Emotional components of pain

Carla J Hale BA Hons, Thomas Hadjistavropoulos PhD

CJ Hale, T Hadjistavropoulos.
Emotional components of pain.
Pain Res Manage 1997;2(4):217-225.

BACKGROUND: Current definitions of pain suggest that emotion is an essential component of pain, however, the presumed relationship between emotion and pain, and the specific emotions that are involved in pain experiences have yet to be clarified.
OBJECTIVE: To address these issues in order to assist in making current conceptualizations of pain more explicit.
DESIGN: Thirty adult patients undergoing routine blood tests were videotaped. Spontaneous facial reactions were examined for distinct expressions of emotion and pain occurring at baseline, swabbing and venepuncture intervals. Expressions were assessed objectively with the Facial Action Coding System (FACS) and rated subjectively by 48 untrained judges. Patients also provided baseline and postneedle self-reports of experienced pain.
RESULTS: Comparison of venepuncture, swabbing and baseline segments revealed that objective measures of pain-related facial activity, subjective ratings of pain expression and self-reported ratings of pain increased significantly from baseline to venepuncture and that measures of disgust, anger, fear and happiness also varied significantly across segments. Regression analyses indicated that measures of pain could be predicted from measures of specific emotions.
CONCLUSIONS: Emotion is an essential component of the acute phasic pain experienced during venepuncture. Although the occurrence of specific emotions varied as a function of pain, objective behavioural indexes and subjective behavioural ratings of pain were predicted by different emotional components than patients' self-reports.

Key Words: *Emotion, Facial Action Coding System, Nonverbal expression, Pain, Pain assessment*

Composantes émotionnelles de la douleur

OBJECTIF : Les définitions courantes de la douleur laissent croire que l'émotion est une composante essentielle de la douleur ; cependant, la relation hypothétique entre l'émotion et la douleur, et les émotions spécifiques qui sont impliquées dans les expériences de la douleur ne sont pas éclaircies. La présente étude tente d'étudier cette question pour permettre de rendre les conceptualisations actuelles de la douleur plus explicites.
MODÈLE : On a réalisé une bande vidéo sur trente adultes en train de subir des prélèvements sanguins. Les réactions faciales spontanées ont été analysées pour des expressions distinctes d'émotion et de douleur se produisant à un temps de référence, pendant la désinfection du site et lors de la ponction intraveineuse. Les expressions ont été évaluées objectivement avec le *Facial Action Coding System* (FACS) et cotées subjectivement par 48 juges sans expérience du domaine. Les patients ont aussi fourni des auto-évaluations de la douleur ressentie au temps de référence et après la ponction veineuse.
RÉSULTATS : La comparaison des segments ponction veineuse, désinfection du site et temps de référence a mis en évidence que les mesures objectives de l'activité faciale liée à la douleur, les cotations subjectives de l'expression de la douleur et les scores des auto-évaluations de la douleur augmentaient sensiblement à partir du temps de référence jusqu'à la ponction veineuse et que les mesures relatives au dégoût, à la colère, à la peur et à la joie variaient aussi considérablement à travers les segments. Les analyses de régression ont démontré que l'on pouvait prédire les mesures de la douleur à partir des mesures des émotions spécifiques.
CONCLUSIONS : L'émotion est une composante essentielle de la douleur en phase aiguë ressentie pendant la ponction veineuse. Bien que l'apparition d'émotions spécifiques variait en fonction de la douleur, on a pu prédire les indices comportementaux objectifs et les cotations comportementales subjectives de la douleur par des composantes émotionnelles qui différaient des auto-évaluations des patients.

The International Association for the Study of Pain (IASP) Committee for Taxonomy has defined pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (1). Although the current definition suggests that emotion is an essential component of pain, the emotions that are involved in pain experiences have not yet been specified, nor has the presumed relationship between sensory and emotional components been operationalized.

Department of Psychology, University of Regina, Regina, Saskatchewan
Correspondence: Ms CJ Hale, Department of Psychology, University of Regina, Regina, Saskatchewan S4S 0A2. Telephone 306-585-4221, fax 306-585-4827, e-mail haleca@meena.cc.uregina.ca
Received for publication September 4, 1997. Accepted October 29, 1997

Much research has been devoted to understanding the roles of depression (2-6) and anxiety (7-9) in the treatment of persons with chronic or persistent pain; however, little research has focused on defining the range of basic core emotions (ie, fear, anger, sadness, etc) that might characterize inceptive or acute pain experiences.

While specification of the emotional components of acute pain may lead to refinements in the current definition of pain, there may also be considerable practical and clinical value in attempting to address such a challenge. For example, it has been suggested that early identification of individuals who are at risk for the development of chronic pain is essential but that this would require a greater understanding of the role of psychological (and social) variables over time, specifically beginning with early acute pain experiences (10). Further, it has been suggested that preemptive measures for more effective treatment of chronic pain would also require basic research examining psychological factors at the onset of noxious stimuli (11). Previous research attempting to specify the basic emotional components of pain has contributed findings based on self-report data. In one correlational study involving patients suffering from chronic pain (12), anger, fear and sadness were predictive of the affective component of self-report measures of chronic pain. Research specifically examining the role of fear in pain experiences (8,13-16) led to models suggesting that fear may be a central component of pain and that it may also have a central role in the maintenance of chronic pain and related disability. Other research and explanatory models have focused specifically on the role of anger in the experience of chronic pain (17-19). This work has led to suggestions that anger may be an especially salient component of chronic pain but that it is probably underestimated due to pervasive human tendencies to deny angry feelings.

