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Detecting deception in pain expressions: the structure of genuine and deceptive facial displays

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Abstract

Clinicians tend to assign greater weight to non-verbal expression than to patients' self-report when judging the location and severity of pain. Judgments can misrepresent the actual experience because patients can successfully alter their pain expressions. The present research provides a basis for discriminating genuine and deceptive pain expressions by expanding detailed accounts of facial expressions to include previously unexamined variables, including study of temporal patterns and contiguity of facial actions as well as the occurrence of specific deception cues. Low back patients' facial expressions ($n = 40$) were videotaped at rest and while undergoing a painful straight leg raise with instructions to: (1) genuinely express their pain, or (2) pretend that it did not hurt. As well, they were asked to fake pain without moving. The Facial Action Coding System was used to describe and quantify facial activity. The different types of expression were compared on the frequency, type, intensity, temporal pattern and contiguity of facial actions, as well as on the frequency of specific deception cues. Findings confirmed the difficulty of discriminating the facial expressions, but indicated that faked pain expressions show a greater number of pain-related and non-pain-related actions, have a longer peak intensity and overall duration, and the facial actions observed tend to be less temporally contiguous than are those in genuine pain expressions. The differences between masked pain and neutral expressions were subtle, with a greater frequency of mouth opening and residual eyebrow movement in masked pain expressions. Thus, there is an empirical basis for discriminating genuine and deceptive facial displays.

Keywords: Chronic pain; Deception; Malingering; Assessment; Facial expressions; Non-verbal behavior

1. Introduction

Deception has been an important clinical issue because some patients report pain and disability levels inconsistent with their tissue damage and observers can attribute this to purposeful dissembling. Patients may exaggerate or fake pain due to perceived personal benefit (e.g. compensation claims) or, alternatively, may minimize their pain due to fear of adverse consequences, such as medication side effects (Lander, 1990), risk of unemployment (Kotarba, 1983), or perceived social/interpersonal pressures (Craig et al., 1999). The possibility of deception needs to be considered in clinical settings, but discrepancies between physical pathology and behavioral evidence of pain alone do not justify decisions about deception, as diagnostic efforts and technologies for identifying physical pathology can be inadequate and research indicates that there is a well-established tenuous relationship between organic damage and reports of pain (Turk and Melzack, 1993). This has provoked a search for evidence of pain that would not be subject to voluntary control or that represented a marker of deception.

Behavioral evidence of pain available to clinicians is comprised of either verbal report (e.g. interviews, standardized questionnaires) or non-verbal information (i.e. pain behaviors), including facial expression (Keefe and Block, 1982; Keefe et al., 1985). Observers often assume that non-verbal behavior is less amenable to deception (Ekman and Friesen, 1969, 1974), and assign greater importance to people's non-verbal behavior when it is discordant with their verbal self-reports of emotion (DePaulo et al., 1978; Jacox, 1980; Craig and Prkachin, 1980; Craig and Prkachin, 1983). In addition, non-trained judges (Poole and Craig, 1992) and clinicians (Johnson, 1977), when provided with

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both verbal report and facial activity, considered facial expressions a more salient source of information on which to base their judgments. However, facial expressions cannot be considered to be simply innate or reflexive responses which provide a direct measure of pain intensity, as they also are amenable to personal control (Kleck et al., 1976; Hadjistavropoulos and Craig, 2002). Nevertheless, facial expressions have been found to provide useful information when assessing the credibility of self-report, as deceptive and genuine pain expressions show subtle differences in the frequency and intensity of certain facial actions (Craig et al., 1991; Hadjistavropoulos and Craig, 1994).

Research has isolated 'core' pain-related facial actions common to acute pain, exacerbations of chronic pain, and various types of experimentally induced pain. These comprise a lowered brow, raised cheeks, tightened eye lids, a raised upper lip or opened mouth, and closed eyes (Prkachin and Mercer, 1989; Craig et al., 1991; Prkachin, 1992b). Research has less consistently identified horizontal or vertical stretching of the lips, a wrinkled nose, deepening of the nasolabial fold and drooping eyelids as pain related actions. These discrepancies may reflect methodological variations such as the type of pain experienced (LeResche, 1982; Prkachin and Mercer, 1989), pain severity (Patrick et al., 1986; Prkachin and Mercer, 1989), situational (Hill, 1996, Prkachin et al., 1983; Prkachin and Craig, 1985) and individual difference variables (Craig, 1992).

