

## Research Article

## Reading Between the Lies

## Identifying Concealed and Falsified Emotions in Universal Facial Expressions

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**ABSTRACT**—*The widespread supposition that aspects of facial communication are uncontrollable and can betray a deceiver’s true emotion has received little empirical attention. We examined the presence of inconsistent emotional expressions and “microexpressions” (1/25–1/5 of a second) in genuine and deceptive facial expressions. Participants viewed disgusting, sad, frightening, happy, and neutral images, responding to each with a genuine or deceptive (simulated, neutralized, or masked) expression. Each 1/30-s frame (104,550 frames in 697 expressions) was analyzed for the presence and duration of universal expressions, microexpressions, and blink rate. Relative to genuine emotions, masked emotions were associated with more inconsistent expressions and an elevated blink rate; neutralized emotions showed a decreased blink rate. Negative emotions were more difficult to falsify than happiness. Although untrained observers performed only slightly above chance at detecting deception, inconsistent emotional leakage occurred in 100% of participants at least once and lasted longer than the current definition of a microexpression suggests. Microexpressions were exhibited by 21.95% of participants in 2% of all expressions, and in the upper or lower face only.*

The face is a dynamic canvas on which people communicate their emotional states and from which they infer the emotional states of others. Observers quickly “read” the faces of strangers to make evaluations of their state (emotions, intentions) and trait characteristics (e.g., Willis & Todorov, 2006). Confronted with a stranger’s face displaying lowered brows, flared nostrils, and “flashing eyes” (Darwin, 1872), one readily recognizes anger and might wisely escape the situation. Often, however, facial

expressions are more difficult to interpret. Complicating their evaluation has been the evolutionary development of interpersonal deception. Modern humans are highly skilled deceivers; observers tend to perform at or slightly above chance in judging whether another person is lying (e.g., Bond & DePaulo, 2006; Ekman & O’Sullivan, 1991; Vrij, 2000, 2008).

One strategy used to facilitate deception is to alter or inhibit the facial expression that normally accompanies a particular emotion. There are three major ways in which emotional facial expressions are intentionally manipulated (Ekman & Friesen, 1975): An expression is *simulated* when it is not accompanied by any genuine emotion, *masked* when the expression corresponding to the felt emotion is replaced by a falsified expression that corresponds to a different emotion, or *neutralized* when the expression of a true emotion is inhibited while the face remains neutral. It is commonly assumed that attention to certain aspects of facial expressions can reveal these forms of duplicity. The Supreme Court of Canada has concluded that the assessment of credibility is “common sense” as long as the judge or jury has a clear view of the witness’s face (*R. v. B. (K.G.)*, 1993; *R. v. Marquard*, 1993). In addition, as a result of terrorist activity, airline security officials in the United States implemented a program to train security staff to identify potential threats in part by reading concealed emotions in the faces of passengers. The U.S. transportation agency has been training hundreds of “behavior detection” officers and plans to deploy them in major American airports by 2008 (Lipton, 2006).

This massive training program is based largely on the work and input of Paul Ekman (T. Frank, 2007), who has argued that aspects of facial communication are uncontrollable and can betray a deceiver’s true emotion to the trained observer (see Ekman, 2006). This idea has its origin in the work of Guillaume Duchenne, who began to document facial actions associated with genuine and false smiles in the 1800s (Duchenne, 1862/1990). In the popular view, a happiness expression is one in which the zygomatic major muscle is contracted, pulling the corners of the mouth upward into a smile. However, Duchenne

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noted that genuine expressions of happiness also involve the activation of the orbicularis oculi, the muscle that surrounds the eye and pulls the cheek up while lowering the brow. Darwin (1872) hypothesized that certain specific facial actions that cannot be created voluntarily may nonetheless be involuntarily expressed in the presence of a genuine emotion. He noted:

A man when moderately angry, or even when enraged, may command the movements of his body, but . . . those muscles of the face which are least obedient to the will, will sometimes alone betray a slight and passing emotion. (p. 79).

Darwin's *inhibition hypothesis* has never been tested empirically (Ekman, 2003). Related to Darwin's observation is Ekman's proposal that when an emotion is concealed, the true emotion may be manifest as a *microexpression*, a fleeting but complete facial expression discordant with the expressed emotion and usually suppressed within 1/5 to 1/25 of a second, so that it is difficult to detect with the naked eye (e.g., Ekman, 1992, 2006).