Although self-report is generally regarded as the tool of choice for measurement of pain, discrepancies due to cognitive-evaluative biases, situational influences and personal characteristics can sometimes place considerable limits on the information that it provides (20,21). Evidence has also indicated that the self-report measurement procedure itself may introduce reactive effects, particularly when measuring subjective states such as emotion and pain (22,23). Although previous research based on self-report has provided valuable insights, one could argue that because self-report occurs sometime after the onset of pain, particularly in cases of chronic pain, it may reflect emotional states that are a consequence rather than a part of the pain experience. The main goal of this investigation was to disentangle and identify the specific emotions involved in the immediate experience of acute pain to assist in making current conceptualizations of pain more explicit. This was to be achieved by collectively employing objective behavioural indexes of emotion and pain, subjective behavioural ratings of emotion and pain, and self-report ratings of pain.

FACIAL EXPRESSION OF EMOTION AND PAIN

Facial expression has been well established as a sensitive and specific nonverbal index of basic emotion (24,25) and pain (26,27). Ekman and Friesen (28) originally developed the Facial Action Coding System (FACS) to study emotional states by providing comprehensive and objective descriptions of all visible movements in the facial musculature. Research based on cross-cultural studies in definitive social contexts, by using measures of subjective states and perceived emotions, has demonstrated concordance among emotional terms, emotional states and distinct emotional expressions. Validity has been established for specific patterns of facial activity corresponding to the basic emotions of fear, anger, disgust, happiness, sadness and surprise (29-36).

Several other investigations have demonstrated that there is also a distinct pattern of facial activity associated with the experience of pain (27,37-43). The majority of studies have reported that the key pain-related facial actions include brow lowering, cheek raising, tightening of the eyelids, nose wrinkling, upper lip raising, oblique lip raising, lip stretching, parting the lips, dropping the jaw, vertical mouth stretching, closing the eyes and blinking. Through research examining facial activity across multiple pain stimulus modalities, Prkachin (27) further revealed that there are four specific facial changes (brow lowering, eyelid tightening, closing the eyes, and nose wrinkling and lip raising) that occur consistently across different types of pain. To simplify the assessment of pain via facial expression, it was suggested that investigators could safely ignore all other pain-related facial actions outside of this core subset. It also was reported, however, that the other pain-related facial actions still contributed substantial information relevant to the different types of pain experienced. Thus, the entire set of identified pain-related facial actions may prove to be a particularly valuable criterion in studies specifically investigating the potentially variable and subjective elements in pain expression (ie, emotional components). Though the FACS has presented an opportunity to examine the emotional composition of pain expression objectively, the opportunity has remained largely unexplored.

In an early investigation (44), the FACS was employed to study patterns of facial activity in photographed expressions of adults experiencing acute pain from severe physical trauma. The pain display showed minimal overlap with elements corresponding to prototypical emotional expressions. Another study (45) employed the FACS to study pain and emotional expression in chronic pain patients, and reported no significant relationships between pain expression and either specific emotional expressions or various measures of emotional distress (eg, depression, anxiety). These researchers concluded that pain expressions were indeed measuring pain rather than non-noxious emotional distress. Both of these studies, however, had limitations that reduced the chances of identifying relationships between measures of emotion and pain expression. For example, in the latter study (45), individual facial actions that serve as inclusion criteria for expressions of specific emotions were deliberately excluded from their pain expression criteria. This may have ensured a pain expression that was independent of emotion.

Acute phasic pain, such as that experienced by patients undergoing blood sampling procedures, may provide a research context more conducive to the strict methodology required for an effective application of FACS procedures. In addition to objective FACS measures, subjective behavioural ratings provided by a group of untrained judges, based on videotaped segments, may also help clarify whether discriminative patterns of emotional expression are communicated during short, sharp pain. Considering also the IASP premise that emotion is an essential component of pain (1), the main objective of the present investigation was to attempt to specify, through a multimethod measurement approach, the emotions that are present during acute phasic pain. It was hypothesized that dis-

tinct expressions of both negative emotion and pain would increase as a function of pain from blood sampling procedures and that FACS measures, judges' ratings and patients' self-report would reflect this.

PATIENTS AND METHODS

Patients

Thirty patients (63% male, mean age 40.7 years, SD 10.43) scheduled to undergo blood tests were recruited from an interdisciplinary rehabilitation program. All patients reported musculoskeletal pain conditions (mean duration 14.9 months, SD 21.7) resulting from work-related injuries, and 27% also reported use of analgesic medication. Past research employing similar procedures has shown that the use of analgesics does not appear to affect facial reactions in this context (41).

Judges

Forty-eight undergraduate students (50% male, mean age 29.6 years, SD 8.19) served as untrained judges.

Measures

Measures completed by patients

Visual Analogue Scale for procedural pain: Patients used the 'pain thermometer' method to make ratings of pain at baseline and immediately following pain stimulation. Pain was rated by moving a glide along a 10 cm scale that was anchored with the polar opposites 'no pain' and 'most pain'. Numbers from 1 to 10 were marked on the reverse side of the scale so that the person administering the scale could readily note the numbers representing the patients' pain. Reliability and validity of the Visual Analogue Scale (VAS) in the context of pain ratings are satisfactory (46).

VAS for average day-to-day pain: Patients provided ratings of day-to-day pain levels on 10 cm scales, anchored with the words 'no pain' and 'a lot of pain' relative to the various different locations on the body that patients regarded as regularly contributing to their persistent pain conditions (eg, back, upper and lower limbs, cervical region, etc). Reported pain levels corresponding to as many as six different locations were averaged to yield a composite score of average day-to-day pain.

Measures completed by judges

VAS for pain: Judges provided ratings for the amount of perceived pain that patients were believed to be experiencing on 10 cm scales anchored with the words 'no pain' and 'a lot of pain'. Interrater reliability was assessed within the context of this investigation and was considered satisfactory. Reliability coefficients were converted to Fisher's *Zr* scores and averaged for three judgment sets. A final coefficient of 0.88 was obtained.

