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# Discovering cultural differences (and similarities) in facial expressions of emotion

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Understanding the cultural commonalities and specificities of facial expressions of emotion remains a central goal of Psychology. However, recent progress has been stayed by dichotomous debates (e.g. nature versus nurture) that have created silos of empirical and theoretical knowledge. Now, an emerging interdisciplinary scientific culture is broadening the focus of research to provide a more unified and refined account of facial expressions within and across cultures. Specifically, data-driven approaches allow a wider, more objective exploration of face movement patterns that provide detailed information ontologies of their cultural commonalities and specificities. Similarly, a wider exploration of the social messages perceived from face movements diversifies knowledge of their functional roles (e.g. the 'fear' face used as a threat display). Together, these new approaches promise to diversify, deepen, and refine knowledge of facial expressions, and deliver the next major milestones for a functional theory of human social communication that is transferable to social robotics.

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## Introduction

Are facial expressions of emotion universal across cultures or are they culture specific? That is, can Chileans understand the emotions of the Chinese from reading their facial expressions, and vice versa? Such questions (and more) have been at the center of one of the longest standing debates in Psychology — whether facial expressions of emotion are hard-wired and universal, or learned and thus subject to cultural variability. By virtue of the dichotomous nature of the debate — that is, nature versus nurture, essentialism versus constructivism — the direction and focus of the field has followed a cyclic, back-and-forth seesaw pattern for over a century (e.g. see [1,2]). Several major milestones have marked this era: Darwin's revolutionary theory of the biological and evolutionary origins of facial expressions that supported views of universality [3]; later counteractions by rising cultural relativism (e.g. [4]); Ekman's pioneering work showing the pan-cultural recognition of six face movement patterns as basic emotions (e.g. [5]) that cemented the recent dominant view that facial expressions of emotion are universal. Indeed, most introductory Psychology textbooks — a litmus test for the main thinking in the field — tend to report that six specific face movement patterns universally convey six basic emotions across all cultures, with cultural variance often consigned to a footnote (if at all). Consequently, research in the past 50 years or so has focused almost exclusively on these six facial expressions with little exploration of the cultural diversity in face movement patterns and the social messages they convey.

Yet, in the last decade or so the emergence of an interdisciplinary scientific culture using new, imported methods and concepts is now pushing research boundaries toward a broader, deeper, and more refined understanding of facial expression communication. Consequently, several significant new advances have questioned the true universality of facial expressions of emotion, instead revealing a more complex account that combines traditionally distinct views (e.g. nature versus nurture). Such an approach sharply contrasts with the cyclic, seesawing patterns of past research, and mark the beginning of a new research culture that has the potential to deliver significant new milestones that cut across fundamental (e.g. Anthropology and Psychology) and applied (e.g. Computing Science and Social Robotics) disciplines of social communication. In this review, we will highlight two recent pieces of research that have used creative, out-of-the-box thinking to advance knowledge of facial expressions of emotion across cultures, and generate new questions that will guide future research directions. To appreciate the relevance and scope of these new approaches, it is first useful to outline the classic methods used to understand facial expressions across cultures.

## Classic approaches to understanding facial expressions of emotion across cultures

Since the inception of the universality debate, a central goal has been to identify which face movement patterns are common across cultures and which are culture-specific.

However, doing so is genuinely challenging because the human face can generate an incredible diversity of facial expressions. To illustrate, consider that the face can produce over 40 individual movements, measured as Action Units (AUs) [6], such as Upper Lid Raiser (AU5), Nose Wrinkler (AU9), and Lip Stretcher (AU20), each of which can be combined in different numbers to create a vast array of complex patterns. Each AU can also be activated with a specific movement pattern across time based on, for example, different acceleration, peak latency, and amplitude, which further magnifies the number of movement combinations the face can generate. Indeed, due to these complex variations Ekman noted that 'it is exceedingly difficult to observe the common facial expressions of emotion across cultures' ([7], p. 234).