Various predictive correlates of facial expression contribute to its clinical utility. The magnitude of facial activity increases with the intensity of noxious stimulation (Prkachin et al., 1983), correlates with self reports of pain severity (Patrick et al., 1986; Prkachin and Mercer, 1989) and unpleasantness (LeResche and Dworkin, 1988; Prkachin and Mercer, 1989), and is discriminable by naive observers, suggesting that facial expressions of pain can communicate quantitatively graded pain information (Prkachin and Mercer, 1989; Prkachin, 1992a). The pain expression also seems relatively specific to pain, as it can be differentiated from other negative subjective states, such as disgust, fear, anger and sadness (LeResche, 1982; LeResche and Dworkin, 1988; Hale and Hadjistavropoulos, 1997). Also, research has not found a relationship between anxiety, depression and the facial expression of pain (LeResche and Dworkin, 1988), despite consistent findings of a correlation between anxiety, depression and verbal pain reports (Craig, 1999).

Neuropsychological research suggests that voluntary and involuntary facial movements may be controlled by the cortical/pyramidal and subcortical/extrapyramidal systems, respectively (Rinn, 1984). If partially independent neural systems are responsible for voluntary and involuntary facial movements, there may be identifiable differences in the topography of genuine and deceptive facial expressions. Research examining the voluntary control of facial activity during experimental (Galin and Thorn, 1993) and clinical pain (Craig et al., 1991; Hadjistavropoulos and Craig, 1994) has confirmed that participants are able to pose deceptive pain faces and that several differences in facial actions distinguish between the genuine, faked, masked and no pain displays. The faked pain expression appears as a more vigorous and 'prototypical' expression of the genuine pain response, as all of the components of the genuine pain expression occurred more frequently and/or more intensely. In addition, the presence of several non-pain related actions distinguished faked from genuine pain displays (Craig et al., 1991; Hadjistavropoulos and Craig, 1994). In contrast, the masked pain expression was represented by a diminished display between the neutral baseline and the genuine pain expression, reflecting residual facial activity or a 'microexpression' which 'leaks out' when there is an attempt to neutralize the genuine facial display (Ekman and Friesen, 1969). Finally, faked and masked pain expressions showed decreased rates of blinking, thought to be a result of the increased cognitive activity required by instructions to fake or mask pain (Craig et al., 1991). These differences are subtle, and would be difficult for observers to distinguish.

The focus of earlier studies was on the configuration and intensity of pain-related facial actions during genuine and deceptive pain. Previously unexamined facial expression variables may provide unique markers of deception and may improve our description of deceptive facial expressions of pain. First, deception may be exhibited as a mix of emotional expressions, that include 'leakage' of the genuine expression, which is most likely to occur around the eyes, due to less differentiated control of the musculature in the upper face than of the lower face (Ekman and Friesen, 1969). Faked pain displays also may contain emotional expressions which are incongruous, such as shame, guilt, or smiles (Hager and Ekman, 1985). Such cues may be difficult to pick up, as pain itself is a complex experience which may include or be influenced by many emotions (Craig, 1999). Certain emotional expressions may appear more often in deceptive versus genuine pain displays. There also may be specific cues associated with deception, such as blushing, sweating, blinking rates (Ekman, 1985; Prkachin, 1992a), or asymmetrical actions (Ekman, 1980; Ekman et al., 1981; Hager and Ekman, 1985; Clarici et al., 1996). Finally, faked facial expressions may have a delayed onset, a longer duration (Ekman and Friesen, 1982), or the individual facial actions may appear serially, rather than in a 'constellation' typical of genuine facial expressions (Lee and Craig, 1986). The aim of the present research was to provide a more detailed description of genuine and deceptive pain expressions by expanding facial analyses to include temporal patterns, contiguity of facial actions, and the occurrence of specific deception cues.

2. Method

2.1. Subjects

Twenty-three males and 17 females, aged 19–75 years of age ($X = 32.6$, $SD = 10.89$) undergoing physiotherapy treatment for low back pain volunteered and were paid CAN$ 10 for their participation. The majority of subjects (65.71%) experienced intermittent pain, while 31.43% of subjects experienced constant pain; pain duration averaged 3.01 years. Daily use of prescription or non-prescription pain medications was reported by 42.9% of patients.

2.2. Procedure

Medical histories were obtained through a questionnaire and medical chart review. Patients rated the unpleasantness and intensity of the pain they experienced on an average day using the Descriptor Differential Scales (DDS). The scale provides 13 descriptive adjectives on two scales, ranging from 'not painful' to 'extremely painful' and 'not unpleasant' to 'extremely unpleasant' (Gracely et al., 1978a,b; Gracely et al., 1979). These descriptors are reliable measures of the pain experience and have been ratio-scaled using cross-modality matching procedures to provide numerical equivalents for the verbal descriptors (0–72.1 for the sensory scale and 0–37.4 for pain unpleasantness) (Gracely et al., 1982).

