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Pain and negative emotions in the face: judgements by health care professionals

Judith Kappesser[a], Amanda C. de C. Williams[b,*]

[a]*Department of Psychology, University of Bath, Claverton Down, Bath BA2 7AY, UK*
[b]*Department of Psychological Medicine, GKT Medical School, University of London, St Thomas' Hospital, London SE1 7 EH, UK*

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Abstract

Facial expression of pain has rarely been researched in the context of facial expression of negative emotions with which it may occur. The main aim of the study was to investigate how pain expression resembled or differed from that of other negative emotions (fear, anger, sadness, surprise, disgust and embarrassment), using multidimensional scaling, a dimensional approach to understanding relationships among emotions. As possible misidentification of facial expressions by participants could distort those results, a judgement study as a categorical approach was conducted to examine the accuracy of identification of pain and negative emotion facial expressions. The sample was health care professionals. Identification of pain was good (unbiased hit rate 58.8%), but less than all other negative emotions. Confidence in ratings approximated accuracy of identification. Multidimensional scaling revealed two dimensions: the first distinguished embarrassment from all other emotion expressions; the second separated pain, sadness and anger from fear, surprise and disgust. Possible explanations for these findings were sought in patterns of facial action units, and in the messages conveyed by the expressions according to Fridlund's Behavioural Ecology View.

Keywords: Facial expression; Pain; Pain behaviour

1. Introduction

Investigation of facial expressions has a long tradition in emotion research. In the last 50 years, research in facial expression of emotion has followed two particular lines of investigation (Wagner, 1997): component studies, in which muscle actions constituting the expression are identified and quantified, usually by the facial action coding system (FACS: Ekman and Friesen, 1978), and judgement studies, which address the information conveyed by the global expression. The latter provide strong evidence of at least five discrete expressions of emotion (happiness, fear, anger, sadness and disgust) which are universally recognised, and to which many would add surprise and contempt (Ekman, 1992; Ekman and Friesen, 1986). However, the exact number of distinct emotional expressions is still undetermined. Keltner and colleagues, for example, initiated research concerning the self-conscious emotions and found evidence for the distinctiveness of the facial expression of embarrassment (Keltner and Buswell, 1996). In contrast to the categorical approaches to emotional prototypes some researchers describe dimensional models of emotion such as Russell (Carroll and Russell, 1996). However, studies by Young et al. (1997) support a categorical rather than a dimensional account of emotions.

Although many emotion theorists assume pain not to be an emotion and have only rarely included pain facial expressions, there are good reasons why the methodologies of these studies provide appropriate tools for investigation of the pain face and why the pain face should be considered in connection with established facial expressions of emotions. The emotional quality of pain is emphasised in the widely used definition of pain (International Association for the Study of Pain, 1979). Furthermore, viewed from an evolutionary perspective, facial expressions signal emotional experience (Prkachin, 1997). This is further supported by the 'Behavioural Ecology View' of faces proposed by Fridlund (1994, 1997), a complementary approach to facial expressions derived from modern accounts of the genetic and cultural evolution of signalling behaviour. The Behavioural Ecology View of faces constitutes a model in its view of how facial expressions evolved, what they signify and how they function in our everyday lives, in contrast with

* Corresponding author. INPUT Pain Management Unit, St. Thomas' Hospital, London SE1 7EH, UK. Tel.: +44-207-922-8107; fax: +44-207-922-8229.

E-mail address: amanda.williams@kcl.ac.uk (A.C. de C. Williams).

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research emphasising the centrality of emotions in explaining facial movements. The latter may be described as 'Emotions View', in which facial movements are directly linked to emotions and facial expressions of emotions are reflex-like readouts of those emotions (Buck, 1994). Fridlund, on the contrary, regards facial expressions as social tools which are 'read' according to the context of the interaction in which they occur. As he assumes that faces exert their influence in the particular context of their occurrence, they may only be interpreted within this context. For instance, rather than describe a face as 'sad', Fridlund would say that this face signals the attempt to recruit help and care. Accordingly, a pain face would signal suffering and attempt to gain relief from pain and emotional suffering.

The facial expression of pain has been investigated not in the context of emotion, but as a class of 'pain behaviour' (Craig, 1980; Fordyce, 1976), other classes of which include verbal communication of pain, paralinguistic vocalisations, distinct movements or postures, and visible physiological changes (Craig, 1992; Craig and Prkachin, 1983; Craig et al., 2001). Facial expression is, socially, the most prominent of these (Craig et al., 2001; Prkachin et al., 1983; von Baeyer et al., 1984).

Component study methodology has identified specific facial movements associated with pain, including lowering the brow, narrowing the eyes by tightening the lids and raising the cheeks or even fully closing the eyes, raising the upper lip, deepening the nasolabial fold and wrinkling the nose as well as opening the lips and mouth in varying degrees. This is consistent across a range of experimental pain modalities (Craig and Patrick, 1985; Galin and Thorn, 1993; LeResche et al., 1992; Patrick et al., 1986; Prkachin, 1992), and across different clinical pain conditions (Craig et al., 1991; Hadjistavropoulos and Craig, 1994; LeResche, 1982; LeResche and Dworkin, 1988; Prkachin and Mercer, 1989).

