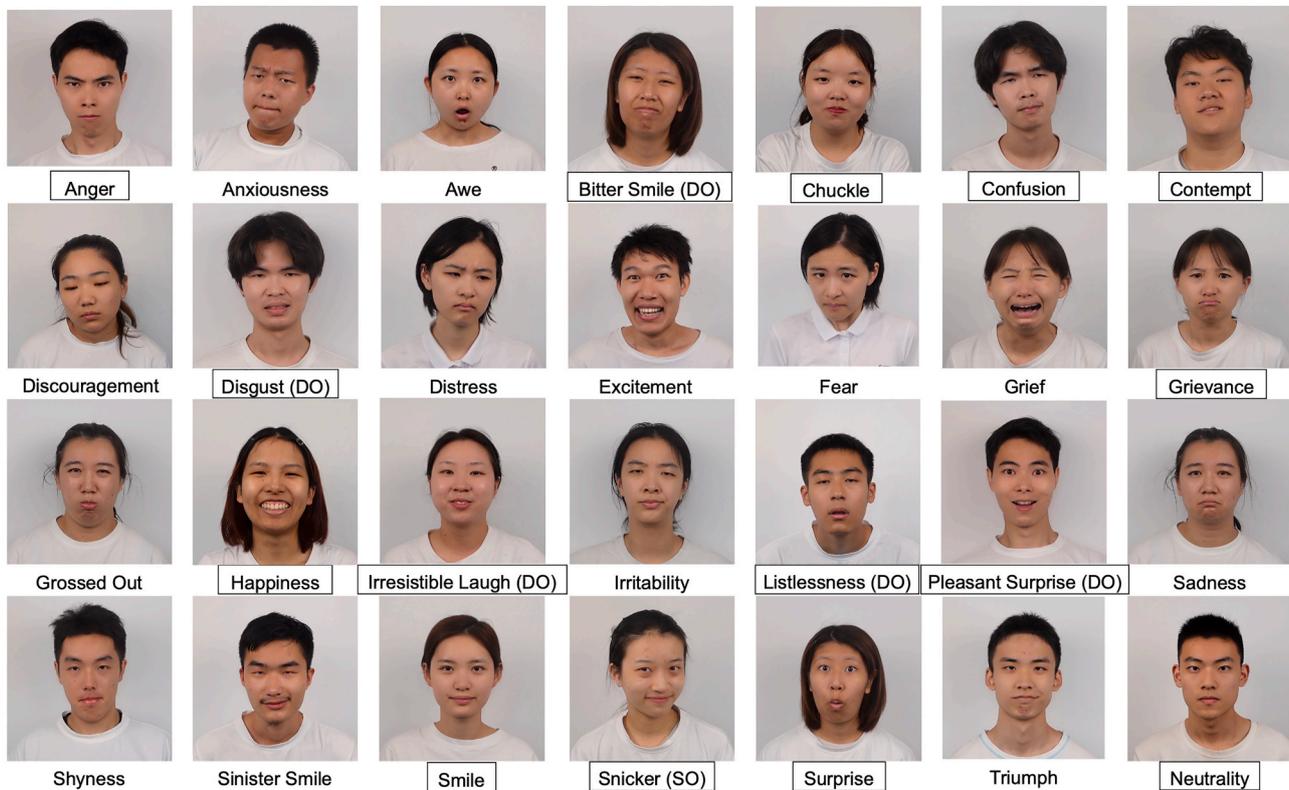


Fig. 4. (continued).

$p = .648$; snicker, $Z = 0.76$, $p = .223$; Lakens, 2017; Lakens, Scheel, & Isager, 2018). Therefore, for these three emotions, the present findings neither support nor refute a dynamic advantage. Unexpectedly, excitement (static $M = 0.10$ vs. dynamic $M = 0.07$; $B = -0.44$, 95 % CI $[-0.76, -0.12]$, $Z = -2.71$, $p = .007$) and happiness (static $M = 0.40$ vs. dynamic $M = 0.36$, $B = -0.24$, 95 % CI $[-0.46, -0.02]$, $Z = -2.13$, $p = .034$) were recognized more accurately in static expressions than dynamic expressions. Together, these results reveal a broad dynamic advantage across most emotions, alongside a surprising static advantage for certain positive states—a pattern we explore further in the General Discussion.