Differential Emotions Scale: Six scaled items from the Differential Emotions Scale (DES [47]), consisting of the fundamental emotion terms – fear, anger, disgust, happiness, sadness and surprise – were used in collecting judges' ratings. Each term was underscored by numbers from 0 to 6, with progressive descriptions from 'not at all' and 'moderately' to 'extremely'. The six DES items and one judge's VAS for pain were combined on each page of a multipaged booklet. All items were randomly ordered on each page, in each booklet and throughout the entire set of booklets. Interrater reliability assessed within the context of this investigation yielded satisfactory reliability coefficients of 0.73 for anger, 0.82 for disgust, 0.75 for fear, 0.94 for happiness, 0.87 for sadness and 0.85 for surprise. Reliability coefficients were obtained by converting the coefficients for three judgement sets to Fisher's *Zr* scores and averaging them.

FACS

The FACS (28) is a comprehensive measurement system that objectively identifies all possible facial muscle actions, and provides an index of the frequency and intensity of behavioural action units (AUs). Frequency measures indicate the number of contractions involving the muscle strands of each facial AU, whereas intensity measures indicate the magnitude of contraction for each behavioural AU. AUs are categorized as thematic configurations, independently of initial coding. The validity and reliability of the FACS has been well established (26,27,30,31).

Procedure

Self-report rating and the production of videotapes: Videotaping took place in a medical laboratory, where consenting patients arriving for scheduled blood tests were seated and asked for demographic information. Immediately before filming, patients provided VAS self-report ratings of existing pain levels with respect to the location of the forthcoming needle, and once again immediately following venepuncture. Patients were unobtrusively videotaped from the neck up during a 10 s neutral baseline period, and throughout swabbing (done to cleanse the skin) and venepuncture procedures. Additional background information (eg, patients' average day-to-day ratings of pain) was obtained following completion of blood sampling procedures. Original videotapes were brought to a laboratory, then superimposed with a video time display and edited by an independent investigator who was guided by audio markers silently embedded during critical moments of the blood testing procedure. Ten seconds each of baseline, swab and venepuncture segments were retained, for a total of 30 s for each patient. Practical considerations regarding the amount of judging time required that the 90 segments for 30 patients be divided into three sets, each of which comprised 30 segments for 10 patients. All segments (ie, baseline, swabbing and venepuncture) for each patient were placed into a randomly assigned set and randomized within that set. There were no significant differences between sets with respect to the patients' age, sex, years of education, average day-to-day pain ratings or duration of existing pain conditions.

Subjective rating of expressed behaviour: Judges met in small groups at a laboratory equipped with a colour video monitor. Upon arrival, they were seated, and given a brief and precise overview of the judging procedure. They were asked to provide ratings for 30 videotaped segments of nonverbal expression, based on the amount of each emotion and/or pain that they perceived to have been expressed by the individuals depicted on the videotape. It was emphasized that their ratings could indicate expression in any perceived combination, as well as in all or none of the possible categories, and that any degree from zero to maximum could be indicated in any of the categories for emotion and pain. Judges were told that they would be given time to view each segment twice, and that they were not to mark their ratings until they had viewed each segment at least once in its entirety. Only the patients' faces and necks appeared on

TABLE 1
Facial Action Coding System measures, judges' ratings and patients' ratings across segments

	Baseline		Swabbing		Venepuncture	
Expression	Mean	SD	Mean	SD	Mean	SD
Facial Action Coding System measures						
Fear	0.10	0.40	0.13	0.43	0.17	0.46
Anger	0.03	0.18	0.10	0.31	0.23	0.57
Disgust	0.17	0.38	0.13	0.35	1.30*†	1.66
Happiness	0.43	0.82	0.03‡	0.18	0.10‡	0.31
Sadness	0.07	0.37	0.00	0.00	0.10	0.40
Surprise	0.27	0.58	0.13	0.35	0.10	0.40
Pain frequency	6.80	4.03	6.53	5.89	8.03	6.08
Pain intensity	0.35	0.40	0.42	0.53	0.87*†	0.88
Judges' ratings						
Fear	1.40	0.45	1.40	0.54	1.60‡	0.44
Anger	0.73	0.55	0.72	0.51	0.92‡	0.57
Disgust	0.76	0.58	0.82	0.58	1.41*†	0.68
Happiness	1.08	1.18	0.72*	0.88	0.57*	0.76
Sadness	1.37	0.75	1.50	0.83	1.54	0.71
Surprise	0.77	0.56	0.88	0.63	0.85	0.69
Pain	2.56	0.82	2.85	1.05	3.34*†	1.16
Patient self-reports						
Pain	1.04	2.17	–	–	3.02*	2.55

*n=30. *P<0.01, versus baseline mean; †P<0.01, versus swabbing mean; ‡P<0.05, versus baseline mean*

the videotape, ensuring that judges would be blind to the experimental procedure and to which of the patients' segments they were watching at a given time. Each of three sets was viewed by 16 different judges, who were also given two practice trials before proceeding to make the nonforced choice ratings of emotion and pain. Total judgement time for each group of judges was approximately 45 mins. The mean judges' rating of pain and each emotion for each of the individual patients was used in the analyses.

Objective measurement of facial activity: Ninety 10 s videotaped segments were scored for the presence of 44 facial AUs by a FACS coder who had successfully completed the qualification examination administered by the developers of the system. The FACS coder was also blind to which segments corresponded to baseline, swabbing and venepuncture intervals. The majority of facial actions were coded for intensity on a scale of 0 to 5, while the remainder that do not lend themselves to an intensity rating (ie, AU41, AU42, AU43, AU44, AU45, AU46 – variations of eyelid movement) were coded as present versus absent. AU25, AU26 and AU27 were combined as varying degrees of mouth openness (coded for intensity as 1, 3 and 5, respectively). Onset, peak maximum and offset times were identified to distinguish groups of AUs occurring as unified expressive events across each 10 s interval. Any action with an onset before an event in which it overlapped was required to increase at least two points in intensity to qualify as contributing to that event.