Using the FACS, the expression of pain can be differentiated from the standard emotion expressions, with some of which it shares certain facial action units as displayed in Table 1 (Craig, 1992; LeResche, 1982). Judgements by observers show identification of pain expression to be well above chance level (Keltner and Buswell, 1996; LeResche and Dworkin, 1984); further, it can be distinguished from other emotions in photos (Boucher, 1969; Haidt and Keltner, 1999; Keltner and Buswell, 1996), and other emotions are seldom mistaken for pain when it is not a stimulus but provided as a response option (e.g. Carroll and Russell, 1996). However, the pain face has also found to be blended with other facial expressions of emotions such as disgust, contempt, anger, fear, and sadness (LeResche, 1982; LeResche and Dworkin, 1988). In a study by Hale and Hadjistavropoulos (1997) patients undergoing a routine blood test were videotaped. Not only facial expression of pain but also facial expressions of disgust, anger, fear, and happiness varied significantly across the conditions (baseline, swabbing, and venepuncture).

One focus of the study of pain expression has been observers' underestimation of pain by reference to the sufferer's evaluation. In a study by Prkachin et al. (1994), observers estimated the amount of pain experienced by patients with shoulder injuries, from the patients' faces seen on videotape: compared with patients' own ratings, facial actions coded with the FACS provided a sensitive measure of pain whereas observers' judgements systematically underestimated patients' pain by as much as 80%. While direct facial measurement provides a more sensitive measure of pain than observers' judgements, attempts to enhance observers' sensitivity to facial expression of pain by training (e.g. Galin and Thorn, 1993; Solomon et al., 1997) have been disappointing. Medical and paramedical professionals in particular appear to show an underestimation bias in the course of clinical work (Choiniere et al., 1990; Teske et al., 1983; Zalon, 1993), although accurate assessment of pain is a prerequisite for adequate treatment.

Facial expression of pain, therefore, has been established in terms of facial action units in relation to other emotions, but judgement studies of pain expression have focused on authenticity or estimation of pain, not (apart from in the embarrassment studies of Keltner and colleagues) the accuracy of distinguishing pain from other emotions. The present study addressed three questions concerning facial expression of pain and other negative emotions as perceived by health care professionals. Our main aim was to identify the dimensions on which pain expression resembled or differed from that of other negative emotions (fear, anger, sadness, surprise, disgust, embarrassment), using multidimensional scaling (MDS) of similarity–dissimilarity comparisons. Possible interpretations for similarities and differences drew on the Emotions View and Fridlund's Behavioural Ecology View. As possible misidentification of facial expressions by participants could distort the results of the similarity–dissimilarity comparisons, a judgement study was conducted to examine the question: to what extent each of the standard facial expressions could be identified correctly by participants. The results of this judgement study also addressed the third question of the extent to which underestimation of pain by health care professionals might be due to their not recognising pain faces, due to their confusing pain with other facial expressions of emotion and/or due to their being less confident in identifying pain, although it could not constitute a direct comparison of these mechanisms.

2. Method

2.1. Participants

Medical and nursing staff working for Accident and Emergency (ER) Departments in two London hospitals were asked to volunteer as participants, since they are exposed to pain faces daily. They were approached before,

Table 1
Prototypical AUs which occur with sadness, fear, anger, disgust, surprise, embarrassment and pain[a]

Emotion	Au																							
	1 Inner brow raiser	2 Outer brow raiser	4 Brow lower	5 Upper lid raiser	6 Cheek raiser	7 Lid tighten	9 Nose wrinkler	10 Upper lip raiser	11 Nasol. furrow deepen	12 Lip corner puller	15 Lip corner depr.	16 Lower lip depr	17 Chin raiser	20 Lip stretch	22 Lip funnel	23 Lip tighten	24 Lip pressor	25 Lips part	26 Jaw drop	27 Mouth stretch	43 Eyes closed	51 Head turn left	54 Head down	64 Eyes down
Sadness	■		■		□				□		■							□	□				□	□
Fear	■	■	■	■										□				■	■	■				
																		__	__	__				
Anger			■	■		■		□					□		■	■	□	■	■					
Disgust							■	■				□	□						□					
Surprise	■	■		■															□	□				
Embarrassment										■							■					■	■	■
Pain			■		■	■	■	■		□				□				□	□	□	■			

[a] The prototypical pain face is mainly based on the results by Prkachin (1992), but considers some extra AUs which are discussed in the literature. ■, AU which characteristically occurs with emotion prototypes; □, may occur with prototype and/or variant; __, AUs which occur together.

during or after their work shift; aim and content of the study were explained and they were asked for their consent.

2.2. Photos

The photos which were used for this study were kindly provided by Dacher Keltner, and are one of the three posers of those used in Keltner and Buswell (1996) and Haidt and Keltner (1999). The photos were generated on the basis of emotion prototypes using the FACS, and include pain alongside various emotions. The coloured photos show a male face, neck and part of the shoulders against a coloured background. The individual who served as a model produced the facial expressions according to the facial action units specified by Ekman and Friesen (1978). While the use of only one model risks confounding variance due to model with variance due to emotion expressions, it was thought more important to avoid the use of different models for different expressions of emotion. Time constraints precluded the presentation of multiple models across all expressions of emotion.

Sadness, fear, anger, surprise, disgust and embarrassment were chosen as additional negative expressions to pain. The photos of the facial expressions of anger, fear, sadness, disgust and surprise are based on their prototypical display according to Ekman and Friesen (1978). The facial expression of embarrassment is based on the findings of Keltner (1995) and the one for pain on results by Patrick et al. (1986).