5.4.3. Is the dynamic advantage moderated by basic six and other emotions?

To investigate whether the dynamic advantage varies between basic six and other emotions, we conducted a GLMM ($\text{glmer}(\text{Accuracy} \sim \text{Emotion Presentation} * \text{Emotion Type} + (1|\text{Encoder}) + (1|\text{Decoder})$, family = binomial(link = "logit")). Both the main effects of Emotion Presentation, $B = 0.36$, 95 % CI $[0.31, 0.41]$, $Z = 14.12$, $p < .001$, and Emotion Type, $B = 0.34$, 95 % CI $[0.30, 0.38]$, $Z = 16.51$, $p < .001$, were significant. Recognition rates were higher for dynamic expressions ($M = 0.26$) compared to static expressions ($M = 0.20$), and higher for basic six emotions ($M = 0.28$) than for other emotions ($M = 0.22$). Importantly, there was a significant interaction between Emotion Presentation and Emotion Type, $B = -0.10$, 95 % CI $[-0.18, -0.02]$, $Z = -2.41$, $p = .016$. The dynamic advantage was smaller for basic six emotions ($M_{\text{diff}} = 0.06$) compared to other emotions ($M_{\text{diff}} = 0.07$). These results suggest that the dynamic advantage is moderated by the distinction between basic six and other emotions.

5.4.4. Exploratory analyses: drivers of the dynamic advantage

We examined whether the dynamic advantage simply reflects difficulties in recognizing static facial expressions, as suggested by previous

research (Dobs et al., 2018; Krumhuber et al., 2023). If so, emotions with poorer static recognition should show larger dynamic-static differences. Consistent with this prediction, we observed a small but significant negative Pearson correlation between static accuracy and the dynamic advantage, $r(1776) = -0.17$, 95 % CI $[-0.22, -0.13]$, $p < .001$, $\text{BF}_{10} > 100$, indicating that static expressions with lower recognition rates tend to benefit more from dynamic presentation.

We then asked what exactly drives the dynamic advantage: the addition of unique AUs or the temporal unfolding of emotional cues? To test this, we compared AU overlap between dynamic and static expressions for the 22 emotions showing a dynamic advantage (excluding neutrality) and the five emotions without such an advantage. Following FACS reliability guidelines (Ekman, Friesen, & Hager, 2002), AU overlap was calculated as: $(\text{Number of AUs activated in both dynamic and static expression}) \times 2 / (\text{Total number of AUs observed in dynamic and static expression})$. The average AU overlap for dynamic-advantage emotions was 84.89 %, which was not significantly different from the 85.66 % overlap observed for non-dynamic-advantage emotions, $t(25) = -0.46$, $p = .653$, Cohen's $d = -0.23$, 95 % CI $[-1.25, 0.80]$, $\text{BF}_{10} = 0.46$ (see Table S5 for details). A Kendall rank correlation likewise confirmed negligible association between AU overlap and dynamic advantage, $r(1712) < 0.01$, 95 % CI $[-0.05, 0.05]$, $p = .944$, $\text{BF}_{10} = 0.03$. Together, these exploratory findings suggest that the dynamic advantage is not driven by novel AUs but rather by the temporal unfolding of emotional cues.

6. General discussion

This research examined which emotions can be communicated through static versus dynamic facial expressions in a Chinese sample, integrating both production and perception approaches. We pursued three goals: (a) to identify which emotion categories could be conveyed through static and dynamic facial expressions, including analysis of their

Table 3
Mean differences and GLMMs comparing recognition rates between dynamic and static facial expressions for 28 emotions.