One of the most popular approaches to understanding facial expressions across cultures has involved selecting images of facial movement patterns thought to convey specific basic emotions based on theory and naturalistic observation, and testing their recognition across cultures (e.g. [8–10]). Most notably, Ekman and colleagues used this approach to show that six specific face movement patterns thought to represent basic emotions of happy, surprise, fear, disgust, anger, and sad elicited above chance recognition accuracy across several distinct cultures (e.g. [5]). Consequently, these six face movement patterns, each represented as a specific combination of AUs — for example, 'happy' involves Cheek Raiser (AU6) and Lip Corner Puller (AU12), whereas 'sad' involves Inner Brow Raiser (AU1), Brow Lowerer (AU4) and Lip Corner Depressor (AU15) — became widely considered as the gold standard in universal displays of emotions thought to be basic.

However, the classic approach of using top-down, theory-driven methods to select and test specific face movement patterns (i.e. the AU patterns proposed by Ekman and colleagues) and the social messages they convey (i.e. six emotion categories) has substantially restricted knowledge of how the face communicates emotion messages. Specifically, such methods are typically grounded in the experimenter's culture and can thus reflect culture-specific intuitions and observations more than human behavior more broadly (i.e. a bias of cultrocentrism) — for example, see [11•,12–14]. Perhaps unsurprisingly then, numerous cross-cultural studies have shown that these 'universal' face movement patterns are in fact not universally recognized across cultures, at least in terms of equal performance levels (see [15,16] for recent reviews. See also Gendron in this special issue). Instead, these face movement patterns are best recognized by Westerners and elicit significantly lower performance in other cultures particularly for 'fear,' 'disgust' and 'anger.' Thus, while this approach has delivered recognizable representations of Western facial movement patterns of emotion, equivalents in other cultures remain largely unknown.

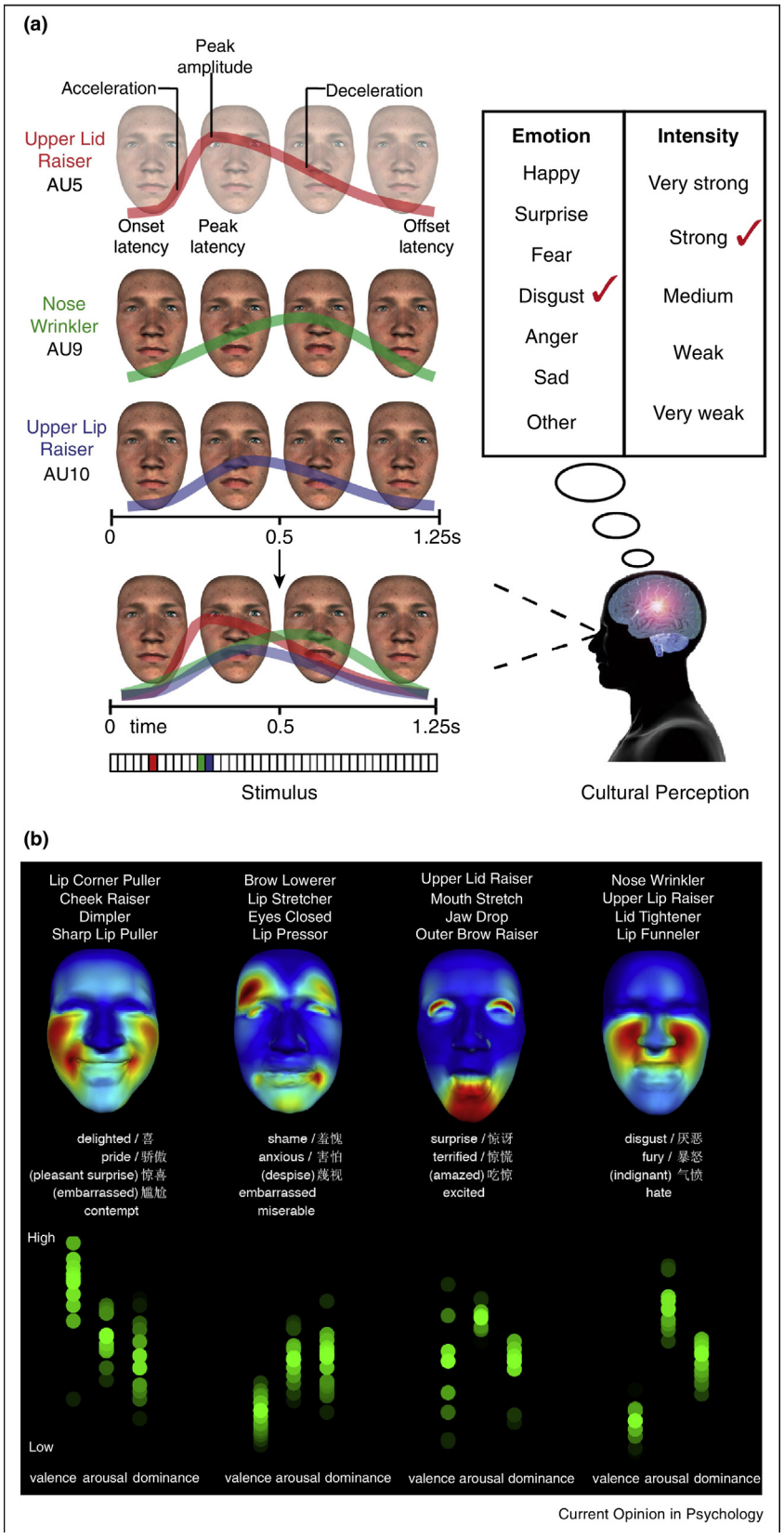
Knowledge has been further restricted by limiting the exploration of the social messages that face movement patterns can convey. For example, classic approaches have focused primarily on only six emotion categories, which, in addition to representing a small proportion of the nuanced emotion messages required for the complex social exchanges of daily life, could instead reflect the main emotion concepts of Western culture (e.g. see [17•,18]). Furthermore, classic approaches have focused mostly on the inner emotional states of the transmitter — for example, a lowered brow with tightened lips and eyes indicates that 'he is angry' — rather than their predicted behaviors toward others — for example, 'he will attack me' — which overlooks key aspects of human social communication and interaction ([19]; see also [20]). Finally, face movements are complex dynamic information patterns (see [21] for a review) where the temporal order and activation of different AUs provide important diagnostic information for emotion categorization (e.g. [22] see also [23]). Classic approaches have mostly used static displays such as images of posed face movements, or created the illusion of movement by progressively morphing between two different static images (e.g. happy and sad). Yet, neither method can capture nor explore how the dynamic parameters of face movements — for example, AU amplitude, acceleration, or peak latency — influence the interpretation of face movement patterns.