2.3. Procedure

After agreeing to participate in the study, participants' age, sex, qualification, overall length of work experience and length of work experience in the ER were recorded. Participants were asked to imagine that the photo represented a patient attending the ER. In the first part of the study, participants were asked to compare each possible pair of the seven photos regarding its similarity or dissimilarity with pain. In the second part, participants had to identify the facial emotion shown on every photo. The second part, a judgement study, is effectively a validity check; a necessary prerequisite which allows for analysing the similarity–dissimilarity comparisons.

2.3.1. Procedure for the similarity–dissimilarity comparisons

Participants were presented with numerical rating scales which consisted of 11 points from 0, 'exactly the same', to 10, 'completely different'. Participants were informed that they would view pairs of photos and that they should rate the extent of similarity/difference between the pair in terms of acute physical pain, that is, that two faces could be judged similar in expressing pain or in not expressing pain, and that where they differed their dissimilarity was judged in terms of degree of closeness to pain. Since these similarity–dissimilarity comparisons assume an internal scale along which the judgements are made, participants previewed the set of seven photographs (sadness, fear, anger, surprise, disgust, embarrassment and pain) for 15 s. After previewing the seven photos, participants were asked to compare pairs of photos. Twenty-one pairs resulted from all pairings of the seven faces, and the order of presentation was randomised across participants. A second presentation of one of the 21 pairs was added in order to assess the stability of the ratings, but to avoid repeating of the same pair's numerical rating scale on the same page, a semi-random order rather than a random one was used.

2.3.2. Procedure for the judgement study

The order of the seven photos was randomised by a random number table. Then the photos were presented to participants serially for each of the participants in random order. All emotion terms (sadness, fear, anger, surprise, disgust, embarrassment), plus pain, were offered with each photo and participants were asked to select the best description of the face, or the option of none, to which participants could append their own best descriptive term. Additionally, they were asked to rate their confidence in each rating on a numerical scale which consisted of 11 points from 0, 'none', to 10, 'total'.

After participants completed the second task, they were offered the chance to ask questions concerning content and aim of the whole study.

2.4. Analysis of data

2.4.1. Analysis of the similarity–dissimilarity comparisons

To estimate the stability of the similarity–dissimilarity ratings, bivariate correlations and differences in the ratings between the repeated pairs were calculated. The data were then subjected to a MDS procedure (SPSS implementation of ALSCAL) to provide spatial representation of similarities, that is, grouping by latent structure (Schiffman et al., 1981).

2.4.2. Analysis of the judgement study

The judgement study examines whether the emotions displayed on the photos are identified as such. Of particular interest was how accurately pain is identified, with what other emotions pain is confused, what other emotions are misread for pain and how confident participants felt about identifying pain.

The results of the judgement study were summarised in a confusion matrix (see Table 2 for example). If the focus is the accuracy of the response, one measure is the simple hit rate, i.e. the proportion of correctly identified target stimuli. In Table 2 this is calculated by a/(a + b) (equivalent of positive predictive value of a diagnostic test). Wagner (1993, 1997) recommends tranforming this to an unbiased hit rate, which takes into account misidentification of the target (cell c in Table 2). The unbiased hit rate (H_U) is the product of two conditional probabilities, that a target stimu-

Table 2
Example of confusion matrix

Stimulus	Response		Sum
	Response 1	Response 2	
Stimulus 1	a	b	a + b
Stimulus 2	c	d	c + d
Sum	a + c	b + d	a + b + c + d

lus will be correctly identified (a/(a + b), designated H_1), and that the response to a stimulus will be correct (a/(a + c), equivalent to sensitivity of a diagnostic test, designated H_2). As for simple hit rates, values for unbiased hit rates lie within the range of 0–1.

For the confidence ratings, the means and standard deviations were calculated and differences investigated according to correct or incorrect identification.

3. Results

3.1. Description of the sample

Altogether 60 nurses and doctors of two ER Departments took part in the study. Among the participants were more women (68.3%) than men and more nurses (73.3%) than doctors. Whereas the distribution of nurses and doctors among the male participants was nearly equal (47.4% male nurses), there were more than 5.5 times as many nurses (85.4%) as doctors among the female volunteers.

All the nurses and doctors were qualified except one final year medical student. The mean age of participants was 28.5 years (SD 4.83 years). Participants had a median 3.25 years of experience as a nurse or doctor (range 0–26 years) and a median 2.0 years (range 0–15 years) of working in ER.

As the judgement study is a necessary prerequisite which allows for analysing the similarity–dissimilarity comparisons (possible misidentification of facial expressions by participants could distort the results of the similarity–dissimilarity comparisons), we show those results first. The order was reversed in the study in order to avoid participants' judgement processes affecting their responses to the MDS.

Table 4
Simple hit rates (H_1, H_2) and unbiased hit rate (H_U) for the seven photos

Photo	Hit rates		
	H_1 (%)	H_2 (%)	H_U (%)
Chance	1/8 = 12.5%	1/7 = 14.3%	
Sadness	96.7	95.1	91.9
Surprise	95.0	85.1	80.8
Embarrassment	86.7	91.2	79.1
Anger	83.3	81.7	73.1
Disgust	85.0	78.5	66.7
Fear	70.0	87.5	61.3
Pain	70.0	84.0	58.8

3.2. Results of the judgement study

As a validity check for the similarity–dissimilarity comparisons, the judgement study examines whether the emotions displayed on the photos are identified as such. Of additional interest was how accurately pain is identified, with what other emotions pain is confused, what other emotions are misread for pain and how confident participants felt about identifying pain.