Although the concept of microexpressions has received enormous attention in the scientific community (e.g., see Duenwald, 2005; Schubert, 2006) and news media (e.g., Adelson, 2004; Ekman, 2006; Henig, 2006), it has been subjected to surprisingly little empirical research. To our knowledge, no published empirical research has established the validity of microexpressions, let alone their frequency during falsification of emotion. Although Ekman has argued that training can help people identify microexpressions and therefore become better detectors of deception (see Schubert, 2006), his conclusion appears to be based on research in which participants were exposed to brief glimpses of still facial expressions and were asked to identify the brief flash of emotion. For example, in a study by M.G. Frank and Ekman (1997), people's ability to judge whether targets were lying was positively related to their performance on a separate task in which they evaluated expressed emotion in static faces viewed for 1/25th of a second. However, the presence of microexpressions in the videotaped targets in the deception-detection task was apparently unexamined. Thus, although the ability to recognize emotion and the ability to detect deception may be related, these findings cannot be taken as evidence for the validity of microexpressions as indicators of false emotions. Further, studies of possible differences among genuine, simulated, masked, and neutralized expressions have rarely examined any basic emotions other than happiness (Ekman, Davidson, & Friesen, 1990).

We conducted the first comprehensive investigation of genuine and falsified facial expressions of emotion. Videotaped displays of emotional expression were analyzed on a frame-by-frame basis for the presence and duration of the universal emotional expressions. Emotional expressions inconsistent with the intended emotional display, microexpressions, and blink rate were coded to determine whether genuine and falsified emotional expressions could be differentiated reliably.

## METHOD

### Participants

Undergraduate students ( $N = 41$ ) participated in return for credit points added to marks in psychology courses. Participants were predominantly female (35 females, 6 males) and had a mean age of 21.51 years ( $SD = 4.79$ ). Six additional naive volunteers judged the veracity of the facial expressions in real time.

### Apparatus and Stimuli

The testing room was arranged with the participant seated in a chair directly in front of a laptop computer on which a timed photographic slide show was presented. A full-frontal, close-up view of the participant's face was recorded by a Sony miniDV video camera (recording speed = 30 frames/s) situated on a tripod directly behind the computer's screen. Video was analyzed frame by frame using iMovie. A naive observer who sat behind the screen could not see the slide show, but maintained an unobstructed view of the participant's face to assess the veracity of each expression.

While being videotaped, each participant viewed a timed slide show of emotional photographic images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999; Lang, Greenwald, Bradley, & Hamm, 1993) and responded to each image with a genuine or deceptive emotional expression. The IAPS is a standardized database of more than 700 emotionally evocative, color photographs and has been well normed. Photographs were selected on the basis of ratings of emotional valence and arousal provided in the IAPS manual (Lang et al., 1999). Each selected image fell into one of three categories: highly positive and arousing, highly negative and arousing, or neither pleasant nor unpleasant and nonarousing (i.e., neutral). The normative emotional categories provided by Mikels et al. (2005) for the IAPS images identified the particular emotion elicited by each image (Mikels et al., 2005). The images were organized into sets (see the next paragraph). In all sets, the emotional images were significantly more emotional and arousing than the neutral images, and all negative images differed from all positive images in ratings of emotional valence (all  $ps < .05$ ), but not arousal.

The timed slide show contained a total of 17 images, organized into five sets defined by the expressions participants were instructed to exhibit (see Procedure). The four emotional sets (express disgust, happiness, sadness, and fear) contained 3 images each. For example, in the happiness set, participants viewed 1 neutral, 1 happy, and 1 sad image. The fifth set included 1 neutral (truck), 1 disgusting (severed hand), 1 sad (incubated baby in distress), 1 happy (puppies playing), and 1 fearful (open-mouthed rabid dog) image, which participants viewed while retaining a neutral facial expression. Each image appeared for 5 s, followed by a 5-s break before the next image

appeared. The slide show also contained 2-min breaks between sets of pictures. Each participant viewed 1 of 10 slide shows that counterbalanced the order of emotional sets, as well as the order of images within each set.<sup>1</sup>

### Procedure

Prior to presentation of the stimuli, participants were asked to display a convincing emotional expression in response to each image and were given explicit instructions regarding the emotion they were to express as each image was presented. For example, participants were instructed to respond to each image in the happiness set with a convincing display of happiness. Thus, in the case of the neutral photo, their happiness expression was simulated; in the case of the happy photo, their expression was genuine; and in the case of the sad image, their expression was masked. As a participant exhibited his or her emotional expressions, an observer judged the veracity of each. The observer was informed of the emotion the participant intended to express, but was blind to the image presented on the screen. Although the presence of an observer was intended primarily to increase the realism of the task and the motivation of the participant, it also permitted us to examine the ability of naive observers to detect deception in emotional facial expressions.