Emotion	Mean Difference	B	95 % CI	Z	p
Anger (气愤)	0.06	0.46	[0.23, 0.69]	3.96	< 0.001
Anxiousness (焦急)	0.04	0.59	[0.26, 0.93]	3.49	< 0.001
Awe (令人惊叹)	0.06	0.45	[0.20, 0.69]	3.60	< 0.001
Bitter Smile (苦笑)	0.07	0.49	[0.27, 0.71]	4.42	< 0.001
Chuckle (偷笑)	0.04	0.32	[0.08, 0.55]	2.68	0.007
Confusion (困惑)	0.13	0.76	[0.55, 0.97]	7.12	< 0.001
Contempt (轻蔑)	0.07	0.41	[0.23, 0.59]	4.40	< 0.001
Discouragement (气馁)	0.10	0.92	[0.67, 1.16]	7.37	< 0.001
Disgust (厌恶)	0.13	0.93	[0.69, 1.17]	7.60	< 0.001
Distress (苦恼)	0.02	0.23	[-0.01, 0.46]	1.85	0.064
Excitement (兴奋)	-0.03	-0.44	[-0.76, -0.12]	-2.71	0.007
Fear (恐惧)	0.07	1.22	[0.85, 1.58]	6.49	< 0.001
Grief (悲痛)	0.05	0.59	[0.31, 0.87]	4.11	< 0.001
Grievance (委屈)	0.10	0.63	[0.42, 0.85]	5.68	< 0.001
Grossed Out (恶心)	0.17	1.66	[1.31, 2.02]	9.13	< 0.001
Happiness (开心)	-0.04	-0.24	[-0.46, -0.02]	-2.13	0.034
Irresistible Laugh (忍俊不禁)	0.13	1.22	[0.92, 1.51]	8.19	< 0.001
Irritability (烦躁)	0.06	0.61	[0.33, 0.89]	4.31	< 0.001
Listlessness (萎靡)	0.03	0.25	[0.01, 0.48]	2.08	0.038
Neutrality (中性)	0.08	0.48	[0.24, 0.73]	3.84	< 0.001
Pleasant Surprise (惊喜)	0.16	1.25	[1.00, 1.49]	9.97	< 0.001
Sadness (悲伤)	0.03	0.23	[-0.02, 0.48]	1.79	0.074
Shyness (害羞)	0.08	1.09	[0.75, 1.43]	6.32	< 0.001
Sinister Smile (奸笑)	0.04	0.48	[0.20, 0.76]	3.33	< 0.001
Smile (微笑)	0.06	0.30	[0.08, 0.52]	2.63	0.008
Snicker (坏笑)	-0.01	-0.10	[-0.31, 0.12]	-0.86	0.390
Surprise (惊讶)	0.11	0.66	[0.45, 0.87]	6.21	< 0.001
Triumph (胜利)	0.05	1.44	[0.93, 1.95]	5.51	< 0.001

Bold values indicate recognition rates for dynamic expressions that are significantly higher than those for static ones; italic values indicate recognition rates for static expressions that are significantly higher than those for dynamic ones. Statistical significance was adjusted using the Benjamini–Hochberg procedure (FDR < 0.05).

prototypical facial AUs; (b) to test for a dynamic advantage for each emotion; and (c) to explore whether the dynamic advantage differed between the six basic emotions (anger, disgust, fear, happiness, sadness, surprise) and other, less-studied emotions. By selecting 28 emotion words commonly associated with facial expressions and engaging Chinese participants in both producing and recognizing these emotions, we discovered that 14 emotions were effectively conveyed through dynamic facial expressions, while 10 were conveyed through static facial

expressions. Additionally, 23 out of the 28 emotions demonstrated a dynamic advantage, with this effect being moderated by whether the emotions were among the basic six or not.