3.2.1. Confusion matrix and hit rates

The results of the judgement study – the confusion matrix and the hit rates – are displayed in Tables 3 and 4. Recognition for all facial expressions is far higher than chance level (1/8 = 12.5% or 7.5 participants choosing this expression), irrespective of whether the simple hit rate or the unbiased hit rate was used. One-tailed binomial tests for the simple hit rates reveal P-values <0.001 for all facial expressions.

Seventy percent of participants (42 of 60) identified the pain face as showing pain; of the remaining 30%, disgust was chosen by 11 (18.3%, for which a one-tailed binomial test was not significant, $P = 0.121$ if the undecided participant's judgement is assigned to disgust, $P = 0.059$ if it is assigned to pain), embarrassment by three (5%) and fear by one (1.67%). Three participants (5%) responded that none

Table 3
Confusion matrix of emotion category responses to photo stimuli

Photo	Response								Sum
	Sadness	Fear	Anger	Surprise	Disgust	Embarrassment	Pain	None of them	
Sadness	58	–	–	–	–	–	–	2	60
Fear	1	42	2	10	1	2	2	–	60
Anger	1	1	50	–	2	–	4	2	60
Surprise	–	3	–	57	–	–	–	–	60
Disgust	–	–	5	–	51	–	2	2	60
Embarrassment	1	1	–	–	–	52	–	6	60
Pain	–	1	–	–	11	3	42	3	60
Sum	61	48	57	67	65	57	50	15	420

of the emotion terms offered could describe the pain face: two offered no alternative, and a third could not decide between pain and disgust. None of the participants thought that the pain face would be best described by the terms sadness, anger or surprise. Furthermore, the confusion matrix shows that pain as a response category was chosen 50 times altogether: 42 (84%) to the pain face, 4 (8%) to the anger face, and two times (4%) to each of the fear and the disgust faces. None of the participants found that the sad, surprised or embarrassed photo would be best described as pain.

3.2.2. Confidences

Although recognition for the pain face ($H_U = 58.80\%$; $H_1 = 70\%$) is far higher than chance level, both hit rates are the lowest when compared to the other facial expressions. This resembles the rank order of confidence ratings in Table 5. The scale for the confidence ratings ranged from 0 ('none') and 10 ('total'), but the lowest point used by respondents was 2, and medians ranged from 7 to 9 (Table 5). Since distributions were skewed, medians were used for comparisons.

The Pearson's correlation coefficient between the median of the confidence ratings and the unbiased hit rates is 0.81 ($P = 0.027$). However, there were significant differences between confidence ratings (Friedman $\chi^2 = 43.844$; $P < 0.0005$). Post hoc analysis, using a Wilcoxon signed rank test and a more stringent P-value ($0.05/20 = 0.0025$), indicated that the differences were due to significantly higher confidence ratings for the sadness face than for each other face (z from 3.165 to 4.781, $P = 0.002$ to <0.001), and significantly lower ratings for the pain face when compared with anger, embarrassment and surprise (z from 3.045 to 3.464, $P = 0.002$ to 0.001).

So far, no distinction has been made between the confidence of subjects who identified a facial expression correctly and subjects who did not. Fig. 1 shows the confidence ratings for both groups. Provided that there were more than seven subjects in the smaller (always incorrect) group, a Mann–Whitney test was used to test for median confidence difference between groups. The two groups for which the hit rate was lowest, fear and pain, also had the largest differences in median confidence rating, but only the difference for the fear photo attained statistical significance ($z = 2.147$, $P = 0.032$).

Table 5
Mean, standard deviation, median and range for the confidence ratings

Photo	Confidence			
	Mean	(SD)	Median	Range
Sadness	8.53	(1.67)	9	2–10
Embarrassment	7.77	(2.00)	8	3–10
Surprise	7.75	(1.82)	8	2–10
Anger	7.67	(1.82)	8	3–10
Disgust	7.65	(1.96)	8	3–10
Fear	7.27	(1.96)	8	2–10
Pain	6.65	(2.35)	7	2–10

3.3. Results of the similarity–dissimilarity comparisons

3.3.1. Reliability check of ratings

The differences in ratings (−10 to +10) for two presentations of the same pair form a normal distribution with a mean of +0.57 and a standard deviation of 2.79. Pearson's correlation coefficient between the repeated pairs is 0.595. For 25% of ratings, there was perfect agreement and for more than 50% of the ratings, the difference was not greater than 1 point on the rating scale. To ensure stability of the ratings, participants whose responses differed by approximately two standard deviations (differences ≥ 5) were excluded from the analysis; this excluded seven participants and the correlation coefficient increased from 0.595 to 0.815.

3.3.2. Identifying the stimulus space

The dimensionality of a stimulus space is determined both by maximum increase in the averaged squared correlations (RSQ) and by the corresponding decrease in stress, to the extent that they covary inversely. Should they increase or decrease together, the RSQ is the more important index (Schiffman et al., 1981). For this data set, an ordinal measurement level was chosen as interval level measurement could not be assumed. The MDS analyses indicate that the stimulus space is better represented by two dimensions (RSQ = 0.744; stress (Kruskal's stress formula 1) = 0.2548) than by three (RSQ = 0.702; stress = 0.175). Although the fit improves for four and five dimensions, using the rule that the square root of the number of stimuli approximates the number of dimensions which may reliably be detected by MDS procedures (Schiffman et al., 1981), two dimensions ($\sqrt{7} = 2.65$) provide the best solution for this data set. The first dimension was more important (0.584) than the second one (0.161). The location of the seven emotion faces within the two-dimensional space is shown in Fig. 2.