### Coding Training and Procedure

Two extensively trained coders coded each frame (duration = 1/30th of a second) of the 5-s videotaped clips (150 frames/clip × 17 clips/participant × 41 participants, for a total of 104,550 coded frames) for the presence and duration of universal emotional expressions in the upper and lower<sup>2</sup> facial regions. Coding required classifying the emotion exhibited in each facial region in each frame and recording the time at which these expressions began and ended (inconsistent emotions lasting from 1/25–1/5th of a second were recorded as microexpressions). Also, the frequency of blinks was recorded for the duration of each expression. The coders were extensively trained in facial musculature, facial action units associated with the universal emotions, and the identification of universal emotional expressions. To facilitate training, we created a detailed reference guide that included numerous examples of each emotion and the main muscle movements involved. Training with this reference guide was complemented by detailed study of the Pictures of Facial Affect (a set of photographs of expressions depicting the uni-

versal emotions; Ekman & Friesen, 1976) and by practice with the Facial Action Coding System (Ekman, Friesen, & Hager, 1976/2002). In addition, the coders reviewed recent studies investigating facial actions involved in the universal emotional expressions (Kohler et al., 2004; Suzuki & Naitoh, 2003).

So we could assess the coders' knowledge level after training, they viewed a slide show of 50 faces from the Pictures of Facial Affect database and classified the emotion expressed in each. Additionally, they viewed 48 videos in a microexpression task similar to that used by M.G. Frank and Ekman (1997). Each of these videos included a 1/25-s glimpse of one still picture of facial affect embedded within another, different expression, and coders were asked to classify the emotion in the microexpression image. The two coders obtained accuracy rates of 96% and 92% on the Pictures of Facial Affect task, and 96% and 94% on the microexpression-identification task. Finally, they practiced frame-by-frame video analysis of emotional facial expressions by coding the video of a sample participant until they were able to attain nearly perfect reliability.

Coders were blind to the veracity of the emotions they were analyzing (i.e., whether participants were displaying genuine, simulated, masked, or neutralized expressions), but aware of the emotions participants intended to portray.

## RESULTS

### Coding Reliability

So that we could assess interrater reliability, both coders analyzed the complete videos of 4 participants (68 expressions, or 10,200 frames). Interrater reliability was at least "good" (as defined, e.g., by Cicchetti & Sparrow, 1981, and Fleiss, 1981) on all indices. The raters averaged 93.3% ( $SD = 16.61$ ) agreement on the number of inconsistent frames per expression (i.e., the number of frames in which they coded an emotion other than the one the participant intended to express). Disagreement in coding a frame as inconsistent was infrequent, occurring for an average of 10.71 ( $SD = 24.63$ ) frames for the upper face and 9.30 ( $SD = 25.38$ ) frames for the lower face, out of 150 frames per expression (i.e., the coders agreed on an average of 139.29 and 140.7 frames for the upper and lower face, respectively). The coders demonstrated good reliability in coding the presence of inconsistent emotions and the duration of the displays,  $r(134) = .71, p < .001$ , and  $r(134) = .70, p < .001$ , respectively. Furthermore, their mean ratings did not differ significantly,  $t(135) = 1.29, p > .05$ , and  $t(135) = 1.44, p > .05$ , respectively.

### Presence and Duration of Inconsistent Emotional Expressions in Genuine and Falsified Expressions

First, we examined whether the emotions participants intended to express and the veracity of the expressions were related to the degree of "leakage," or emotional expressions inconsistent with

<sup>1</sup>The order in which stimuli were presented was analyzed as a between-subjects variable and had no impact on any dependent measure. Thus, counterbalancing was successful, and order effects were minimal.