6.1. Emotions conveyed through facial expressions

Regarding our first research question, the results revealed that 10 emotions could be conveyed through static expressions: anger, chuckle, confusion, contempt, grievance, happiness, smile, snicker, surprise, plus neutrality. Dynamic expressions conveyed all these emotions (except snicker) plus bitter smile, disgust, irresistible laugh, listlessness, and pleasant surprise. Unexpectedly, the basic emotions of fear and sadness were not effectively communicated in either dynamic or static facial expressions, while disgust was only found in dynamic expressions.

Further examination of the confusion matrices (Fig. 3) revealed that both static and dynamic fear were most often misclassified as surprise. This finding aligns with previous research demonstrating that facial expressions of fear and surprise share morphological similarities (Fang, Sauter, & Van Kleef, 2018; Jack et al., 2009; Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007). However, our results also showed that surprise was rarely misrecognized as fear (see also Fang et al., 2019; Jack et al., 2009). This asymmetry may reflect collectivistic cultural values that prioritize group harmony and potentially reduce exposure to negative emotional expressions (Nisbett, Peng, Choi, & Norenzayan, 2001). Reduced familiarity with negative emotional expressions may consequently affect emotion decoding processes (Matsumoto, 1989), leading to less accurate categorization of negative expressions in collectivistic cultures (Biehl et al., 1997).

Contrary to previous research showing confusing disgust as anger (e.g., Fang et al., 2019; Jack et al., 2009), our confusion matrices indicated that both static and dynamic disgust expressions were most frequently confused with confusion, and anger expressions were also most often mistaken for confusion. Examining the frequent AUs present in dynamic expressions of these three emotions (Fig. 4) reveals considerable overlap: anger commonly engaged AUs 4 (brow lowerer), 5 (upper lid raiser), 7 (lids tightener), 17 (chin raiser), 23 (lip tightener), and 25 (lips part); disgust recruited AUs 4, 7, 10 (upper lip raiser), and 17; and confusion featured AUs 4, 7, 17, 23, 25. Although this morphological similarity likely underlies their perceptual confusability, confusion itself was less frequently misperceived as anger or disgust, mirroring the asymmetric pattern seen with fear and surprise. This pattern may again suggest that limited exposure to negative expressions in collectivist settings may hinder their recognition (Biehl et al., 1997; Matsumoto, 1989).

Additionally, to account for the potential differentiation between moral and physical disgust proposed by previous research (Pochedly, Widen, & Russell, 2012; Rozin, Lowery, & Ebert, 1994; Widen et al., 2013), we included the Chinese term “恶心” (“grossed out”) to specifically capture the concept of physical disgust in Experiment 2. However, our results did not support distinct facial patterns for moral and physical disgust. The dynamic expressions of “grossed out” were identified as “厌恶” (the Chinese translation for “disgust”, which more closely associates with moral disgust) at similar rates (29.13 %) as they were identified as “恶心” (“grossed out”) (28.54 %). The static expressions of “grossed out” were even more frequently identified as “disgust” (19.10 %) rather than “grossed out” (11.24 %). These findings suggest that moral and physical disgust in Chinese samples may share facial signals.

Regarding the absence of recognizable sad facial expressions, we found that both static and dynamic facial expressions of sadness were frequently misidentified as “委屈” (roughly “grievance”). As shown in Fig. 4, the most frequent AUs for grievance—AU4 (brow lowerer), AU7 (lid tightener; dynamic only), AU15 (lip corner depressor), and AU17 (chin raiser)—overlap substantially with one of the major variants of the facial prototypes of sadness (Ekman et al., 2002), which likely explain this confusion. The confusion matrices also show that expressions intended as grief were often mistaken for sadness. We propose two potential explanations to account for these misclassifications. First,

Chinese cultural display rules often emphasize emotional restraint (Matsumoto et al., 2008), potentially causing grief to be expressed with reduced intensity and consequently misperceived as sadness, while sadness expressions with reduced intensity may be misidentified as “委屈”. Second, “委屈” itself appears to be a culturally specific emotion: Chinese scholars describe it as arising from perceived unfair treatment in interpersonal relationships, accompanied by feelings of powerlessness and forced endurance, with no direct English equivalent (Ma, Wang, Yang, & Yu, 2025). Consistent with this view, our confusion matrices reveal that Chinese participants applied the term “委屈” more readily than “sadness” to expressions of discouragement, distress, grief, and other negative states.