4. Discussion

Overall, the results supported the hypothesis of a distinct and identifiable pain face. The facial expression of pain presented on a photo was correctly identified by most participants from a range of negative emotion expressions. However, pain expression had the lowest correct identification rate (unbiased hit rate 58.8%, compared to the best, 91.9% for sadness) and the lowest rating of confidence in judgements (median 7/10 vs. 9/10 for sadness). Two findings suggest that participants were able to make a reasonable estimate of the accuracy of their judgements. First, there was a substantial correlation between participants' confidence in their ratings and their accuracy (unbiased hit rates), across all expressions. Second, confidence ratings were lower for those who identified the expression incorrectly than for those who identified it correctly, with the

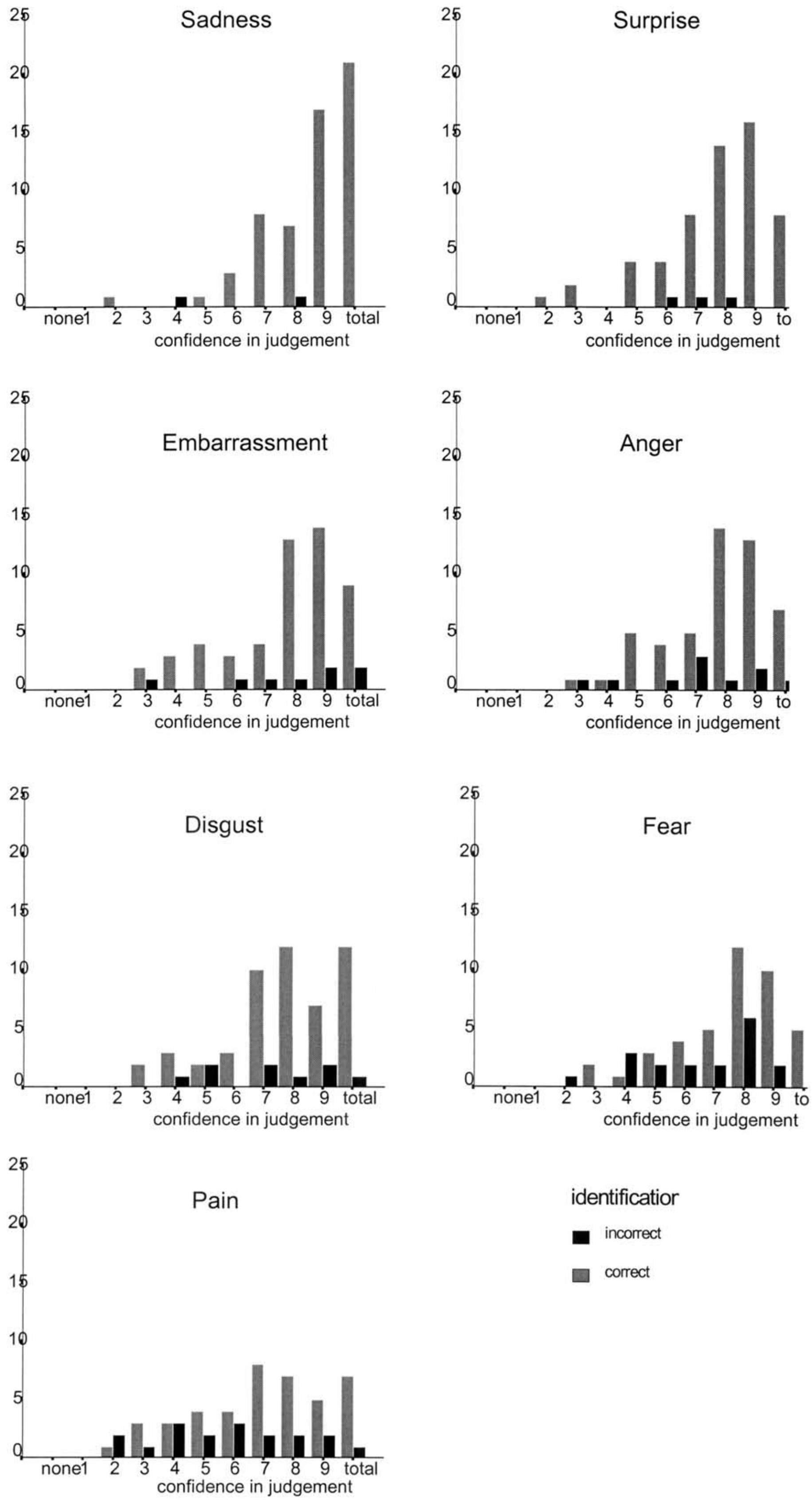

Fig. 1. Frequencies of confidence ratings according to correct or incorrect photo identification.

largest differences for fear and pain, for which the hit rate was lowest.