<sup>2</sup>The upper facial region corresponds to the eye and forehead regions, and the muscles underlying the upper-face action units in the Facial Action Coding System (Ekman, Friesen, & Hager, 1976/2002); these muscles include the frontalis, corrugator, orbicularis oculi, and procerus. The lower facial region corresponds to the nose, mouth, cheek, and chin areas; the muscles involved include the risorius, orbicularis oris, zygomatic major, and mentalis.

the intended display. Although inconsistencies for genuine, simulated, and masked expressions were defined as any emotion other than what was intended, the definition of inconsistency for neutralized expressions was *any* exhibited emotion. Given the difference in these outcome measures, the neutralized emotional expressions were analyzed separately from the genuine, simulated, and masked expressions.

#### *Genuine, Simulated, and Masked Expressions*

A 4 (emotion: disgust, happiness, sadness, fear)  $\times$  3 (veracity of facial expression: genuine, simulated, or masked) multivariate analysis of variance (MANOVA) with the presence/absence of inconsistent emotion in the upper and lower facial regions as the dependent variables revealed main effects for emotion,  $F(6, 35) = 17.33, p < .001, \eta_p^2 = .75$ , and veracity,  $F(4, 37) = 3.03, p < .05, \eta_p^2 = .25$ . Univariate analyses indicated that the effect of emotion was present in both the upper and the lower facial regions,  $F(3, 120) = 13.75, p < .001$ , and  $F(3, 120) = 14.39, p < .001$ , respectively. However, the effect of veracity was found only in the lower face,  $F(2, 80) = 5.45, p < .01$ . Pair-wise comparisons revealed that inconsistencies were less frequent in happy expressions than in sad, fearful, and disgusted expressions, in both facial regions (all  $ps < .001$ ). Also, inconsistent expressions in the lower face were more common in masked expressions than in genuine or simulated emotional displays ( $ps < .05$ ; see Table 1).

A parallel 4  $\times$  3 MANOVA examining the duration of inconsistent expressions (in seconds) in the upper and lower facial regions revealed a main effect for emotion,  $F(6, 35) = 16.06, p < .001, \eta_p^2 = .73$ , present in both the upper face,  $F(3, 120) = 13.90, p < .001$ , and the lower face,  $F(3, 120) = 12.97, p < .001$ . Pair-wise comparisons of emotional expressions in the upper face indicated that inconsistent expressions were of shorter duration in happy expressions ( $M = 0.44, SD = 0.25$ )<sup>3</sup> than in sad ( $M = 1.18, SD = 1.26$ ), fearful ( $M = 1.97, SD = 1.38$ ), and disgusted ( $M = 1.32, SD = 1.06$ ) expressions ( $ps < .001$ ). Similarly, in the lower face, inconsistent expressions were shorter in happy expressions ( $M = 0.74, SD = 0.48$ ) than in sad ( $M = 0.92, SD = 0.66$ ), fearful ( $M = 2.15, SD = 1.56$ ), and disgusted ( $M = 1.40, SD = 1.17$ ) expressions ( $ps < .001$ ). Although the main effect of veracity was not significant,  $F(4, 37) = 1.5, p > .05$ , it is important to note that the inconsistent displays of emotion in genuine (upper face:  $M = 1.56, SD = 1.39$ ; lower face:  $M = 1.42, SD = 1.39$ ), simulated (upper face:  $M = 1.54, SD = 1.29$ ; lower face:  $M = 1.58, SD = 1.22$ ), and masked (upper face:  $M = 1.40, SD = 1.23$ ; lower face:  $M = 1.47, SD = 1.28$ ) displays were much longer than expected; such cues to

<sup>3</sup>Means represent the length (in seconds) of inconsistent emotional expressions for only those expressions in which inconsistencies actually occurred. In other words, expressions that did not contain any inconsistent emotion (i.e., 0 s inconsistent) were excluded from the calculation of means to produce a more accurate illustration of the length of inconsistent emotional expressions when they did occur.

**TABLE 1**  
*Percentage of Expressions in Which Inconsistent Emotional Expressions Occurred*

Expression category	Upper face	Lower face
Intended emotion		
Happiness	7.30	8.13
Sadness	30.9	38.2
Fear	49.6	47.2
Disgust	32.5	42.3
Veracity of expression		
Genuine	26.8	31.1
Simulated	32.3	31.1
Masked	31.1	39.6

emotional deception typically leaked out for several times longer than the duration of an Ekman (1992) microexpression.