Classic approaches have undoubtedly advanced understanding of how face movements can convey different emotions, but knowledge remains limited to only a small and (Western) specific set of facial patterns and social messages. Consequently, substantial knowledge gaps remain both in the characterization of face movement patterns (in terms of AU composition and their respective timings) and the messages they convey within and across cultures. Rather, revealing the true diversity of dynamic face patterns along with their cultural commonalities and specificities first requires a broader understanding of the face movements used in different cultures and the messages they convey (see also [24] for further discussions). We will now outline two key studies that have made significant advances toward this goal.

## Characterizing dynamic face movement patterns using data driven methods

In recent work, Jack and colleagues [25••] diversified and deepened knowledge of how face movements convey emotions across cultures using a novel data-driven approach to objectively and mathematically model dynamic face movement patterns. Figure 1(a) illustrates this approach. On each experimental trial, a dynamic face movement generator [26] creates a random facial animation by randomly selecting a subset of individual face movements (i.e. AUs; see colored labels on left) and applying a random dynamics to each AU (see color-coded curves). The cultural observer categorizes the facial animation by

**Figure 1**


(a)
Peak amplitude
Acceleration
Deceleration
Upper Lid Raiser AU5
Onset latency
Peak latency
Offset latency
Nose Wrinkler AU9
Upper Lip Raiser AU10
0
0.5
1.25s
0 time
0.5
1.25s
Stimulus
Emotion
Happy
Surprise
Fear
Disgust
Anger
Sad
Other
Intensity
Very strong
Strong
Medium
Weak
Very weak
Cultural Perception
(b)
Lip Corner Puller
Cheek Raiser
Dimpler
Sharp Lip Puller
Brow Lowerer
Lip Stretcher
Eyes Closed
Lip Pressor
Upper Lid Raiser
Mouth Stretch
Jaw Drop
Outer Brow Raiser
Nose Wrinkler
Upper Lip Raiser
Lid Tightener
Lip Funneler
delighted / 喜
pride / 骄傲
(pleasant surprise) 惊喜
(embarrassed) 尴尬
contempt
shame / 羞愧
anxious / 害怕
(despise) 蔑视
embarrassed
miserable
surprise / 惊讶
terrified / 惊慌
(amazed) 吃惊
excited
disgust / 厌恶
fury / 暴怒
(indignant) 气愤
hate
High
Low
valence arousal dominance
valence arousal dominance
valence arousal dominance
valence arousal dominance
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emotion (e.g. disgust) and rates its intensity (e.g. strong) when the face movement pattern correlates with their prior knowledge of that face movement pattern and its associated message (e.g. 'strong disgust'). If the pattern does not correspond to one of the response options (here, the six classic emotions) the observer selects 'other.' After many such trials, measures of statistical association (e.g. regression, correlation, mutual information) are used to build a relationship between the dynamic patterns presented on each trial and the observer's responses. The analysis thus produces, for each observer independently, a mathematical model of the dynamic face movement patterns that convey these specific emotions to individuals in a given culture. These mathematical models can then be submitted to rigorous analyses to extract patterns that are common across cultures and those that are culture-specific.