Misidentification of pain for other emotions (disgust, embarrassment, and fear but not sadness, anger or surprise) differed from the misidentification of other emotions for pain (anger, fear and disgust). Except for the (non-significant) misidentification of pain as disgust, by 18% of participants, the errors involved small numbers whose interpretation is injudicious. This is strikingly similar to the findings by other research groups. Keltner and Buswell (1996) found that 19.5% of subjects misidentified pain as disgust (with 52% identifying it correctly and no other major misidentifications). Hale and Hadjistavropoulos (1997) found a high incidence of disgust expressions when videotaping patients during venepuncture and analysing their faces using the FACS. One reason for the misidentification could be that disgust and pain share some facial action units (9 and 10, nose wrinkler and upper lip raiser), but while these are the only prototypical facial action units for disgust (Ekman and Friesen, 1978), they occur in combination with several others in pain (Prkachin, 1992). It is possible that for those individuals who misidentified pain as disgust, those common action units were given undue weight. Misidentification of pain for disgust may also be attributable to particular characteristics of the pain photo, which was the same in this study as in Keltner and Buswell's study. Since the facial expression of pain is often blended with other emotions, among these emotions with disgust, the misidentification may also be explicable by the frequent co-occurrence of pain and disgust in the face. Moreover, in terms of the information both facial expressions convey, both appear to share the motivation to expel bodily experiences which are not desirable.

Given sufficiently accurate identification of pain expression and confidence in the judgement, the last part of the study addressed a separate issue, the perception of negative emotion expressions in relation to pain, using MDS. Interpretation of results from only one model can only be cautious in the absence of replication using a variety of models. The major axis distinguished embarrassment from all other expressions, including pain. The obvious difference between the embarrassed face and all other negative emotion faces presented is that the embarrassed face is characterised by AU 12, lip corner puller (Keltner, 1995), producing a smile of sorts. Interestingly, on viewing the embarrassed face, several participants remarked that "someone who smiles cannot be in pain". The second axis distinguished anger, sadness and pain near one extreme, from surprise, fear and disgust near the other; embarrassment was intermediate. The groupings on this dimension cannot be explained by particular combinations of facial action units (see Table 1). However, one of the anonymous referees suggested an alternative basis for the clusters, that of physical characteristics of the expressions: fear, surprise and disgust share vertical changes in the face, while pain, anger and sadness involve more centrifugal changes. This seems entirely plausible, and no data can be presented here to distinguish between the two explanations. Speculatively, one might suggest some meeting ground between the two explanations in terms of the evolution of multiple facial expressions from their morphological origins, which perhaps could be characterised in terms of vertical change as the origin of one set of related expressions and centrifugal change as the origin of another set.

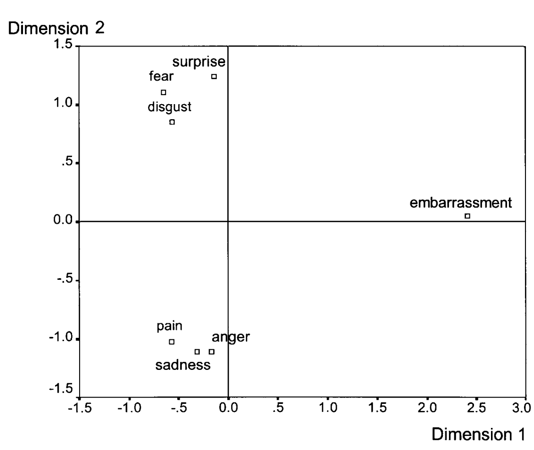

Fig. 2. Two-dimensional plot of similarities and differences with respect to pain of the seven facial expressions.

An alternative framework for interpreting the second axis may be the contextual understanding of expression according to Fridlund's (1994, 1997) Behavioural Ecology View of faces: facial expressions as social tools which are 'read' according to the context of the interaction in which they occur. For instance, a real smile signals readiness to affiliate, a false smile signals appeasement. Given that the task involved imagining that the photo was of a patient presenting in the ER, the pain face conveys suffering and an attempt to enlist help, as does the sad face, as indicated by participants' comments such as "Oh! Poor him!". This explanation cannot apply to the anger face whose proximity to sadness and pain remains puzzling. A partial explanation, to do with the nature of the stimulus, was the comment of a number of participants that the angry (male) face could represent an attempt not to show pain, but with difficulty, resulting in a rigid and staring expression. In contrast, the faces which express fear, surprise, disgust and embarrassment appear to represent a reaction to an external stimulus or situation. Why did MDS place pain and disgust at opposite ends of the second axis, while the judgement study demonstrated confusion of the pain face with the expression of disgust by a substantial minority of participants? The nature of the tasks – judging similarity of pairs of faces to pain versus naming the specific emotion represented – is perhaps more different than is at first apparent. In the judgement study, confusion of pain for disgust is assumed to be due to similarity of the two expressions (as described above in terms of facial action units), but this is not certain, whereas for MDS, participants were explicitly asked to judge similarity. Only finer grained methods, such as asking subjects to explain their identification of emotion from facial expression, could distinguish between possible explanations.

The main methodological problem affecting interpretation of results is the confounding of characteristics of the expression with characteristics of the particular photo and model. These cannot be distinguished within a judgement study, which uses only one model and set of photographs; however, this consideration was overruled by the need for comparability of the stimulus across participants, who were available only for a short time. It may therefore be the case that when participants viewed the stimulus photo, they were comparing the expression shown with an imagined 'perfectly posed expression', as much as or rather than with an emotion or pain expression category (Etcoff and Magee, 1992; Young et al., 1997).