To examine the effect of expression veracity and emotion on falsified emotions in particular, we conducted a similar 4 (emotion: disgust, happiness, sadness, fear)  $\times$  2 (veracity of facial expression: simulated, masked) MANOVA. As in the previous analysis, the main effect of emotion was significant,  $F(6, 35) = 9.98, p < .001, \eta_p^2 = .63$ ; emotional leakages were significantly shorter in falsified happy expressions than in falsified negative expressions ( $ps < .05$ ).

#### *Neutralized Expressions*

The presence and duration of inconsistent emotional displays in neutralized expressions of felt emotion were examined. A MANOVA examining the presence of inconsistent emotional leakage in the upper and lower facial regions did not reveal a significant effect of felt emotion (neutral control, happy, sad, fear, and disgust),  $F(8, 33) = 0.65, p > .05$ . Similarly, a parallel MANOVA examining the duration of emotional leakage was not significant,  $F(8, 320) = 0.94, p > .05$ . Thus, participants were largely successful in neutralizing their emotional expressions.

#### **Microexpressions as a Cue to Deception**

No complete microexpressions (1/5th–1/25th of a second) involving both the upper and lower halves of the face simultaneously (as described by Ekman & Friesen, 1975) were detected in any of the 697 analyzed expressions. However, 9 participants exhibited 14 partial microexpressions, 7 in the upper and 7 in the lower facial region. These partial microexpressions occurred in the following emotional contexts: 6 during genuine, 3 during simulated, 4 during masked, and 1 during a neutralized expression. The 5 microexpressions occurring during masked and neutralized emotional portrayals all were congruent with the felt emotion. Thus, partial microexpressions, although infrequent, do tend to be subtle manifestations of an underlying emotion, and may be an indicator of felt emotion in masked expressions. However, they occur with similar frequency in genuine expressions.

### Blink Rate

To assess the effect of emotion and veracity on blink rate, we conducted a 4 (emotion: disgust, happiness, sadness, fear)  $\times$  4 (veracity of expression: genuine, simulated, masked, neutralized) analysis of variance with the number of blinks during each 5-s expression serving as the dependent variable. This analysis revealed a main effect of veracity,  $F(3, 360) = 11.11, p < .001, \eta_p^2 = .21$ . Pair-wise comparisons revealed that blinking increased in masked expressions ( $M = 1.86, SD = 0.22$ ) and decreased in neutralized expressions ( $M = 1.06, SD = 0.12$ ), relative to genuine expressions ( $M = 1.46, SD = 0.16$ ),  $ps < .05$ .

### Accuracy of the Observers in Judging the Veracity of Expressions

A final question was whether the observers could identify deceptive facial expressions with the naked eye. A two-tailed  $t$  test indicated that the judges achieved an overall mean accuracy of 59.76%, which was significantly above chance,  $t(40) = 3.56, p < .01$ . Specifically, judges performed above the level of chance in detecting deception in happy,  $t(40) = 2.78, p < .01$ , and disgusted,  $t(40) = 2.23, p < .05$ , expressions, although their accuracy in judging the veracity of sad and fearful expressions did not differ from chance ( $ps > .05$ ). However, even when accuracy levels exceeded chance, decisions remained highly flawed (about 40% of decisions were incorrect).

## DISCUSSION

The widespread assumption that observers can accurately infer the emotion and intentions of another person by reading his or her facial expressions is the foundation of a massive training program that has been implemented by the U.S. transportation agency in an effort to identify suspicious passengers. The notion that attention to facial expressions can reveal deception originates in the inhibition hypothesis, which suggests that certain aspects of genuine facial expression are difficult to fabricate; however, these same aspects are likely to emerge involuntarily when the individual genuinely feels the corresponding emotion but is attempting to conceal it. Ekman and his colleagues have argued for decades that certain uncontrollable aspects of facial communication can reveal a liar's true emotion, sometimes in the form of fleeting microexpressions (e.g., Ekman, 1992; M.G. Frank & Ekman, 1997). Despite the popularity and application of this hypothesis, it has received virtually no direct empirical validation.