2.2.1. Videotaping protocol

Participants faced the camera and their head and shoulders were videotaped during a neutral 'at rest' condition, as well as during two straight leg raise exercises (which low back pain patients report to be very painful), with instructions to: (1) genuinely express any pain that they felt, and (2) pretend that it did not hurt. Patients were also asked to give a faked expression, by pretending that they were in pain without actually moving their legs. The order of the three pain conditions (genuine, masked, faked) was counterbalanced across patients to control for order effects. Facial expressions were videotaped continuously, but the focus was upon the 10 s following initiation of each condition. Patients then rated the unpleasantness and intensity of the most severe pain they experienced during the leg-lifting exercises, using the DDS.

2.2.2. Quantification of facial activity

The 160 10-s segments were edited from the original videotape and randomized on a dubbed tape. Coders were blind to pain condition. Each segment was coded for each of the 44 Facial Action Coding System (FACS) units (AUs) (Ekman and Friesen, 1978a,b). Following earlier conventions (Prkachin, 1992a; Hadjistavropoulos and Craig, 1994) AUs which involve the same muscle action were combined to produce new variables: AU1 (inner brow raise) and AU2 (outer brow raise) produced 'brow raise', AU 6 (cheek raise) and AU 7 (lid tighten) produced 'orbit tightening', AU 9 (nose wrinkle) and 10 (upper lip raise) produced 'levator contraction' and AU 25 (lips apart), 26 (jaw drop) and 27 (mouth stretch) produced 'mouth opening'). Intensity for each AU was rated on a standardized 5-point rating scale, ranging from 'trace' to 'maximum'. AU 11 (nasolabial deepening), AU 38 (nostril dilation), and AU45 (blinking) did not allow for intensity coding. The mouth opening variable was coded on a 3 point scale, with a score of 1 for AU 25, a 2 for AU26 and a 3 for AU 27 (Ekman and Friesen, 1983; Prkachin, 1992a).

The basic FACS coding approach was modified to measure the time of AU onset and AU offset, the maximum intensity or 'apex' of the AU, and the apex duration. Coding was performed by two trained FACS coders (Ekman and Friesen, 1978b). Intercoder reliability was examined for 20% of the segments. Percent agreement for occurrence of AUs, within 0.02 s, was 82.5%, while the reliability of intensity ratings, using a Pearson correlation, was 0.85. The reliability of temporal paramenters, using agreements within 0.50 s, was: onset duration (82.7%), apex duration (80.0%), and response duration (84.0%).

3. Results

Patients rated their average daily pain as 'barely strong' ($X = 16.4$, $SD = 14.0$, $N = 33$) in intensity and 'slightly distressing' ($X = 10.0$, $SD = 6.5$, $N = 33$) in unpleasantness. The range of motion exercise was rated as 'barely strong' ($X = 15.0$, $SD = 13.3$, $N = 33$) in pain intensity and 'slightly distressing' ($X = 7.6$, $SD = 4.2$, $N = 33$) in unpleasantness.

Fifteen AUs were observed in more than 5% of the coded segments, which is comparable to previous studies (e.g. Hadjistavropoulos and Craig, 1994). These 15 AUs were the focus of analyses. Offset duration was not codeable due to frequent continuation of AUs beyond the end of the 10 s segments. Separate mixed model multivariate analysis of variances (MANOVAs) compared individual facial actions across pain conditions on each of the following variables: frequency, intensity, apex duration, duration, and frequency of asymmetry/pulsating apices. Univariate F-tests and Tukey's post-hocs compared individual AUs across pain conditions.

3.1. Frequency

Frequency of facial actions differed significantly across pain instruction conditions. This included five typically pain-related facial actions (brow lowering, opened mouth, orbit tightening, levator contraction, and closed eyes). Brow lowering and an opened mouth occurred more frequently in faked pain expressions than in the genuine pain, masked pain or neutral expressions. Genuine and masked pain expressions did not differ in the frequency of brow lowering or mouth opening, but both exhibited a greater frequency of mouth opening than the neutral expression. Masked pain and neutral expressions did not differ in the frequency of brow lowering. Orbit tightening, levator contraction and eye closure movements all occurred more frequently in the faked pain expressions than in the masked pain or neutral

Table 1
Results of MANOVA and followup ANOVAs examining frequency of facial actions across pain conditions[a]

	df	*F*	*P*
Multivariate main effect	45, 315	2.18	0.001
Univariate *F*-tests			
Brow raise (AU 1/AU 2)	3,117	6.22	0.001
Brow lowering (AU4)	3,117	16.85	0.001
Orbit tightening (AU6/AU7)	3,117	7.82	0.001
Levator contraction (AU9/AU10)	3,117	5.05	0.003
Lip corner pull (AU12)	3,117	1.89	0.136
Dimpler (AU14)	3,117	1.95	0.125
Chin raise (AU17)	3,117	1.66	0.180
Tongue show (AU19)	3,117	1.72	0.168
Lip press (AU24)	3,117	1.05	0.373
Opened mouth (AU25/26/27)	3,117	6.52	0.001
Nostril flare (AU38)	3,117	0.75	0.525
Eye slit (AU42)	3,117	2.16	0.096
Eyes closed (AU43)	3,117	7.37	0.001
Eye squint (AU44)	3,117	3.33	0.022
Blinking (AU45)	3,117	3.20	0.026