We also uncovered several emotions not previously identified as conveyable through facial expressions, including bitter smile (dynamic only), chuckle, irresistible laugh (dynamic only), listlessness (dynamic only), pleasant surprise (dynamic only), and snicker (static only). Notably, four of these—bitter smile, chuckle, irresistible laugh, and snicker—are smile-related, which may reflect the Chinese cultural tendency to use smiles to conceal true feelings and preserve harmony. Previous work has described similar phenomenon—such as “bitter smile” and “forced smile”—as cultural strategies for suppressing negative feelings behind a positive facade (Sun, 2010; Ye, 2006). Our findings offer the first empirical evidence for these culturally specific smile variations and highlight that their differentiation depends primarily on dynamic, rather than static, facial cues.

6.2. Dynamic advantage in emotion recognition

Addressing our second and third research questions, our findings revealed a dynamic advantage in the recognition of most emotions (23 out of 28), with this advantage more pronounced for the basic six compared to other emotions. However, we found no significant dynamic advantage for distress, sadness, and snicker (though results were statistically inconclusive), and even observed a static advantage for happiness and excitement. Examination of the confusion matrices showed that the top three perceived emotions for dynamic happiness were happiness (36.06 %), smile (22.55 %), and bitter smile (9.42 %), whereas for static happiness, they were happiness (40.01 %), smile (21.23 %), and bitter smile (5.03 %). Previous research has demonstrated that genuine and fake smiles differ in dynamic features (e.g., genuine smiles typically have longer onset and offset periods; Hess & Kleck, 1990; Schmidt, Ambadar, Cohn, & Reed, 2006; Schmidt, Bhatnagar, & Denlinger, 2009). The posed dynamic displays in our study may have inadvertently conveyed cues of inauthentic or “fake” happiness, increasing the likelihood of misclassifying happiness as a bitter smile and consequently resulting in more accurate recognition of static compared to dynamic happiness expressions.

6.3. Exploratory mechanisms of the dynamic advantage

Consistent with previous studies (Ambadar et al., 2005; Bould & Morris, 2008), we found a negative correlation between the dynamic advantage effect and the recognition rates of static expressions. As the recognition rates of static expressions decreased, the dynamic advantage effect became more prominent. Moreover, the recognition rates for static basic six emotions were significantly higher than those for other emotions. Together, these findings suggest that dynamic expressions may provide additional information when static expressions lack sufficient emotional cues, thereby facilitating emotion recognition (Dobs et al., 2018; Kätsyri & Sams, 2008; Krumhuber et al., 2023; Richoz et al., 2024).

Importantly, this dynamic advantage did not appear to derive from specific AUs associated with dynamic expressions, but rather from the temporal features of these expressions. Consider pleasant surprise, dynamic expressions involve a sequence of eyebrows raising (AUs 1 + 2), eyes widening (AU5), and mouth corner lifting (AU12). This sequential

unfolding allows perception of joy layered over surprise, leading to recognition of pleasant surprise. However, when the facial expression reaches its apex, as captured in a static image, it includes all AUs simultaneously (AUs 1 + 2 + 5 + 12). The relatively intense surprise-related AUs (1 + 2 + 5) may overshadow the more subtle joy-related AU (12), leading to misinterpretation of the expression as surprise.

6.4. Implications

Beyond identifying which emotions can be conveyed through dynamic and static facial expressions in Chinese culture and which emotions demonstrate a dynamic advantage effect, this research has produced a comprehensive database of emotional facial expressions—the Chinese Dynamic Facial Expressions Database (CDFED). Containing both static and dynamic displays of 28 emotions performed by 64 encoders, CDFED represents the largest such database in terms of emotion categories. For each expression stimulus, we provide recognition rates, ratings of emotional intensity, emotional clarity, valence, arousal, authenticity, as well as patterns of AUs. Additionally, we include common facial evaluations for each encoder’s neutral face, including attractiveness, dominance, trustworthiness, unusualness, and masculinity-femininity. All information can be accessed through the OSF at https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc. This resource should facilitate research in various fields, including emotion perception and face perception, particularly in East Asian or Chinese cultural contexts.