Our findings partially support the inhibition hypothesis; inconsistent expressions occurred more frequently in masked than in genuine expressions. Contrary to the predictions of the inhibition hypothesis, however, inconsistent expressions did not differentiate genuine neutral expressions and neutralized expressions of felt emotion. That is, participants were largely successful in neutralizing their emotions. This pattern of results

likely relates to the complexity of creating a masked expression, which requires concealing the underlying emotion and expressing an opposing, artificial emotion—a more complex task than simply concealing the felt emotion. It seems to be more difficult to adopt an emotional mask than to appear unemotional, as involuntary leakage of emotion in the lower face was more frequent in masked than in genuine expressions, whereas neutralized expressions did not differ from genuine neutral expressions. Similarly, masking emotion appears to lead to higher blink rates, whereas neutralizing the face reduces the number of blinks exhibited. This finding for blink rates suggests that the type of emotional lie and context are important in interpreting changes in blinking behavior. In a study of offenders engaged in real-life high-stakes lies, Mann, Vrij, and Bull (2002) found that deception was associated with a decrease in blink rate and postulated that this pattern resulted from a relatively high cognitive load. However, offenders' faces were not examined for facial expressions occurring during deception. In light of our findings, we suggest that offenders may have been attempting to maintain a neutral face when denying their criminal involvement; the decrease in blinking (as seen in our neutralizing condition) might be better explained as overcontrolled behavior arising from an attempt to appear credible.

A critical finding is that all participants showed at least one inconsistent emotional expression during deception, which suggests that emotional leakage in the face may be a ubiquitous, perhaps innate, involuntary aspect of human behavior, as Ekman (1992) has argued. However, displays of inconsistent emotion varied in frequency and duration according to the falsified emotion, indicating that certain emotions are more difficult to fabricate than others. Specifically, participants were better able to create convincing displays of happiness than to create convincing displays of negative expressions. This pattern may relate to people's relatively high level of experience with creating false expressions of happiness in daily life. From the perspective of the inhibition hypothesis, these findings suggest that negative emotional expressions include muscle actions that are under less volitional control than those involved in expressions of happiness.

Although our results lend support to the hypothesis that inconsistent emotional displays appear during emotion falsification, they are rarely so brief as to be classified as microexpressions according to the traditional definition (Ekman, 1992; Ekman & Friesen, 1975); in fact, on average, they lasted several times longer (more than a second) than a microexpression. In other words, when inconsistent expressions appeared during deceptive displays, the "recovery" was relatively difficult for the deceiver. This finding suggests that with training, inconsistent emotions during deception may be easier to spot than previously thought. But in another way, microexpressions are even *more* subtle than originally hypothesized: All 14 of those identified in this study were partial microexpressions manifested only in the upper or the lower face. When partial microexpressions did

occur in masked expressions, they were a reliable indicator of the disguised emotion. However, their occasional occurrence in genuine expressions makes their usefulness in airline-security settings questionable, given the implications of false-positive errors (i.e., potential human-rights violations). Certainly, current training that relies heavily on the identification of full-face microexpressions may be misleading.

How well can observers identify when a target is faking an emotion? Although we found that observers were not merely guessing at the veracity of each facial expression, they made errors 40.24% of the time, and their accuracy in judging sad and fearful expressions did not differ from chance. These results are similar to those of Hess and Kleck (1994), who found that participants judging the veracity of emotional expressions performed only at or slightly above chance because they relied on invalid cues. The low accuracy of our observers' assessments, coupled with our finding that most inconsistencies occurred in the lower face, is intriguing in light of work by Vinette, Gosselin, and Schyns (2004), which indicated a preference for gleaning identifying information from the eyes of a target during rapid presentations of facial expression. Perhaps greater control of the eye region during emotion falsification is strategically aimed at counteracting this attentional preference.

It is possible that emotional displays associated with a higher level of motivation and arousal in the deceiver are more difficult to fake than emotional displays of lesser consequence. However, Vrij and Mann (2001) found that police officers performed at the level of chance when assessing the honesty of individuals during emotional press conferences concerning a missing relative. Although previous research with real criminal interviews indicated that police officers might be able to detect deception with accuracy slightly above the level of chance, only 1 of the 99 officers in the study subsequently reported having used emotion as a cue to deceit (Mann, Vrij, & Bull, 2004). Thus, appropriate training on facial cues to deceit may be essential to improve the detection of deception. Given that some previous attempts at training individuals to detect deception by focusing on verbal and nonverbal behavior have been modestly successful (e.g., Porter, Woodworth, & Birt, 2000), the addition of a facial-analysis component could substantially increase the efficacy of training. However, one must be careful not to jump to conclusions regarding the efficacy of facial-analysis training in security settings; the difficulty of reliably detecting emotional deceit in such settings is increased given that conditions are highly uncontrolled, and security staff lack the ability to conduct frame-by-frame analysis, working in real time. Therefore, we believe that further research is required before facial "behavior detection" should be implemented in applied settings.