[a] Note: Bonferroni adjustments suggest a significance level of 0.003.

expressions, but occurred as frequently in the genuine pain expressions. The genuine, masked and neutral expressions were equivalent. As well, the frequency of one non-pain-related facial action (brow raise) varied across pain instruction conditions, occurring more often in faked pain than in genuine pain, masked pain, or neutral expressions, which were equivalent (see Tables 1 and 2).

3.2. Intensity

The intensity of facial actions differed significantly across pain instruction conditions. Three of the pain-related facial actions varied across condition (brow lowering, orbit tightening and levator contraction). Brow lowering intensity was greater in faked pain than in the genuine pain, masked pain or neutral expressions. Brow lowering intensity in genuine pain was equivalent to masked pain, but greater than in neutral expressions; masked pain and neutral expressions did not differ. Orbit tightening and levator contraction intensity were greater during faked pain than during a masked pain or neutral expression, which were equivalent. Orbit tightening intensity did not differ among genuine pain, the faked pain, masked pain or neutral expressions. Levator contraction intensity in faked pain and genuine pain were equivalent, as were genuine pain and masked pain expressions. Genuine pain expressions, however, exhibited greater levator contraction intensity than did the neutral expressions. The intensity of one non-pain-related facial action (brow raise) differed across condition, occurring more intensely in the faked pain condition than either the genuine, masked or neutral expressions, which were equivalent (see Tables 3 and 4).

3.3. Apex duration

Apex duration differed significantly across pain conditions. Three pain-related facial actions (brow lowering, orbit tightening, and eye closure) differed in apex duration across pain instruction conditions. Brow lowering apex duration was greater in faked pain versus each of the genuine pain, masked pain and neutral expressions, which were equivalent. The apex durations of orbit tightening and eye closure were equivalent for faked and genuine pain, with a longer apex duration occurring in faked pain relative to either the masked or neutral expression; genuine pain, masked pain and neutral expressions were equivalent in

Table 2
Mean facial action frequency across pain conditions (*difference reaches $P < 0.01$)

(AU) Facial action	Neutral		Genuine		Masked		Faked	
	M	SD	*M*	SD	*M*	SD	*M*	SD
Brow raise	0.12	0.56	0.20	0.56	0.10	0.44	0.75[a*,b*,c*]	1.32
Brow lowering	0.00	0.00	0.50[a]	0.99	0.10	0.38	1.20[a*,b*,c*]	1.38
Orbit tightening	0.00	0.00	0.22	0.53	0.20	0.46	0.55[a*,c]	0.75
Levator contraction	0.00	0.00	0.25	0.63	0.08	0.35	0.35[a*,c]	0.66
Lip corner pull	0.05	0.22	0.20	0.46	0.20	0.46	0.25	0.44
Dimpler	0.00	0.00	0.12	0.33	0.08	0.27	0.15	0.43
Chin raise	0.02	0.16	0.22	0.58	0.20	0.56	0.12	0.40
Tongue show	0.00	0.00	0.12	0.40	0.10	0.30	0.05	0.22
Lip press	0.02	0.16	0.12	0.33	0.12	0.40	0.10	0.30
Open mouth	0.18	0.45	0.70[a*]	0.85	0.62[a*]	0.87	0.90[a*,b*,c*]	0.98
Nostril dilate	0.00	0.00	0.08	0.27	0.10	0.50	0.10	0.38
Eye slit	0.00	0.00	0.08	0.27	0.02	0.16	0.15	0.48
Closed eyes	0.00	0.00	0.25	0.54	0.05	0.32	0.42[a,*]	0.75
Eye squint	0.00	0.00	0.10	0.38	0.00	0.00	0.20	0.56
Blinking	2.50	2.70	3.95	3.44	2.60	2.35	3.28	3.43

[a] Mean is significantly greater than neutral mean ($P < 0.05$).
[b] Mean is significantly greater than genuine mean ($P < 0.05$).
[c] Mean is significantly greater than masked mean ($P < 0.05$).