AUs were categorized by event into universal emotional configurations as per criteria established by the developers of the system (28). Validity evidence for the AU criteria, hypothesized as operative in each basic emotion, has been published elsewhere (24,30-32). Only prototypes and major variants for each configuration were used to determine the presence of fear, anger, disgust, happiness, sadness and surprise. The emotion of happiness, for instance, was characterized by oblique lip raising, with or without cheek raising. Each occurrence of an emotional configuration was assigned a score of one, configurations that did not occur were assigned zero and, finally, sums for each category of configuration were assigned to segments. Pain expressions were determined on the basis of the complete set of AUs that have shown significant relationships to pain among adults in the previous literature (eg, 27,37,38,42-45). This consisted of brow lower, cheek raise, lid tighten, nose wrinkle, upper lip raise, oblique lip raise, lip stretch, mouth open, jaw drop, mouth stretch, eyes closed and blink. Scores representing the frequency of pain expression for each segment were calculated as the sum of all single pain AUs occurring in that segment. Intensity measures of pain expression were calculated by averaging the intensity measures for individual pain AUs occurring at each segment.

RESULTS

Effects of pain on emotional expression

The means and standard deviations for FACS and judges' measures of pain (Table 1) appeared to be consistent with our hypothesis that more pain-related facial activity would be identified by both FACS and judges at the venepuncture segments. To test this hypothesis statistically, a MANOVA with three repeated measures (ie, baseline, swab and venepuncture) was performed to determine whether there were significant changes in pain expression across conditions. The omnibus analysis for FACS and judges' pain variables was significant according to the Wilks criterion ($F[112,6]=4.51$, $P<0.001$).

Univariate analyses (Figure 1) showed main effects for FACS measures of pain intensity (F[2,58]=6.28, P<0.003) and judges' pain ratings (F[2,58]=9.55, P<0.001). Follow-up Tukey post hoc tests revealed that FACS measures of pain intensity increased at the venepuncture segment in relation to baseline (Q=4.68, P<0.01) and in relation to the swab segment (Q=3.97, P<0.01). Likewise, judges assigned significantly more pain to venepuncture segments in relation to baseline segments (Q=6.11, P<0.01) and in relation to swab segments (Q=3.84, P<0.01). The frequency of pain-related AUs did not change significantly across segments.

Consistent with the authors' hypothesis, the occurrence of negative emotions increased from baseline to venepuncture segments (Table 1). To test the hypothesis statistically, a second MANOVA was performed for FACS measures of emotional expression and judges' ratings of emotion, and was significant overall (F[94,24]= 2.83, P<0.001). Univariate analyses showed that FACS detected significant changes across segments in the frequency of expressions corresponding to disgust (F[2,58]=13.50, P<0.001) and happiness (F[2,58]=5.02, P<0.01). Follow-up post hoc tests showed that FACS measures of disgust increased significantly at venepuncture in relation to baseline (Q=6.25, P<0.01) and in relation to the swab segments (Q=6.47, P<0.01). FACS indicated significantly less happiness at venepuncture in relation to baseline (Q=3.45, P<0.05), and during swab segments the FACS measures of happiness were significantly less than at baseline (Q=4.18, P<0.05). Univariate analyses for judges' ratings showed significantly different ratings across segments for disgust (F[2,58]=20.58, P<0.001), happiness (F[2,58]=5.93, P<0.005), anger (F[2,58]=3.48, P<0.04) and fear (F[2,58]=3.26, P<0.05). Judges' ratings of disgust were significantly greater at venepuncture segments in relation to swab segments (Q=7.48, P<0.01) and in relation to baseline segments (Q=8.19, P<0.01). For happiness, judges ratings were significantly lower at venepuncture segments than at baseline segments (Q=4.75, P<0.01), and during swab segments the judges' ratings of happiness were lower than at baseline segments (Q=3.28, P<0.01). For anger, judges' ratings were significantly greater at venepuncture segments than at baseline segments (Q=3.13, P<0.05). Finally, for fear, judges' ratings were significantly greater at venepuncture segments than at baseline segments (Q=3.06, P<0.05).

Patients' self-report ratings of pain were examined for differences between baseline and postneedle reports, with a paired samples *t* test of mean ratings (Table 1). The amount of pain reported to have been experienced during venepuncture was significantly greater than the amount of pain that patients reported at baseline (*t*[29]=7.13, P<0.001).

Emotional predictors of pain measures

Table 2 illustrates the patterns of correlation for FACS, and judges' and patients' ratings during the venepuncture segment. To explore further the role of identified patterns of emotional expression in determining the various assessments of experienced pain, the following stepwise multiple regressions were performed on venepuncture variables: FACS frequency of specific emotional expressions predicting FACS frequency of pain-related AUs; FACS frequency of specific emotional expressions predicting FACS intensity of pain-related AUs; FACS frequency of specific emotional expressions predicting judges' pain ratings; judges' emotion ratings predicting judges' pain ratings; FACS frequency of specific emotional expressions predicting patients' postneedle self-reports of pain; and judges' emotion ratings predicting patients' postneedle self-reports of pain. Table 3 summarizes the results of these regressions.