In interpreting these findings, some limitations of this study should be considered. First, we were unable to examine the expression of two universal emotions—anger and surprise. Anger, in particular, could be a common affective experience that must be concealed in order to engage in violence and even

terrorist acts. Second, this study examined undergraduates, who may exhibit different behavior than criminal offenders, who may be more convincing liars than most other people (e.g., Porter, Doucette, Woodworth, Earle, & MacNeil, 2007). Third, our participants' motivation to conceal and fabricate emotions convincingly was not comparable to the motivation of high-stakes liars. Therefore, we currently are conducting research on guilty perpetrators' and innocent individuals' facial expressions in videotaped pleas for the return of a missing relative (see Vrij & Mann, 2001). This will permit us to determine whether microexpressions are a reliable indicator of deception during the concealment or falsification of extreme emotions.

In conclusion, the rich canvas of the human face clearly has the potential to reveal secretly held emotions. However, our findings also bring into question some existing assumptions about facial communication, such as the assumption that whole-face microexpressions are common and are associated with deception. The current findings suggest that facial expressions of emotion provide critical evidence for assessing their credibility—particularly in the case of negative emotions. However, the presence of inconsistent emotional expressions in genuine expressions may lead to incorrect interpretations that the emotion is falsified. Therefore, one could argue that the applied value of inconsistent expressions may lie in everyday social interactions, clinical settings, and police investigations (with an identified suspect and capacity for video analysis). It is more difficult to justify the widespread application of these findings to assessing the general public in airport settings, in which faulty interpretations have the potential to create human-rights violations.

The empirical documentation of inconsistent emotional expressions in falsified facial expressions offers new and exciting possibilities for advancing the scientific understanding of human emotion and, we hope, will lead to necessary reforms in training applications in forensic and security settings.

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## REFERENCES

- Adelson, R. (2004). Detecting deception. *Monitor on Psychology, 35*, 70.
- Bond, C.F., & DePaulo, B.M. (2006). Accuracy of deception judgments. *Personality and Social Psychology Review, 10*, 214–234.
- Chicchetti, D.V., & Sparrow, S.A. (1981). Developing criteria for establishing interrater reliability of specific items: Applications to assessment of adaptive behavior. *American Journal of Mental Deficiency, 86*, 127–137.