Table 3
Results of MANOVA and followup ANOVAs examining intensity of facial actions across pain conditions[a]

	df	F	P
Multivariate main effect	39,312	2.35	0.001
Univariate F-tests			
Brow raise (AU 1/AU 2)	3,114	7.33	0.001
Brow lowering (AU4)	3,114	22.70	0.001
Orbit tightening (AU6/AU7)	3,114	6.26	0.001
Levator contraction (AU9/AU10)	3,114	8.10	0.001
Lip corner pull (AU12)	3,114	2.17	0.095
Dimpler (AU14)	3,114	1.85	0.141
Chin raise (AU17)	3,114	1.83	0.145
Tongue show (AU19)	3,114	2.52	0.061
Lip press (AU24)	3,114	1.53	0.211
Opened mouth (AU25/26/27)	3,114	4.41	0.006
Eye slit (AU42)	3,114	1.42	0.240
Eyes closed (AU43)	3,114	4.52	0.005
Eye squint (AU44)	3,114	3.81	0.012

[a] Note: Bonferroni adjustments suggest a significance level of 0.003.

apex duration. Apex durations for all of the non-pain-related facial actions were consistent across pain conditions (see Tables 5 and 6).

3.4. Facial action duration

Facial action response duration varied across pain instruction conditions for both one non-pain-related facial action (eye squint) and four pain-related facial actions (brow lowering, orbit tightening, levator contraction, and eye closure) (see Tables 7 and 8). The duration of brow lowering, orbit tightening, eye closure, and eye squint were significantly longer in faked pain than in genuine pain, masked pain and neutral expressions, which were equivalent. Levator contraction duration was also longer in faked pain than in either the masked pain or neutral expressions; faked and genuine pain expressions were equivalent.

Table 5
Results of MANOVA and followup ANOVAs examining apex duration of facial actions across pain conditions[a]

	df	F	P
Multivariate main effect	42,318	2.35	0.001
Univariate *F*-tests			
Brow raise (AU 1/AU 2)	3,117	0.79	0.499
Brow lowering (AU4)	3,117	13.60	0.001
Orbit tightening (AU6/AU7)	3,117	4.66	0.004
Levator contraction (AU9/AU10)	3,117	1.88	0.136
Lip corner pull (AU12)	3,117	0.99	0.398
Dimpler (AU14)	3,117	2.07	0.108
Chin raise (AU17)	3,117	0.18	0.909
Tongue show (AU19)	3,117	0.99	0.402
Lip press (AU24)	3,117	0.35	0.792
Opened mouth (AU25/26/27)	3,117	1.76	0.159
Eye slit (AU42)	3,117	2.27	0.084
Eyes closed (AU43)	3,117	5.26	0.002
Eye squint (AU44)	3,117	2.44	0.068

[a] Note: Bonferroni adjustments suggest a significance level of 0.004.

3.5. Onset duration

Onset duration, defined as the average time lag between the initial onset of a facial action and peak intensity across all AUs, was compared across pain instruction conditions using a mixed-model analysis of variance (ANOVA). A significant difference in overall onset duration was found ($F(3,37) = 15.02$, $P < 0.001$). Tukey's post-hoc analyses showed that the onset of genuine and faked pain displays were equivalent. Neutral facial expressions showed a longer

Table 4
Mean facial action intensity across pain conditions (*difference reaches $P < 0.01$)

Facial action (AU)	Neutral		Genuine		Masked		Faked	
	M	SD	*M*	SD	*M*	SD	*M*	SD
Brow raise	0.08	0.35	0.13	0.57	0.05	0.32	0.80[a,*b,c,*]	1.5
Brow lowering	0.00	0.00	0.85[a]	1.60	0.13	0.57	2.36[a,*b,c,*]	2.33
Orbit tightening	0.00	0.00	0.54	1.37	0.44	1.11	1.15[a,*c]	1.71
Levator contraction	0.00	0.00	0.62[a]	1.39	0.13	0.57	0.95[a,*,c,*]	1.64
Lip corner pull	0.15	0.67	0.38	0.99	0.62	1.40	0.80	1.59
Dimpler	0.00	0.00	0.38	1.04	0.33	1.06	0.41	1.12
Chin raise	0.3	0.16	0.46	1.12	0.44	1.10	0.28	0.97
Tongue show	0.00	0.00	0.26	0.78	0.36	1.09	0.05	0.32
Lip press	0.03	0.16	0.33	0.93	0.28	0.89	0.23	0.71
Open mouth	0.23	0.58	0.69	0.86	0.74	0.91	0.80	0.83
Eye slit	0.00	0.00	0.20	0.92	0.10	0.64	0.36	1.18
Closed eyes	0.00	0.00	0.18	0.82	0.00	0.00	0.62	1.48
Eye squint	0.00	0.00	0.33	1.18	0.00	0.00	0.62	1.52

[a] Mean is significantly greater than neutral mean.
[b] Mean is significantly greater than genuine mean.
[c] Mean is significantly greater than masked mean.