Furthermore, while this research focused primarily on facial expressions, emotion expression is inherently multimodal. As research on multimodal emotion expression advances, the complex emotional experiences of humans become increasingly comprehensible. In this research, we compiled a list of emotion words with high typicality and low similarity and conducted a preliminary exploration of their expressibility through different channels. Future research can refer to this list to investigate: What emotions can be conveyed through each channel? Which channels more efficiently communicate specific emotions? What social functions do different channels serve in emotion communication (Manokara, Đurić, Fischer, & Sauter, 2021)? Such inquiries will further illuminate the multimodal processes underlying emotional communication.

6.5. Limitations and future directions

The present research has several limitations that should be acknowledged. First, the reliance on typicality and similarity ratings to identify emotion categories may have increased the clarity of category boundaries, potentially leading to higher recognition rates for facial expressions (e.g., Crivelli et al., 2017; Gendron et al., 2018). While natural language contains thousands of terms describing nuanced emotional states, not all terms are psychologically distinct (Keltner, Tracy, et al., 2019), and collecting expressions for such a vast set was infeasible. Our selection procedure balanced breadth with feasibility by choosing representative terms for broader categories. Similarly, our forced choice paradigm—though supplemented with a “none of the above” option and open-ended follow-up—may have constrained participants to select the closest available label, increasing the agreement but potentially overlooking blended emotions (Fang et al., 2018, 2019) or non-emotional interpretations (Crivelli & Fridlund, 2018, 2019; Kollareth et al., 2020, 2023). Future studies could incorporate open-ended responses and finer-grained emotion terms to test whether facial expressions can reliably convey subtler emotional states.

Second, the facial expressions collected in this research were exclusively posed, nonspontaneous expressions. Yet, a growing body of evidence indicates that posed and spontaneous expressions of the same emotion differ in facial muscle activation and temporal dynamics (Fang et al., 2022; Namba, Kagamihara, Miyatani, & Nakao, 2017; Namba, Makihara, Kabir, Miyatani, & Nakao, 2017; see Jia et al., 2021 for a

review). As a result, posed displays may not fully capture the subtlety of everyday expressions. On the other hand, deliberately posed expressions can reduce the influence of cultural display rules—especially in collectivist cultures where participants may suppress their emotional displays in laboratory contexts (Matsumoto, 1990; Matsumoto et al., 2008). To capture more authentic expressions, future research should examine how these emotions emerge in spontaneous contexts, such as naturalistic interactions or richer mood-induction protocols.

Third, our AU analysis was limited to the 19 AUs that FaceReader can detect. Due to the time-consuming and labor-intensive nature of manual coding, we employed an automated facial expression analysis method to extract AU activation patterns. However, it is crucial to acknowledge that there exist other movements or autonomous reactions that play critical communicative roles, such as head tilts, eye rolls, tears, or skin coloration changes (Keltner & Cordaro, 2017; Keltner, Sauter, et al., 2019). Moreover, we have yet to characterize the temporal features (e.g., sequence, speed, duration) that likely underpin recognition of the dynamic-only emotions. Developing analytic tools to capture these temporal patterns presents a key next step.