A second consideration is that emotional and pain expression as encountered in clinical and other settings is much more likely to occur as blends of expressions (Fridlund and Duchaine, 1996; Hale and Hadjistavropoulos, 1997; LeResche and Dworkin, 1988; Prkachin, 1997) than as sequences of prototypes; further, the setting itself provides an aid to identification and understanding. Both of these are problems for the interpretation of studies using posed photographs. In this study, participants were instructed to imagine the photograph as a patient presenting in the ER, and their comments suggested that most were able to do so. In relation to blends of expression, although some researchers argue that posed expression has no relevance to the interpretation of spontaneous expression (Motley and Camden, 1988; Russell, 1994), there is some evidence that processing of expression uses categories. Young et al. (1997) found categorical recognition of facial expression in photos which used computer morphing to produce intermediate blends between posed prototypes.

The simple hit rates in this study were comparable with those of Keltner and Buswell (1996) and Haidt and Keltner (1999), who used the same photos but different judges (undergraduate students rather than clinical professionals). Use of the unbiased hit rate represented a methodological improvement on the simple hit rate for estimating accuracy of judgements, but the present sample was not of sufficient size, nor was the error rate high enough, to investigate the possible influences of age, sex and experience on judgement. Further understanding of identification and misidentification of pain expression in the context of other emotion would benefit from replications using blends of expression, or videotape of actual patients, as stimuli for judgements by groups of health professionals, patients themselves, and others.

This work has several clinical implications, the more so because results were generated from a sample of health professionals. While both students (Prkachin et al., 1994) and medical professionals (Choiniere et al., 1990; Teske et al., 1983; Zalon, 1993) tend to underestimate pain as rated by the patient, there appears to be some influence on underestimation of exposure to pain expression, although not straightforward. In a study by Prkachin et al., (2001), three groups of people who differed in their exposure to pain estimated pain on videotapes of patients undergoing a painful medical procedure. By comparison with patients' pain ratings, observers with experience of pain in their families attributed greater pain to the patients than did observers with no experience of pain in their families. However, health care professionals (physiotherapists and occupational therapists) attributed least pain to the patients. It may be that sensitivity to pain expression is enhanced by repeated exposure to a family member in pain, where judgements can be confirmed or disconfirmed, but not by multiple exposure to strangers and little feedback on the quality of judgements made. An alternative interpretation is that taken in light of evidence of adequate identification of pain by health professionals in the present study, this finding suggests a cognitive discounting bias among health professionals when faced with a patient's pain. It is unlikely, therefore, that training health professionals better to identify pain (Galin and Thorn, 1993; Solomon et al., 1997) will significantly improve the match of their pain estimate to those of the patients. Underestimation bias can be produced in experimental situations by alerting judges to possible deception (Poole and Craig, 1992), and in clinical settings by certain information about the presenting patient, such as injury type (Todd et al., 1994); it may be better understood by reference to biases in detection of social cheating (Cosmides, 1989) and lying (Ekman and O'Sullivan, 1991). Systematic underestimation of pain by health professionals is of particular concern because of the widespread undertreatment of pain recorded in many settings (Donovan et al., 1987; Lavies et al., 1992; Melzack et al., 1987; Owen et al., 1990).

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References

von Baeyer CL, Johnson ME, McMillan MJ. Consequences of nonverbal expression of pain: patient distress and observer concern. Soc Sci Med 1984;19:1319–1324.

Buck R. Social and emotional functions in facial expression and communication: the readout hypothesis. Biol Psychol 1994;38:95–115.

Boucher JD. Facial displays of fear, sadness and pain. Percept Motor Skills 1969;28:239–242.

Carroll JM, Russell JA. Do facial expressions signal specific emotions? Judging emotion from the face in context. J Pers Soc Psychol 1996;70:205–218.

Choiniere M, Melzack R, Girard N, Rondeau J, Paquin MJ. Comparisons between patients' and nurses' assessment of pain and medication efficacy in severe burn injuries. Pain 1990;40:143–152.

Cosmides L. The logic of social exchange. Cognition 1989;31:187–276.

Craig KD. Ontogenetic and cultural influences on the expression of pain in man. In: Kosterlitz HW, Terenius LY, editors. Pain and society, Weinheim: Verlag Chemie GmbH, 1980. pp. 37–52.

Craig KD. The facial expression of pain. Better than a thousand words? Am Pain Soc J 1992;1:153–162.

Craig KD, Patrick CJ. Facial expression during induced pain. J Pers Soc Psychol 1985;48:1080–1091.

Craig KD, Prkachin KM. Nonverbal measures of pain. In: Melzack R, editor. Pain measurement and assessment, New York, NY: Raven Press, 1983. pp. 173–179.

Craig KD, Hyde SA, Patrick CJ. Genuine, suppressed and faked facial behavior during exacerbation of chronic low back pain. Pain 1991;46:161–171.

Craig KD, Prkachin KM, Grunau RVE. The facial expression of pain. In: Turk DC, Melzack R, editors. Handbook of pain assessment, New York, NY: Guildford Press, 2001. pp. 153–169.

Donovan M, Dillon P, McGuire L. Incidence and characteristics of pain in a sample of medical–surgical inpatients. Pain 1987;30:69–78.

Ekman P. An argument for basic emotions. Cognition Emotion 1992;6:169–200.

Ekman P, Friesen WV. Facial action coding system, . Palo Alto, CA: Consulting Psychologists Press, 1978.

Ekman P, Friesen WV. A new pan cultural expression of emotion. Motivation Emotion 1986;10:159–168.

Ekman P, O'Sullivan M. Who can catch a liar? Am Psychol 1991;46:913–920.

Etcoff NL, Magee JJ. Categorical perception of facial expression. Cognition 1992;44:227–240.