Such an approach provides several advantages, particularly in relation to the debate about the universality of facial expressions of emotion. First, data-driven methods typically make few *a priori* assumptions about which stimulus patterns will convey which messages to whom, thereby allowing a much broader and agnostic exploration of face movement patterns as carriers of relevant information. This approach also makes intuitive sense for the purposes of objective study, particularly of groups for which there may be little existing knowledge (e.g. Sentinelese society). Second, building detailed, quantitatively characterized facial movement patterns (i.e. an information ontology) enables precise and objective analyses and comparisons to show *how* face movement patterns are similar or different across cultures. Third, such methods are generic and can be used to sample any objectively measureable information space (e.g. face morphology and complexion, body movements [27], vocalizations [28,29]) to test against almost any perceptual category (e.g. attractive, trustworthy [30,31], interested, confused [32], delighted, embarrassed [25••]). Such methods therefore have significant potential to advance understanding of how the human face conveys different messages because they impose fewer (subjective) restrictions on empirical investigation (see also [33•] for further discussion).

Jack and colleagues [25••] used this approach to explore cultural commonalities and specificities in facial expressions of emotion by modeling the dynamic face movement patterns associated with over 60 different emotions across two cultures — Western and East Asian. Using a multivariate data reduction technique applied to the resulting culturally valid face movement models, they revealed four latent and culturally common Action Unit (AU) patterns each associated with a specific combination of valence, arousal, and dominance. Figure 1(b) summarizes the results. Color-coded face maps show the four latent face movement patterns with red indicating stronger AU presence and blue indicating weaker AU presence (see also AU labels above each face map). Emotion words below each face show a sub-sample of the face movement models that the latent pattern contributes most to (see [25••] for full list of emotion words). Plots below each face show the distribution of average ratings of valence, arousal, and dominance for each emotion word associated with each latent movement pattern. Extracting these latent patterns from the set of 60+ culturally valid face movement models also revealed the specific face movements that accentuate each latent pattern to create complex facial expressions of emotion in each culture (see also [34] for discussion on cultural accents).

Together, these data question the widely held view that six facial movement patterns universally convey the six emotions of happy, surprise, fear, disgust, anger, and sad, and instead suggest that four latent patterns are common across cultures. Furthermore, the combination of culturally common face movement patterns and culture-specific accents also suggests a symbiosis (not opposition) of biology and culture, thereby generating new predictions about the bio-cultural phylogeny and ontogeny of facial expressions. The projection of latent face movement patterns onto broad dimensions (e.g. valence, arousal) with specific accents that map more closely to specific