Fourth, although we moved beyond WEIRD samples, our participants remain drawn from urban, university-educated East Asian cohorts—effectively replicating an “EIRD” profile (Henrich, Heine, & Norenzayan, 2010). Truly non-WEIRD contexts encompass rural, non-university, and socioeconomically diverse populations in regions such as Africa, South Asia, and Latin America (Anjum & Aziz, 2024), where emotion production and perception systematically diverge from those observed in WEIRD groups (Elfenbein et al., 2007; Elfenbein & Ambady, 2002, 2003; Gendron, Roberson, van der Vyver, & Barrett, 2014). To develop a genuinely global account of facial emotion communication, future studies should move beyond the East–West dichotomy to include a broader spectrum of cultural contexts (e.g., Kryś, De Almeida, Wasielec, & Vignoles, 2025), as well as more diverse participant groups—including rural populations, non-college adults, and ethnically diverse communities within each culture.

Finally, our design builds on the basic-emotion framework, which assumes relatively stable correspondences between facial expressions and emotional states (Ekman & Cordaro, 2011; Keltner & Cordaro, 2017; Keltner, Sauter, et al., 2019). Yet alternative theories challenge this view. For instance, the behavioral ecology view (Crivelli & Fridlund, 2018, 2019) and constructionist perspectives (Barrett, 2022; Barrett & Lida, 2024) have questioned direct correspondences between facial expressions and emotional states. Recent debate between Durán and Fernández-Dols (2021, 2023) and Witkower, Rule, and Tracy (2023) further underscored these theoretical divisions. Although our inclusion of a broader emotion set, dynamic stimuli, and a non-WEIRD sample extends basic-emotion assumptions, future research should examine these questions through the lenses of alternative frameworks to fully capture the complexity of facial emotion expression.

7. Conclusion

By expanding our investigation beyond the traditional focus on basic six emotions, static expressions, and the WEIRD population, the present research contributes valuable insights into the broader repertoire of emotions that can be communicated through facial expressions in Chinese individuals. We unveiled 14 dynamic facial expressions and 10 static facial expressions, along with their respective facial movement patterns. Notably, the dynamic advantage was found in the recognition of most emotions. Importantly, our findings suggest that this dynamic advantage is primarily driven by the dynamic features of the facial expressions, rather than the specific facial configurations unique to dynamic expressions. These findings deepen our understanding of the diversity of emotion expression and further highlight the significance of incorporating a wide range of dynamic facial expressions of emotion from non-WEIRD population within the field of emotion research.

Open science practices

All data, analysis code, research materials and survey example in English are available at https://osf.io/57tvb/files/osfstorage?view_only=0bb1eb0767f24900b4b234e98f0564fc. All statistical analyses and visualizations were performed using R, Version 4.4.0 (R Core Team, 2024), package lme4, Version 1.1–35.5 (Bates, Mächler, Bolker, & Walker, 2015), package lmerTest, Version 3.1–3 (Kuznetsova, Brockhoff, & Christensen, 2017), package simr, Version 1.0.7 (Green & MacLeod, 2016), package emmeans, Version 1.10.1 (Lenth, 2022), package BayesFactor, Version 0.9.12–4.7 (Morey & Rouder, 2024), package bayestestR, Version 0.15.2 (Makowski, Ben-Shachar, & Lüdtke, 2019), package bruceR, Version 2024.6 (Bao, 2024), package ggplot2, Version 3.5.1 (Wickham, 2016). The design and analysis method of this research were not pre-registered. Due to privacy regulations, facial expression stimuli used in the present study were not publicly available. After obtaining user consent, our database is available for researchers to download and use for scientific research purposes.

CRedit authorship contribution statement

Zhihe Pan: Visualization, Investigation, Data curation, Writing – original draft, Project administration, Formal analysis. **Hweemin Tan:** Investigation, Data curation, Writing – original draft, Formal analysis. **Siqi Liu:** Investigation, Data curation. **Xia Fang:** Writing – review & editing, Supervision, Methodology, Formal analysis, Writing – original draft, Project administration, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jesp.2025.104836>.

Data availability

All data and analysis code are available at https://osf.io/57tvb/?view_only=0bb1eb0767f24900b4b234e98f0564fc. Due to privacy regulations, facial expression stimuli used in the present study were not publicly available. After obtaining user consent, our database is available for researchers to download and use for scientific research purposes.

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