Fordyce WE. Behavioural methods for chronic pain and illness. St. Louis, MO: Mosby, 1976.

Fridlund AJ. Human facial expression: an evolutionary view. San Diego, CA: Academic Press, 1994.

Fridlund AJ. The new ethology of human facial expressions. In: Russell JA, Fernandez-Dols JM, editors. The psychology of facial expression, Cambridge, MA: Cambridge University Press, 1997. pp. 103–129.

Fridlund AJ, Duchaine B. 'Facial expressions of emotion' and the delusion of the hermetic self. In: Harre R, Parrott WG, editors. The emotions: social, cultural and biological dimensions, London: Sage, 1996. pp. 259–284.

Galin KE, Thorn BE. Unmasking pain: detection of deception in facial expressions. J Soc Clin Psychol 1993;12:182–197.

Hadjistavropoulos HD, Craig KD. Acute and chronic low back pain: cognitive, affective, and behavioral dimensions. J Consult Clin Psychol 1994;62:341–349.

Haidt J, Keltner D. Culture and facial expression: open-ended methods find more expressions and a gradient of recognition. Cognition Emotion 1999;13:225–266.

Hale CJ, Hadjistavropoulos T. Emotional components of pain. Pain Res Manage 1997;2:217–225.

International Association for the Study of Pain. Pain terms: a list with definitions and notes on usage. Pain 1979;6:249–252.

Keltner D. Signs of appeasement: evidence for the distinct displays of embarrassment, amusement, and shame. J Pers Soc Psychol 1995;68:441–454.

Keltner D, Buswell BN. Evidence for the distinctness of embarrassment, shame, and guilt: a study of recalled antecedents and facial expressions of emotion. Cognition Emotion 1996;10:155–171.

Lavies N, Hart L, Rounsefell B, Runciman W. Identification of patient, medical and nursing staff attitudes to postoperative opioid analgesia: stage 1 of a longitudinal study of postoperative analgesia. Pain 1992;48:313–319.

LeResche L. Facial expression in pain: a study of candid photographs. J Nonverbal Behav 1982;7:46–56.

LeResche L, Dworkin SF. Facial expression accompanying pain. Soc Sci Med 1984;19:1325–1330.

LeResche L, Dworkin SF. Facial expressions of pain and emotions in chronic TMD patients. Pain 1988;35:71–78.

LeResche L, Dworkin SF, Wilson L, Ehrlich KJ. Effect of temporomandibular disorder pain duration on facial expressions and verbal report of pain. Pain 1992;51:289–295.

Melzack R, Abbott FV, Zackon W, Mulder DS, Davis MWL. Pain on a surgical ward: a survey of the duration and intensity of pain and the effectiveness of medication. Pain 1987;29:67–72.

Motley MT, Camden CT. Facial expression of emotion: a comparison of posed versus spontaneous expressions in an interpersonal setting. West J Speech Commun 1988;52:1–22.

Owen H, McMillan V, Rogowski D. Postoperative pain therapy: a survey of patients' expectations and their experiences. Pain 1990;41:303–307.

Patrick CJ, Craig KD, Prkachin KM. Observer judgements of acute pain: facial action determinants. J Pers Soc Psychol 1986;50:1291–1298.

Poole GD, Craig KD. Judgements of genuine, suppressed, and faked facial expressions of pain. J Pers Soc Psychol 1992;63:797–805.

Prkachin KM. The consistency of facial expressions of pain. A comparison across modalities. Pain 1992;51:297–306.

Prkachin KM, Berzins S, Mercer SR. Encoding and decoding of pain expressions: a judgement study. Pain 1994;58:253–259.

Prkachin KM, Solomon P, Hwang T, Mercer SR. Does experience affect judgements of pain behaviour? Evidence from relatives of pain patients and health-care providers. Pain Res Manage 2001;6:105–112.

Prkachin KM, Currie NA, Craig KD. Judging nonverbal expressions of pain. Can J Behav Sci 1983;15:409–421.

Prkachin KM, Mercer SR. Pain expression in patients with shoulder pathology: validity, properties and relationship to sickness impact. Pain 1989;39:257–265.

Russell JA. Is there a universal recognition of emotion from facial expression? A review of the cross-cultural studies. Psychol Bull 1994;115:102–141.

Schiffman SS, Reynolds ML, Young FW. Introduction to multidimensional scaling. New York, NY: Academic Press, 1981.

Solomon PE, Prkachin KM, Farewell V. Enhancing sensitivity to facial expression of pain. Pain 1997;71:279–284.

Teske K, Daut RL, Cleeland CS. Relationships between nurses' observations and patients' self-reports of pain. Pain 1983;16:289–296.

Todd KH, Lee T, Hoffman JR. The effect of ethnicity on physician estimates of pain severity in patients with isolated extremity trauma. J Am Med Assoc 1994;271:925–928.

Wagner HL. On measuring performance in category judgement studies of nonverbal behavior. J Nonverbal Behav 1993;17:3–28.

Wagner HL. Methods for the study of facial behavior. In: Russell JA, Fernandez-Dols JM, editors. The psychology of facial expression, Cambridge, MA: Cambridge University Press, 1997. pp. 31–54.

Young AW, Rowland D, Calder AJ, Etcoff NL, Seth A, Perrett DI. Facial expression megamix: tests of dimensional and category accounts of emotion recognition. Cognition 1997;63:271–313.

Zalon ML. Nurses' assessment of postoperative patients' pain. Pain 1993;54:329–334.