**(Figure 1 Legend)** Exploring cultural commonalities and differences in face movement patterns of emotion. **(a)** Modeling dynamic face movement patterns of emotion. Stimulus: On each experimental trial, a dynamic face movement generator [26] randomly selects a subset of face movements (i.e. AUs; see red, green, and blue labels on left) — here, Upper Lid Raiser (AU5), Nose Wrinkler (AU9), and Upper Lip Raiser (AU10) — from a core set of 42 AUs and assigns a random movement to each AU individually using six temporal parameters: onset latency, acceleration, peak amplitude, peak latency, deceleration, and offset latency (see labels illustrating the red curve). The randomly selected and actived AUs are then combined to produce a photorealistic facial animation (shown with four snapshots across time). Cultural Perception: The cultural observer categorizes the facial animation as meaningful (e.g. disgust) and rates the intensity of the emotion (e.g. strong) when the dynamic facial movement pattern correlates with their conceptual (i.e. prior) knowledge of that face movment pattern and its associated message. Thus, building a relationship between the dynamic AU patterns presented on each trial and the observer's responses produces a statisticallty robust mathematical model of each dynamic face movement pattern of emotion message. **(b)** Culturally common and latent face movement patterns. Color-coded face maps show the four culturally common latent face movement patterns extracted from 62 culturally validated Western and East Asian face movement models of emotion. Red indicates stronger Action Unit (AU) presence, blue indicates weaker presence (see corresponding AU labels above each face). Emotion words listed below each face map shows a subset of the face movement models to which the latent pattern contributes most (see [25••] for full list). Words separated by a / indicate both Western and East Asian face movement models; words in parenthesis provide English translation only. The plot below shows the distribution of average ratings of valence, arousal, and dominance for each emotion word associated with each latent face movement pattern.

categories (e.g. rage, disgust) also suggests a specific synergy between the dimensional and categorical perception of face movements [35,36].

## Beyond six emotions — understanding the messages that face movements convey

In addition to characterizing the specific face movement patterns that are used for social interaction in different cultures, a central and related goal is to understand their communicative aspects. That is, what messages do face movements convey to others? While psychologists have typically focused on messages that reflect the inner states of the transmitter (e.g. 'he feels angry'), behavioral ecologists have tended to consider face movement patterns as tools to influence the receiver's behavior (e.g. 'I should submit') [37]. Since mouting evidence now questions the traditional psychological view that specific face movement patterns are pan-cultural transmitters of 'basic' emotions (e.g. [38–40]), new opportunities now emerge to explore the broader range of messages that face movements convey within and across cultures.

In a recent cross-cultural study [41••] Crivelli and colleagues stepped beyond the traditional set of six emotion categories to explore the social motives that could be attributed to face movement patterns. Across two complementary experiments, Trobriand Islanders of Papua New Guinea matched the classic face movement patterns of emotion with classic emotion labels (i.e. 'happy,' 'surprise,' 'fear,' 'disgust,' 'anger,' and 'sad') and with different social motives such as 'social invitation,' 'protection,' 'threat,' 'submission' and 'rejection.' Contrary to the view that these face movement patterns primarily convey emotions, Trobriand Islanders matched them with emotions *and* social motives. In further contrast to widely held views of universality, Trobriand Islanders consistently associated the classic 'fear' face movement pattern — that is, knitted brows, wide-open eyes, laterally stretched mouth — with 'anger' and 'threat.' Examination of the Trobriand Islanders' material culture [11•] and observation of their traditional rituals and social interactions [42] further corroborated these findings by showing that classic 'fear' face movement patterns are consistently used as threat displays in their own culture as well as others (e.g. Maori, !Kung Bushmen, Himba, Eipo). Together, these results show that face movements convey multi-component messages including behavioral intentions rather than a fixed set of emotion categories [43].

## Conclusions

Here, we have highlighted two recent studies that have moved beyond the boundaries of traditional approaches to make significant new discoveries on how face movement patterns convey social messages across cultures. In doing so, each study demonstrates the power and potential of interdisciplinary approaches to access the corners of knowledge that have so far been overlooked or have remained inaccessible. In particular, mature data-driven methods imported from visual psychophysics combined with state-of-the-art dynamic 3D computer graphics can now characterize face movement patterns with unprecedented detail to deliver precise information ontologies and reveal *how* face movement patterns differ (or are similar) across cultures. Similarly, integrating perspectives from separately evolving fields (e.g. social face perception of emotions, personality, conversational messages, e.g. [44]) or across dichotomous debates (e.g. nature versus nurture) boosts progress in understanding the functional (e.g. see [45–47]) and perceptual ontologies of face movement patterns (e.g. personality traits [30,48], intelligence [49]. See also Niedenthal in this special issue). Applications of advanced technologies, interdisciplinarity, and creative thinking now mark the emergence of a new scientific culture that holds great potential to make significant new milestones, and to raise the profile and impact of Psychology to realize its potential in other fields (e.g. computer vision, social robotics; see [50]).

## Conflict of interest statement

Nothing declared.

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