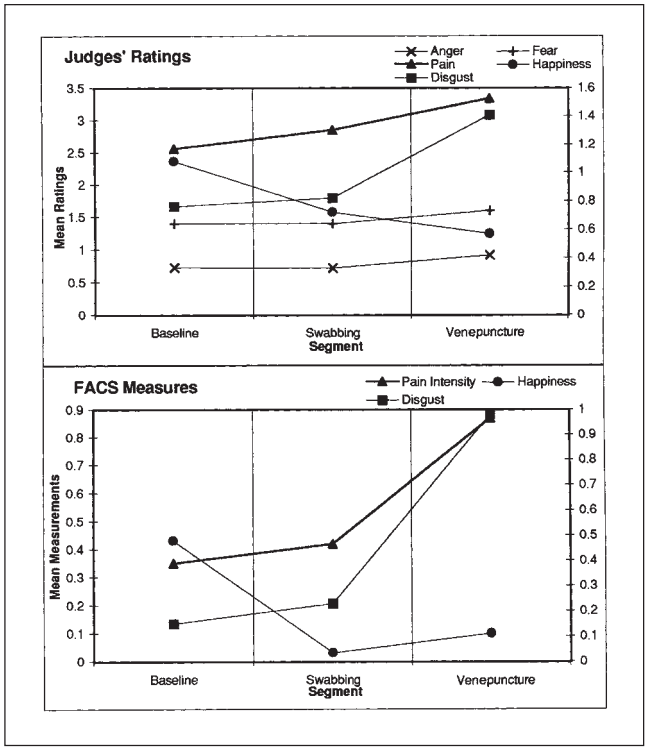

Figure 1) Facial Actions Coding System (FACS) and judges' ratings of pain and emotion that were found to vary significantly from baseline venepuncture segments

In the first regression to predict FACS frequency of pain-related AUs from FACS frequency measures of emotional expression, FACS frequency of disgust (β=0.55, P=0.0002) and FACS frequency of anger (β=0.39, P=0.0055) met the P<0.05 level of entry into the model. Together, these variables accounted for 64% of the variance in FACS frequency measures of pain-related AUs (F[2,27]=24.10, P=0.0000).

With FACS frequency measures entered as predictors of FACS pain intensity measures, the following were indicated: FACS frequency of disgust (β=0.78, P<0.0000), FACS frequency of happiness (β=0.48, P=0.0000), FACS frequency of fear (β=0.21, P<0.0105) and FACS frequency of sadness (β=0.17, P<0.0301). Together these variables accounted for 86% of the variance in FACS intensity measures of pain-related AUs (F[4,25]=38.15, P=0.0000). The third regression equation, with judges' pain ratings as the criterion variable, revealed that, of the FACS emotion frequencies, only FACS frequency of disgust met the P<0.05 entry level (β=0.72, P=0.0000). It accounted for 51% of the variance in the judges' pain ratings (F[1,28]=29.37, P=0.0000). The fourth equation, with judges' ratings of emotion entered as predictors of the judges' pain ratings, showed that judges' ratings of anger (β=0.38, P=0.0271) and judges' ratings of fear (β=0.36, P=0.0330) met the P<0.05 entry level. These variables accounted for 32% of the variance in judges' pain ratings (F[2,27]=6.25, P=0.0059).

Results of the fifth equation, with FACS frequency variables for

TABLE 2
Correlation matrix of Facial Action Coding System measures, judges' ratings and patients' self-report ratings for venepuncture segment

Expression	F-fear	F-anger	F-disgust	F-happiness	F-sadness	F-surprise	F-f-pain	F-i-pain	J-fear	J-anger	J-disgust	J-happiness	J-sadness	J-surprise	J-pain	P-pain
F-fear	–															
F-anger	–0.02	–														
F-disgust	0.20	0.43*	–													
F-happiness	–0.12	0.26	–0.13	–												
F-sadness	–0.09	–0.11	0.06	–0.08	–											
F-surprise	0.84****	–0.11	0.31	–0.08	–0.06	–										
F-f-pain	0.27	0.63****	0.72****	0.22	–0.06	0.27	–									
F-i-pain	0.30	0.50***	0.77****	0.34	0.16	0.36*	0.74****	–								
J-fear	0.13	0.32	0.16	0.10	–0.13	0.25	0.27	0.16	–							
J-anger	0.15	0.01	0.24	–0.15	–0.24	0.23	0.15	0.03	0.16	–						
J-disgust	0.11	0.51***	0.41*	0.12	0.10	0.15	0.43*	0.46**	0.35	0.50***	–					
J-happiness	–0.21	–0.19	–0.33	0.16	0.03	–0.13	–0.22	–0.21	–0.06	–0.49**	–0.59****	–				
J-sadness	–0.22	0.24	0.28	–0.11	–0.23	–0.25	0.18	0.08	0.21	0.54***	0.51***	–0.55****	–			
J-surprise	0.47**	0.17	0.18	0.12	–0.04	0.54***	0.34	0.19	0.39*	–0.05	–0.06	0.31	–0.36*	–		
J-pain	0.37*	0.35	0.72****	–0.13	–0.17	0.31	0.61****	0.52***	0.42*	0.43*	0.37*	–0.40	0.36*	0.29	–	
P-pain	0.26	0.05	0.18	–0.08	0.10	0.38*	0.22	0.13	0.65****	–0.02	–0.05	0.09	–0.09	0.54***	0.39*	–

*n=30. *P<0.05; **P<0.01; ***P<0.005; ****P<0.001. F Facial Action Coding System; f Pain frequency; i Pain intensity; J Judges; P Patients*

emotional expression entered as predictors of patients' postneedle self-reports of pain, indicated that only FACS frequency measures of surprised expression met the entry criterion (β=0.38, P=0.0408). Frequency of surprise accounted for 14% of the variance in patients' postneedle self-reports of pain (F[1,28]=4.60, P=0.0408). Finally, with judges' emotion variables entered as predictors of the patients' postneedle self-reports of pain, the following variables were indicated: Judges' ratings of fear (β=0.52, P=0.0014) and judges' ratings of surprise (β=0.34, P=0.0284). These two variables accounted for 52% of the variance in patients' postneedle self-reports of experienced pain (F[2,27]=14.43, P=0.0001). To examine the relation of self-reported pain during venepuncture, with pain reported before the blood sampling procedures, correlation coefficients were calculated for patients' self-reported postneedle pain, with their self-reported baseline pain (r=0.80, P<0.001), average day-to-day reports of pain (r=0.46, P<0.01) and duration of pre-existing pain conditions (r=0.55, P<0.001).