Table 6
Mean facial action apex duration across pain conditions (*difference reaches $P < 0.01$)

Facial action (AU)	Neutral		Genuine		Masked		Faked	
	M (s)	SD	*M* (s)	SD	*M* (s)	SD	*M* (s)	SD
Brow raise	0.09	0.53	0.05	0.22	0.03	0.21	0.14	0.36
Brow lowering	0.00	0.00	0.05	0.18	0.01	0.02	0.24[a*,b*,c*]	0.37
Orbit tightening	0.00	0.00	0.07	0.31	0.04	0.16	0.23[a*,c*]	0.50
Levator contraction	0.83	0.00	0.82	0.13	0.83	0.04	0.82	0.13
Lip corner pull	0.06	0.27	0.07	0.21	0.17	0.61	0.22	0.73
Dimpler	0.00	0.00	0.02	0.07	0.02	0.06	0.10	0.39
Chin raise	0.04	0.23	0.04	0.17	0.02	0.07	0.05	0.31
Tongue show	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01
Lip press	0.06	0.40	0.11	0.59	0.05	0.21	0.03	0.10
Open mouth	0.13	0.54	0.37	0.74	0.32	0.74	0.48	0.82
Eye slit	0.00	0.00	0.00	0.01	0.00	0.00	0.20	0.82
Closed eyes	0.00	0.00	0.07	0.22	0.00	0.00	0.18[a*,c*]	0.44
Eye squint	0.00	0.00	0.01	0.03	0.00	0.00	0.12	0.48

[a] Mean is significantly greater than neutral mean.
[b] Mean is significantly greater than genuine mean.
[c] Mean is significantly greater than masked mean.

onset duration ($X = 1.44$ s, $SD = 0.38$, $P < 0.01$) than either the faked ($X = 0.89$ s, $SD = 0.61$) or genuine pain expressions ($X = 0.93$ s, $SD = 0.49$). The onset duration of masked pain expressions were equivalent to both the neutral and genuine pain expressions, but were significantly longer than the faked pain expressions ($X = 1.24$, $SD = 0.70$, $P < 0.05$).

3.6. Asymmetry and pulsating apexes

The frequency of asymmetrical facial actions and pulsating apexes varied across pain instruction conditions ($F = 2.58$, $P < 0.03$). Genuine and faked pain expressions exhibited similar frequencies of both asymmetrical facial actions and pulsating apices. Faked facial actions showed asymmetry and pulsating apices significantly ($P < 0.01$) more frequently than either the masked pain or neutral expressions, while there were no significant differences between the genuine pain, masked pain and neutral expressions.

Table 7
Results of MANOVA and followup ANOVA's examining the duration of facial actions across pain conditions[a]

	df	*F*	*P*
Multivariate main effect	42,318	2.26	0.00
Univariate *F*-tests			
Brow raise (AU 1/AU 2)	3,117	2.02	0.115
Brow lowering (AU4)	3,117	20.07	0.001
Orbit tightening (AU6/AU7)	3,117	8.80	0.001
Levator contraction (AU9/AU10)	3,117	4.64	0.004
Lip corner pull (AU12)	3,117	1.86	0.140
Dimpler (AU14)	3,117	2.19	0.093
Chin raise (AU17)	3,117	0.27	0.848
Tongue show (AU19)	3,117	1.16	0.326
Lip press (AU24)	3,117	0.35	0.785
Opened mouth (AU25/26/27)	3,117	2.82	0.042
Nostril flare (AU38)	3,117	0.82	0.484
Eye slit (AU42)	3,117	2.57	0.058
Eyes closed (AU43)	3,117	7.75	0.001
Eye squint (AU44)	3,117	4.61	0.004

[a] Note: Bonferroni adjustments suggest a significance level of 0.004.

3.7. Temporal contiguity of facial actions

Agglomerative (within group) average linkage cluster analysis, with Pearson correlations as the similarity grouping measure, were used to analyze facial action onset times of genuine and faked pain expressions. For genuine pain expressions, a four cluster solution produced two clusters containing pain-related and non-pain-related facial actions, and two clusters containing only non-pain-related facial actions. The first 'pain' cluster contained orbit tightening, levator contraction, eyes closed, blinking and eyebrow raise. The second 'pain' cluster contained brow lowering, mouth opening, squinting and lip corner pull. The first 'no pain' cluster included eye slit, nostril dilate, lip press and chin raise, while the second was composed of dimpler and tongue show movements. Results suggest that pain-related facial actions appeared fairly closely together in time during genuine pain expressions. In comparison, a four cluster solution for faked pain expressions showed pain-related facial actions spread across all four clusters. In addition, brow lowering and mouth opening, which appeared together and were the most frequent facial response to genuine pain, did not occur within the same cluster for faked pain. Thus, while the facial actions instigated during genuine and suppressed reactions appear largely contiguously, faked

Table 8
Mean facial action duration across pain conditions (*difference reaches $P < 0.01$)