- Darwin, C. (1872). *The expression of the emotions in man and animals*. Chicago: University of Chicago Press.
- Duchenne, G.B. (1990). *The mechanism of human facial expression*. New York: Cambridge University Press. (Original work published 1862)
- Duenwald, M. (2005, February 1). The physiology of facial expressions. Retrieved September 19, 2007, from the *Discover* Web site: <http://discovermagazine.com/2005/jan/physiology-of-facial-expressions>
- Ekman, P. (1992). *Telling lies: Clues to deceit in the marketplace, politics, and marriage*. New York: Norton.
- Ekman, P. (2003). Darwin, deception and facial expression. In P. Ekman, R.J. Davidson, & F. De Waals (Eds.), *Annals of the New York Academy of Sciences: Vol. 1000. Emotions inside out: 130 years after Darwin's The Expression of the Emotions in Man and Animals* (pp. 205–221). New York: New York Academy of Sciences.
- Ekman, P. (2006, October 29). How to spot a terrorist on the fly. *Washington Post*. Retrieved September 19, 2007, from <http://www.washingtonpost.com>
- Ekman, P., Davidson, R.J., & Friesen, W.V. (1990). The Duchenne smile: Emotional expression and brain physiology: II. *Journal of Personality and Social Psychology*, *58*, 342–353.
- Ekman, P., & Friesen, W.V. (1975). *Unmasking the face: A guide to recognizing emotions from facial clues*. Englewood Cliffs, NJ: Prentice-Hall.
- Ekman, P., & Friesen, W.V. (1976). *Pictures of facial affect*. Palo Alto, CA: Consulting Psychologists Press.
- Ekman, P., Friesen, W.V., & Hagar, J.C. (2002). *Facial Action Coding System*. Salt Lake City, UT: Network Information Research. (Original work published 1976)
- Ekman, P., & O'Sullivan, M. (1991). Who can catch a liar? *American Psychologist*, *46*, 913–920.
- Fleiss, J.L. (1981). *Statistical methods for rates and proportions* (2nd ed.). New York: John Wiley and Sons.
- Frank, M.G., & Ekman, P. (1997). The ability to detect deceit generalizes across different types of high-stake lies. *Journal of Personality and Social Psychology*, *72*, 1429–1439.
- Frank, T. (2007, September 25). Airport security arsenal adds behavior detection. *USA Today*. Retrieved November 20, 2007, from <http://www.usatoday.com>
- Henig, R.M. (2006, February 5). Looking for the lie. *New York Times*. Retrieved September 19, 2007, from [www.nytimes.com](http://www.nytimes.com)
- Hess, U., & Kleck, R.E. (1994). The cues decoders use in attempting to differentiate emotion-elicited and posed facial expressions. *European Journal of Social Psychology*, *24*, 367–381.
- Kohler, C.G., Turner, T., Stolar, N.M., Bilker, W.B., Brensinger, C.M., Gur, R.E., & Gur, R.C. (2004). Differences in facial expressions of four universal emotions. *Psychiatry Research*, *128*, 235–244.
- Lang, P., Bradley, M., & Cuthbert, B.N. (1999). *International Affective Picture System (IAPS): Instruction manual and affective ratings* (Tech. Rep. No. A-4). Gainesville: University of Florida, Center for Research in Psychophysiology.
- Lang, P., Greenwald, M.K., Bradley, M., & Hamm, A.O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology*, *30*, 261–273.
- Lipton, E. (2006, August 17). Threats and responses: Screening; faces, too, are searched as U.S. airports try to spot terrorists. *New York Times*. Retrieved September 19, 2007, from [www.nytimes.com](http://www.nytimes.com)
- Mann, S., Vrij, A., & Bull, R. (2002). Suspects, lies, and videotape: An analysis of authentic high-stake liars. *Law and Human Behavior*, *26*, 365–376.
- Mann, S., Vrij, A., & Bull, R. (2004). Detecting true lies: Police officers' ability to detect suspects' lies. *Journal of Applied Psychology*, *89*, 137–149.
- Mikels, J.A., Fredrickson, B.L., Larkin, G.R., Lindberg, C.M., Maglio, S.J., & Reuter-Lorenz, P.A. (2005). Emotional category data on images from the International Affective Picture System. *Behavioral Research Methods*, *37*, 625–630.
- Porter, S., Doucette, N., Woodworth, M., Earle, J., & MacNeil, B. (2007). 'Halfe the world knows not how the other halfe lies': Investigation of cues to deception exhibited by criminal offenders and non-offenders. *Legal and Criminological Psychology*, *13*, 27–38.
- Porter, S., Woodworth, M., & Birt, A.R. (2000). Truth, lies, and videotape: An investigation of the ability of federal parole officers to detect deception. *Law and Human Behavior*, *24*, 643–658.
- R. v. B. (K.G.), 1 S.C.R. 740 (Supreme Court of Canada, 1993).
- R. v. Marquard, 4 S.C.R. 223 (Supreme Court of Canada, 1993).
- Schubert, S. (2006, October). A look tells all. Retrieved September 19, 2007, from the *Scientific American Mind* Web site: <http://www.sciam.com/article.cfm?articleID=0007F06E-B7AE-1522-B7AE-83414B7F0182>
- Suzuki, K., & Naitoh, K. (2003). Useful information for face perception is described with FACS. *Journal of Nonverbal Behavior*, *27*, 43–55.
- Vinette, C., Gosselin, F., & Schyns, P.G. (2004). Spatio-temporal dynamic of face recognition in a flash: It's in the eyes. *Cognitive Science: A Multidisciplinary Journal*, *28*, 289–301.
- Vrij, A. (2000). *Detecting lies and deceit: The psychology of lying and the implications for professional practice*. Chichester, England: Wiley.
- Vrij, A. (2008). *Detecting lies and deceit: Pitfalls and opportunities*. Chichester, England: Wiley.
- Vrij, A., & Mann, S. (2001). Who killed my relative? Police officers' ability to detect real-life high-stake lies. *Psychology, Crime and Law*, *7*, 119–132.
- Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological Science*, *17*, 592–598.

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