TABLE 3
Summary of multiple regression analyses for predicting pain assessments (n=30)

Variable	B	SE B	Beta
†FACS Frequency of pain-related AUs			
Disgust (FACS emotion frequency)	2.02	0.47	0.55****
Anger	4.13	1.37	0.39**
‡FACS Intensity of pain-related AUs			
Disgust (FACS emotion frequency)	0.42	0.04	0.78****
Happiness	1.39	0.22	0.48****
Fear	0.41	0.15	0.21*
Sadness	0.38	0.17	0.17*
§Judges' pain ratings			
Disgust (FACS emotion frequency)	0.50	0.09	0.72****
¶Judges' pain ratings			
Anger (judges' emotion ratings)	0.77	0.33	0.38*
Fear	0.97	0.43	0.36*
††Patients' self-reported pain			
Surprise (FACS emotion frequency)	2.38	1.11	0.38*
‡‡Patients' self-reported pain			
Fear (Judges' emotion ratings)	3.03	0.85	0.52***
Surprise	1.24	1.31	0.34*

*Only significant values have been included in the table. Dependent variables are in boldface. *P<0.05; **P<0.01; ***P<0.005; ****P<0.001. Analyses are based on venepuncture segments. †R^2=0.64, adjusted R^2=0.61, F(2,27)=24.10, P<0.0001; ‡R^2=0.86, adjusted R^2=0.84, F(4,25)=38.15, P<0.0001; §R^2=0.51, adjusted R^2=0.50, F(1,28)=29.37, P<0.0001; ¶R^2=0.32, adjusted R^2=0.27, F(2,27)=6.25, P<0.01; ††R^2=0.14, adjusted R^2=0.11. F(1,28)=4.60, P<0.05; ‡‡R^2=0.52, adjusted R^2=0.48, F(2,27)=14.43, P<0.0001. AU Action Units; B Unstandardized regression coefficients; FACS Facial Action Coding System*

DISCUSSION

Through an experimental design, results from this investigation revealed that the facial expressions communicated during acute phasic pain are composed of distinct emotional components. Consistent with our hypothesis, expressions of negative emotion and pain increased in direct response to venepuncture. Objective FACS measures and subjective ratings provided by judges revealed that distinct expressions of disgust increased significantly during venepuncture compared with baseline and swabbing conditions. Both the FACS measures and judges' ratings showed that there were significantly greater expressions of pain during venepuncture than during baseline or swab segments, although for the FACS, this was indicated by significant increases in the intensity rather than frequency of pain expression. Patients also reported significant increases in the amount of pain experienced during venepuncture compared with their baseline self-reports of pain.

The FACS and judges' ratings indicated that expressions of happiness decreased significantly from baseline to venepuncture segments; however, venepuncture segments were not significantly different from swab segments for either FACS or judges' ratings. This suggests that the observed decreases in expressions of happiness may have been due to some other aspect of the procedure besides pain. It is possible that the swabbing procedure may have caused patients to increase their attention and composure in anticipation of the forthcoming needle, resulting in fewer expressions of happiness. In that case, it is likely that the observed decreases in expressions of happiness were effects common to both swab and venepuncture conditions.

Judges' ratings for expressions of anger and fear were significantly greater during venepuncture segments, but only in relation to baseline. FACS measures also showed signs of this trend. Thus, the significant increases found in relation to baseline may indicate that anger and fear are also characteristic of acute phasic pain. Given that FACS frequency measures and judges' ratings clearly agreed about overall increases in the expression of disgust, this group of patients may have experienced the unpleasantness of pain induced from blood sampling procedures as distinctly disgusting. Perhaps the manifestation of disgust can be interpreted as an automatic adaptive response, consistent with findings from aversion-learning research involving preparedness and illness associations (48-50). It has been shown that, in many cases, both innate and conditioned aversion responses appear to be characteristically strong, spontaneous and difficult to override.

Results from the regression analyses provided information that was used to clarify the role of observed emotions in determining the various pain assessments. These results yielded further evidence consistent with the above experimental outcomes. Sixty-four per cent of the variance in objectively assessed frequency of pain expression was predicted by specific expressions of disgust and anger. Intensity measures pertaining exclusively to relative changes within the observed group of pain-related AUs allowed for a more detailed examination of changes occurring across segments and consequently revealed a more complex expression of experienced pain. The presence of all basic emotional expressions, except anger and surprise, was significantly predictive of increases in the intensity of pain expression. While basic expressions of anger weighed heavily in the frequency of pain expression, anger did not predict the intensity of pain expression. This finding may be relevant to previous research (17-19) suggesting that angry feelings tend to be inhibited. Despite that people may learn not to openly express anger in some

contexts, in this case, anger may have been at least initially experienced at the onset of pain stimulation. Previous research suggests that emotions are difficult to inhibit entirely when the eliciting conditions also engage the startle reflex and automatic efferent impulses for patterned facial activity (51,52). Perhaps a socially learned response to pain has a slightly longer onset latency than a prepared (ie, reflexive) response. In contrast, distinctive expressions of surprise do not appear to have been significantly predictive of either the FACS frequency or intensity assessments of experienced pain.

Judges' ratings for anger and fear accounted for 32% of the variance in their ratings of the patients' experienced pain. However, the judges' ratings for each of the segments indicated that, in addition to anger and fear, they also perceived significant changes in the expression of disgust and happiness in response to pain. That expressions of disgust and happiness were not predictive of the judges' pain ratings suggests that judges may have held a priori theories that anger and fear are probable accessories to pain. Thus, anger, fear and pain may have been consciously rated in relation to one another across the segments, whereas ratings for disgust, happiness, sadness and surprise may not have been rated this way. Although the judges' ratings for each category of expression probably represent somewhat different constructs than the respective categories as measured by the FACS, the FACS measure of disgust nonetheless accounted for 51% of the variance in the judges' assessments of experienced pain.