(AU) Facial action	Neutral		Genuine		Masked		Faked	
	M (s)	SD	*M* (s)	SD	*M* (s)	SD	*M* (s)	SD
Brow raise	0.09	0.53	0.10	0.36	0.08	0.38	0.30	0.58
Brow lowering	0.00	0.00	0.13	0.28	0.01	0.04	0.46[a*,b*,c*]	0.56
Orbit tightening	0.00	0.00	0.16	0.48	0.06	0.18	0.55[a*,b*,c*]	0.98
Levator contraction	0.41	0.00	0.57	0.53	0.44	0.11	0.68[a*,c]	0.63
Lip corner pull	0.11	0.41	0.14	0.38	0.36	1.02	0.45	1.15
Dimpler	0.00	0.00	0.12	0.38	0.04	0.12	0.16	0.56
Chin raise	0.04	0.23	0.06	0.18	0.04	0.12	0.09	0.50
Tongue show	0.00	0.00	0.02	0.08	0.03	0.10	0.01	0.07
Lip press	0.06	0.40	0.15	0.62	0.19	0.83	0.11	0.38
Open mouth	0.16	0.56	0.48	0.81	0.45	0.92	0.66	0.98
Eye slit	0.00	0.00	0.01	0.03	0.00	0.02	0.22	0.83
Closed eyes	0.00	0.00	0.13	0.31	0.02	0.12	0.47[a*,b,c*]	0.97
Eye squint	0.00	0.00	0.03	0.15	0.00	0.00	[a,b,c]	0.84

[a] Mean is significantly greater than neutral mean.
[b] Mean is significantly greater than genuine mean.
[c] Mean is significantly greater than masked mean.

pain expressions seem to be comprised of pain-related facial actions which do not cluster closely in time.

4. Discussion

The study demonstrated consistent differences among genuine and deceptive facial displays of pain in temporal patterns of specific facial actions and in specific deception cues, supporting the position that differentiation of these facial displays is possible.

4.1. Component facial actions of genuine pain expressions

Genuine pain expressions were characterized by an increased frequency (brow lowering, mouth open) and intensity (brow lowering, nose wrinkle/upper lip raise) of pain-related facial actions, as identified in past research, but the full range of facial actions observed in earlier studies was not present. The limited number of pain-related facial actions was not due to reduced procedural pain, as previous patients have reported similar perceived pain, but exhibited a much fuller pain display. However, patients in earlier studies appeared to have more intense and more unpleasant pain on a daily basis, suggesting that the broader context in which one is experiencing pain might influence his/her facial displays of pain (Hadjistavropoulos and Craig, 1994). This interpretation concurs with findings that: (1) patients whose pain problems have had a greater psychological and physical impact on their lives have been shown to exhibit a greater intensity and duration of pain-related facial actions in response to a painful stimulus (Prkachin and Mercer, 1989), and (2) pain-related anxiety increases pain responses by directing attention to the pain experience (Arntz et al., 1991), exacerbating musculoskeletal pain through increased muscle tension (Keefe and Gil, 1986), or intensifying the unpleasant affective response to pain (Eich et al., 1990).

4.2. Component facial actions of faked pain expressions

Patients were good at fabricating a pain display, as faked pain expressions contained facial actions previously identified as part of the 'prototypical' genuine pain display, and most were seen with comparable frequency and intensity in the genuine and deceptive pain expressions. The attempt to fake pain expressions was not wholly successful, however, as some pain-related facial actions appeared with greater frequency (brow lowering, opened mouth) and intensity (brow lowering) in the faked pain expression compared to the genuine pain expressions.

Faked pain expressions also exhibited an increased frequency and intensity of one non-pain-related facial action, brow raise, providing support for the hypothesis that faked expressions are likely to include 'extra', atypical facial actions which arise because the poser is not consciously aware of what a genuine expression looks like on his/her face, or due to the person's state or emotions while engaging in deception. Inner/outer brow raise, is typically associated with a startle response or the experience of fear. It is hypothesized that this facial action would be appropriate if subjects were faking a pain expression in response to an acute pain stimulus with rapid onset, but that it may be less appropriate when faking a response to a familiar pain stimulus which causes a mild exacerbation of a chronic pain condition. This suggests that people seem to have a difficult time reconstructing even a very familiar pain experience, and that people with less frequent and less recent pain experience may have greater difficulties dissimulating pain. Results also suggest that people may base their deceptive pain displays on reactions to acute pain, which people have typically experienced and observed more frequently.

4.3. Component facial actions of masked pain expressions

Patients were very successful at minimizing their pain display, as masking did not result in any uniquely distinguishing facial features, and the differences between the masked pain and neutral expression were very subtle: patients exhibited a greater frequency of mouth opening during masked pain, and residual brow lowering was observed. Masked pain expressions presented as a midpoint between the genuine pain and neutral expressions, suggesting a 'leakage' of residual facial activity during attempts to neutralize a genuine pain display. It was hypothesized that any 'leakage' during masked pain expressions would occur in the eye region. However, increased mouth movements were the most substantial difference between the masked and neutral conditions. When judging another's emotional state based on facial expressions, observers attach more importance to movements in the area of the eyes and upper face (Lee and Craig, 1986). When deceiving others, there may be a similar awareness that greater effort should be expended to control movements around the eyes. Alternatively, systematic changes in pain expressions during painful events may account for these differences, as research suggests that brow lowering and eye closing will be the first facial actions to appear in response to pain, followed by mid-face actions such as upper lip raise and nose wrinkling, and finally mouth opening (Prkachin and Mercer, 1989). The increased frequency of mouth opening during masked pain suggests that deceivers exert a reasonable amount of control over their facial actions immediately, with a gradual lessening of control as the urgency of the pain response decreases.

4.4. Temporal qualities of deceptive versus genuine pain expressions

The present study was the first to examine the temporal patterns of genuine and deceptive pain expressions using the comprehensive FACS coding system. Results confirmed expectations of different temporal patterns for deceptive and genuine pain expressions. One pain-related facial action (brow lowering) had a longer peak intensity in the faked condition, and the overall response duration of two pain-related facial actions (brow lowering, mouth opening) were significantly longer in faked pain compared to genuine pain expressions. These findings indicate that faked expressions tend to be exaggerated in not only the number and intensity of pain-related facial actions but also in the length of peak intensity and the duration of the facial expression. None of the temporal variables differentiated between genuine pain, masked pain and neutral expressions, highlighting the subtle nature of facial cues indicative of masking.

Results also confirmed expectations of variations in temporal contiguity for deceptive and genuine pain expressions. During genuine pain, pain-related facial actions appeared together in two of four clusters based on onset times. In comparison, faked pain expressions showed pain-related facial actions scattered throughout all four clusters. Therefore, when faking pain, people exhibited the component facial actions in a sequential manner compared to genuine pain when pain-related facial actions appear more closely together in time. The fundamental integrity and organized pattern of motoric displays during the actual experience of pain is violated during faked pain; results confirm that the biological mechanisms underlying the genuine and faked pain experience must differ.

4.5. Incidence of deception cues in deceptive versus genuine pain expressions

Cues described as indicative of deception elsewhere in the literature (blinking, facial action asymmetry, pulsating apexes), did not differentiate among neutral, genuine pain, faked pain and masked pain expressions. Previous hypotheses that blinking rates will either increase due to an increase in general emotional arousal (Ekman, 1985), or decrease due to conscious efforts to control one's emotions during deception, were not supported. However, using blinking as a deception cue is complicated by pain expression research, which suggests both that blinking rates increase (Craig and Patrick, 1985; Patrick et al., 1986) and decrease following pain (Craig et al., 1991; Prkachin, 1992b; Prkachin and Mercer, 1989).

4.6. Limits to generalizability

The information on genuine and deceptive facial expressions obtained in this study was collected in a clinical setting, but were subject to artificial conditions, such as videotaping, which may have influenced the patients' pain presentations. The facial actions found to discriminate between genuine pain and neutral facial expressions (brow lowering and mouth opening) were exhibited by only 30 and 45% of patients, respectively, in this study. The current study did not investigate the individual differences in facial actions observed in genuine and deceptive pain displays, nor did it investigate the impact of patient variables (e.g. average daily pain intensity, movement-induced pain levels) on genuine and deceptive pain expressions.

5. Summary

Confirming past studies, genuine and deceptive pain expressions were found to differ in the type, frequency and intensity of facial actions. This investigation was the first to provide evidence that the facial actions presented during deliberately dissimulated pain expressions show significantly different temporal patterns than do genuine pain expressions. Faked pain expressions were found to remain at peak intensity longer, to last for a longer period of time, and pain-related facial actions did not appear as closely together in time as did those exhibited in a genuine pain expression. Further research is needed to determine the level of discrimination among the pain conditions that these additional cues will provide.

Research to date has not investigated individual differences in the ability to pose deceptive facial expressions, and the following questions remain: (1) do facial action parameters differ between good and bad deceivers?; (2) do good and bad deceivers differ in how closely the FACS coding of faked expressions approximate genuine pain ?; (3) do average daily pain levels or situational pain levels influence genuine pain displays and deception ability?; (4) are pain history variables a possible predictor of deception ability?; (5) what is the impact of pain coping strategies on deception ability (i.e. are patients who ignore their pain better able to mask their pain expressions? Do patients exhibiting considerable pain behavior show more exaggerated pain expressions?). These questions are of considerable clinical interest and importance, and point to a potentially productive area of research.

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