Patients' postneedle self-reports of pain were associated with a distinctly different pattern of emotional themes. In no case were patients' self-reports of experienced pain predicted by either judges' or FACS measures of disgust or anger. Judges' ratings of surprise and fear were significant predictors, accounting for 52% of the variance in patients' postneedle self-reports, and FACS measures of surprise significantly predicted 14% of the variance in patients' postneedle self-reports of pain. This outcome suggests that patients' self-reports of pain reflected a different construct than both the judges' and FACS pain assessments. Indeed, while FACS and judges' measures were based on immediate, spontaneous responses during penetration of the needle, patients' self-report ratings of experienced pain were provided during the interval following venepuncture. Consequently, it may have been relatively more difficult for patients to maintain objectivity when rating the level of experienced acute phasic pain after this pain had already subsided.

Self-report gathered retrospectively, in relation to short sharp pain, probably leaves the patient no other choice but to invoke content consciously from memory and then gauge his or her report with reference to baseline or prior expectation. This is consistent with other research (15,53,54) indicating that prior expectations and predictability of pain are significant factors in the self-report of pain. If patients' self-reports of pain were affected by the extent to which experienced pain matched their expectations, it is reasonable that the expectancy-based emotions of surprise and fear were the only observed emotions to hold over for a significant association with the self-reports. Moreover, patients' self-reports of pain were significantly correlated with their baseline self-reports of pain, average day-to-day pain ratings and duration of the pre-existing pain condition. This demonstrates that patients' postneedle self-reports of pain were consistently associated with their baseline and prior evaluations. Although patients' self-reports of pain corresponded with different emotional components than those of either FACS measures or judges' assessments of pain, patients' assessments of experienced pain, nonetheless, were also accounted for by distinct emotional components.

CONCLUSIONS

This study clarifies some of the emotional components of pain that are implicit in the IASP definition. This was demonstrated by evidence from both objective and subjective measures, showing significant increases in the spontaneous expression of disgust as a function of acute phasic pain. Distinct expressions of anger, fear and happiness also varied significantly across conditions. In addition, objective assessments of the frequency of pain expression were significantly predicted by expressions of disgust and anger; objective assessments of the intensity of pain expression were significantly predicted by all emotions except for anger and surprise; judges' assessments of pain were significantly predicted by expressions of anger and fear; and patients' self-report ratings of pain were significantly predicted by indexes of fear and surprise. The emotional composition of pain, as evident in the present data, reveals some potential differences in information provided by the various instruments used for pain measurement in this investigation. Studies based on both objective and subjective measures of complex pain experiences may contribute to further refinements in the understanding and conceptualization of pain. Studies using a similar methodological design should include patient self-reports of emotion to study their correspondence with judges' ratings and FACS measures of expressed emotion. It would also be of interest to determine whether the emotions found to characterize pain during venepuncture in this investigation generalize to other types of acute pain.

ACKNOWLEDGEMENTS: This research is based on an honours thesis submitted to the University of Regina by Carla Hale, and was supported in part by a Health Services Utilization and Research Commission Grant to Thomas Hadjistavropoulos. A portion of a preliminary version of this paper was presented at the 1997 Convention of the Canadian Psychological Association in Toronto, Ontario. The support of D LaChapelle, F McLeod, CL von Baeyer, GJG Asmundson, and staff and patients of the Wascana Rehabilitation Centre is gratefully acknowledged. The authors also thank two anonymous reviewers for their helpful comments.

REFERENCES

1. Merskey H. The definition of pain. Eur J Psychiatry 1991;6:153-9.
2. Beutler LF, Engle D, Oro-Beutler ME, Daldrup R, Meredith K. Inability to express intense affect: A common link between depression and pain? J Consult Clin Psychol 1986;54:752-9.
3. Brown GK. A causal analysis of chronic pain and depression. J Abnorm Psychol 1990;99:127-37.
4. Magni G, Rossi MR, Rigatti-Luchini S, Merskey H. Chronic abdominal pain and depression. Epidemiological findings in the United States. Hispanic Health and Nutrition Examination Survey. Pain 1992;49:77-85.
5. Romano JM, Turner JA. Chronic pain and depression: Does the evidence support a relationship? Psychol Bull 1985;97:18-34.
6. Rudy TE, Kerns RD, Turk DC. Chronic pain and depression: toward a cognitive-behavioral mediation model. Pain 1988;35:129-40.
7. Asmundson GJG, Norton GR. Anxiety sensitivity in patients with physically unexplained chronic back pain: A preliminary report. Behav Res Ther 1995;33:771-7.
8. McCracken LM, Zayfert C, Gross RT. The pain anxiety symptoms scale (PASS): A multi-modal measure of pain-specific anxiety symptoms. Behav Therapist 1992;16:183-4.

9. Philips HC. Avoidance behavior and its role in sustaining chronic pain. Behav Res Ther 1987;25:273-9.
10. Turk DC. The role of psychosocial factors in the transition from acute to chronic pain. Paper presented at the 8th World Congress on Pain. International Association for the Study of Pain, Vancouver, August 17-22, 1996.
11. Kalso EA. Prevention of chronicity. Paper presented at the 8th World Congress on Pain. International Association for the Study of Pain, Vancouver, August 17-22, 1996.
12. Fernandez E, Milburn TW. Sensory and affective predictors of overall pain and emotions associated with affective pain. Clin J Pain 1994;10:3-9
13. Asmundson GJG, Taylor S. Role of anxiety sensitivity in pain-related fear and avoidance. J Behav Med 1996;19:577-86.
14. Lethem J, Slade PD, Troup JD, Bentley G. Outline of a Fear-Avoidance Model of exaggerated pain perception – I. Behav Res Ther 1983;21:401-8.
15. Rachman SJ, Lopatka C. Accurate and inaccurate predictions of pain. Behav Res Ther 1988;25:291-6.
16. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek J. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995;62:363-72.
17. Berendt JW. The influence of anger on chronic pain treatment. Paper presented at the Pain, Disability, and Personal Injury Conference: Scientific and Applied Aspects. Regina Health District, Regina, May 24-25, 1996.
18. Fernandez E, Turk DC. The scope and significance of anger in the experience of chronic pain. Pain 1995;61:165-75.
19. Kerns RD, Rosenberg R, Jacob MC. Anger expression and chronic pain. J Behav Med 1994;17:57-67.
20. Melzack R, Wall PD. The Challenge of Pain. New York: Basic Books, 1983.
21. Turk DC, Meichenbaum D, Genest M. Pain and Behavioral Medicine: A Cognitive-Behavioral Perspective. New York: Guilford Press, 1983.
22. Mikail SF, VanDeursen J, von Baeyer CL. Rating pain or rating serenity: effect on cold-pressor pain tolerance. Can J Behav Sci 1986;18:126-32.
23. von Baeyer CL. Reactive effects of measurement of pain. Clin J Pain 1994;10:18-21.
24. Ekman P, Friesen WV. Unmasking the Face: A Guide to Recognizing Emotions from Facial Clues. New Jersey: Prentice Hall, 1975.
25. Izard CE. Basic emotions, relations among emotions, and emotion-cognition relations. Psychol Rev 1992;99:561-5.
26. Craig KD, Prkachin KM, Grunau RVE. The facial expression of pain. In: Turk DC, Melzack RA, eds. Handbook of Pain Assessment. New York: Guilford Press, 1992:257-76.
27. Prkachin KM. The consistency of facial expressions of pain: a comparison across modalities. Pain 1992;51:297-306.
28. Ekman P, Friesen WV. Facial Action Coding System: A Technique for the Measurement of Facial Movement. California: Consulting Psychologists Press, 1978.
29. Ekman P. Universal and cultural differences in facial expressive movements. In: Hind RA, ed. Nebraska Symposium on Motivation, vol 19. Nebraska: University of Nebraska Press, 1972:297-314.
30. Ekman P. Emotion in the Human Face, 2nd edn. Cambridge: University of Cambridge Press, 1982.
31. Ekman P. An argument for basic emotions. Cogn Emotion 1992;6:169-200.
32. Ekman P, Friesen WV. Constants across cultures in the face and emotion. J Pers Soc Psychol 1971;17:124-9.
33. Ekman P, Friesen WV. Detecting deception from body or face. J Pers Soc Psychol 1974;29:288-98.
34. Ekman P, Friesen WV, Ancoli S. Felt, false, and miserable smiles. J Nonverbal Behav 1980;6:238-52.
35. Ekman P, Friesen WV, Simons RC. The boundary between emotions and reflex: An examination of startle. J Nonverbal Behav 1985;6:238-52.
36. Ekman P, Sorenson ER, Friesen WV. Pan cultural elements in facial displays of emotion. Science 1969;164:86-8.
37. Craig KD, Hyde S, Patrick CJ. Genuine, suppressed and faked facial behavior during exacerbation of chronic low back pain. Pain 1991;46:161-72.
38. Craig KD, Patrick CJ. Facial expression during induced pain. J Pers Soc Psychol 1985;48:1080-91.
39. Craig KD, Whitfield MS, Grunau RVE, Linton J, Hadjistavropoulos HD. Pain in the pre-term neonate: Behavioral and physiological indices. Pain 1993;52:287-99.
40. Hadjistavropoulos HD, Craig KD, Hadjistavropoulos T, Poole GD. Subjective judgments of deception in pain expression: Accuracy and errors. Pain 1996;65:251-8.
41. Hadjistavropoulos T, Craig KD, Martin N, Hadjistavropoulos HD, McMurtry B. Toward a research outcome measure of pain in frail elderly in chronic care. Pain Clinic 1997;10:71-9.
42. Patrick CJ, Craig KD, Prkachin KM. Observer judgments of acute pain: facial action determinants. J Pers Soc Psychol 1986;50:1291-8.
43. Prkachin KM, Mercer SR. Pain expression in patients with shoulder pathology: validity, properties and relationship to sickness impact. Pain 1989;39:257-65.
44. LeResche L. Facial expression in pain: a study of candid photographs. J Nonverbal Behav 1982;7:46-56.
45. LeResche L, Dworkin S. Facial expressions of pain and emotions in chronic TMD patients. Pain 1988;35:71-8.
46. Turk DC, Melzack RA. Handbook of Pain Assessment. New York: Guilford Press, 1992.
47. Izard CE, Dougherty LM. Differential Emotions Scale. In: Izard CE, ed. The Face of Emotion. New York: Appelton-Century-Crofts, 1971.
48. Chambers KC. A neural model for conditioned taste aversions. Ann Rev Neurosci 1990;13:373-85.
49. Seligman MEP, Hager JL. Biological Boundaries of Learning. New York: Appleton-Century-Crofts, 1972.
50. Rachman SJ. Fear and Courage, 2nd edn. New York: WH Freeman & Co, 1990.
51. Ekman P, O'Sullivan M, Friesen WV, Scherer KR. Face, voice and body in detecting deception. J Nonverbal Behav 1991;15:125-35.
52. Ekman P, Friesen WV. Nonverbal leakage and clues to deception. Psychiatry 1969;32:88-105.
53. Arntz A. Why do people tend to overpredict pain? On the asymmetries between underpredictions and overpredictions of pain. Behav Res Ther 1996;34:545-54.
54. Crombez G, Vervaet L, Baeyens, F, Lysens R, Eelen, P. Do pain expectancies cause pain in chronic low back patients? A clinical investigation. Behav Res Ther 1996;34:919-25.