

CORRELATES OF FACIAL FLUSHING AND PALLOR IN ANGER-PROVOKING SITUATIONS

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Summary—The face usually flushes with rage but can also become pallid during seemingly similar emotional experiences. To investigate this paradox, 200 respondents rated their expected facial colour and the intensity of anger, fear and embarrassment to a range of questionnaire items that involved interpersonal threat or conflict, and also completed questionnaires on blushing propensity, anger expression, facial pallor and fear of injury. Respondents associated flushing with anger and pallor with fear, and reported a propensity for facial flushing, linked with blushing, or a propensity for pallor across a range of threatening and distressing situations. These findings suggest that facial colour during threatening interpersonal interactions may be influenced by fear as well as anger cues which depend, at least in part, on personality attributes. © 1997 Elsevier Science Ltd

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INTRODUCTION

One of the most dramatic physiological signs of emotion is the face flushing with rage. In his influential treatise on the expression of emotions, Darwin (1872/1965) noted that the face reddens or becomes purple during rage, with distension of forehead and neck veins. However, Darwin also noted that the face sometimes becomes pallid or livid during intense rage, a response that he attributed to imperfect function of the heart. Darwin was also puzzled by the paradox of cardiac activation and facial pallor during fear and terror, although he was aware that excitation of a central vasomotor centre can initiate contraction of cutaneous arterioles.

Since Darwin, there has been little further insight into the situational determinants or individual characteristics that influence whether facial flushing or pallor will develop during rage; in fact, the effect of anger on vascular activity in the face has been largely ignored. Ax (1953) and Schachter (1957) found that facial temperature (which covaries moderately with facial blood flow) sometimes fell when participants were harassed and rudely abused by the experimenter, and also when participants were led to believe that they were in danger of electrocution. However, facial blood flow appears to increase during minor frustration (Drummond, 1994). Taken together, these findings are consistent with the notion that the face flushes with annoyance but may go pale during more extreme provocation, possibly because an additional element of fear activates sympathetic cutaneous vasoconstriction as part of the fight-flight response.

In the present study, a questionnaire approach was used to explore influences on facial blood flow during anger. Respondents rated their expected facial colour and intensity of anger to a range of hypothetical situations that involved interpersonal threat or conflict. One possible influence on facial blood flow during anger is whether or not anger is expressed, a dimension that is built into assessment tools such the Hostility and Direction of Hostility Questionnaire (Caine, Foulds & Hope, 1967) and Spielberger's (1991) State-Trait Anger Expression Inventory. To investigate this issue, each incident in the questionnaire used in the present study involved the expression or control of anger. A second possible influence on vascular responses in the face during anger is the simultaneous experience of emotions such as embarrassment or fear. For instance, flushing might develop when anger is coupled with embarrassment whereas pallor might develop during threatening

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situations. To explore these possibilities, respondents rated the expected intensity of embarrassment and fear for each of the anger-provoking incidents. Finally, individual differences in how readily facial blood vessels dilate or constrict might influence facial blood flow during anger. This effect would be predicted from Lacey and Lacey's principle of autonomic response-stereotypy, which holds that different stressful stimuli evoke consistent but idiosyncratic patterns of physiological response (Lacey & Lacey, 1958). Thus, the survey aimed to establish whether a propensity for blushing in embarrassing situations (Leary & Meadows, 1991), or for facial pallor during excitement or fear, was associated with an expected propensity for facial flushing or pallor when angry.

METHOD

Respondents

The sample consisted of 50 male and 150 female university students aged between 17 and 51 years (mean age 24.5 ± 8.2 years) enrolled in an undergraduate psychology course. The questionnaires were administered by a female research assistant to groups of 15 to 20 students. The questionnaires were filled out in class, but did not attract course credit.

Materials

Respondents completed a battery of self-report inventories consisting of the State-Trait Anger Expression Inventory (Spielberger, 1991), the Blushing Propensity Scale (Leary & Meadows, 1991), and the Mutilation Questionnaire (Klorman, Weerts, Hastings, Melamed & Lang, 1974; Kleinknecht & Thorndike, 1990). After filling out these questionnaires, respondents answered questions on facial pallor and changes in facial colour during anger. The questionnaires took approximately 20 minutes to complete.

The State-Trait Anger Expression Inventory contains a 10-item Trait Anger scale consisting of two subscales: Angry Temperament (the disposition to experience and express unprovoked anger), and Angry Reaction (anger in response to provocation). In addition, the Inventory contains three 8-item scales that measure the expression of anger toward other people or objects (the Anger-out scale), the suppression of angry feelings (the Anger-in scale), and the attempt to control the expression of anger (the Anger Control scale). These three scales are combined to form the 24-item Anger Expression scale, a general index of the frequency that anger is expressed, regardless of the direction of expression. Subjects did not complete the 10-item State Anger scale.

The Blushing Propensity Scale contains 14 items concerned with the degree to which people blush in everyday social settings. This scale was included to investigate the association between blushing provoked by embarrassment and flushing provoked by anger, as perceived by the respondent.

The Mutilation Questionnaire is a 30-item scale that measures fear of blood and injury. This questionnaire was included to investigate the association between individual differences in blood-injury fears and the propensity for facial pallor.

A *Blanching Scale* was developed to measure the propensity for facial pallor in everyday situations. Subjects used a 5-point scale (1 = never, 5 = always) to rate how frequently their face went pale in frightening or exciting situations (Table 1). Situations included exposure to blood, injections, injury and medical settings, to other frightening or startling situations, and to pleasant or thrilling events.

Change in Facial Colour during Anger. Subjects used a 5-point scale to rate their expected facial colour during hypothetical incidents that involved interpersonal threat or conflict (1 = my face would go extremely pale, 5 = my face would flush deeply). These ratings were later recoded into two measures: facial pallor (2 = extreme pallor, 1 = mild pallor, 0 = no change or flushing), and flushing (2 = deep flush, 1 = mild flush, 0 = no change or blanching). The questionnaire included items describing the expression or control of anger in each of nine threatening situations; the wording of each question and the position of each item in the questionnaire is shown in Table 2. Respondents also rated how angry, embarrassed and frightened they would feel in each situation, using a 4-point scale (0 = not at all, 3 = very much so).

Table 1. The Blanching Scale

Item	Mean \pm SD	Item-Total <i>r</i>
13. When I watch an exciting game	1.4 \pm 0.7	0.48
18. When I receive good personal news unexpectedly	1.5 \pm 0.7	0.35
5. When I watch an exciting race	1.5 \pm 0.8	0.52
11. When I visit the doctor	1.6 \pm 0.8	0.57
2. When I watch a scary movie	2.0 \pm 1.1	0.49
12. When I speak in public	2.2 \pm 1.2	0.47
9. When I watch someone else receive an injection	2.2 \pm 1.2	0.36
8. When an extremely loud noise startles me	2.2 \pm 1.0	0.57
1. At the sight of blood	2.2 \pm 1.0	0.51
7. When I visit the dentist	2.3 \pm 1.2	0.50
4. Before an important test or examination	2.6 \pm 1.1	0.56
3. When I receive an injection	2.8 \pm 1.3	0.33
15. When I feel exhausted	2.9 \pm 1.2	0.41
10. When I get a bad fright or shock	3.1 \pm 1.1	0.59
16. When I suddenly find myself in a dangerous situation	3.1 \pm 1.1	0.60
14. When I hurt myself badly	3.1 \pm 1.1	0.53
6. When I receive bad personal news unexpectedly	3.4 \pm 1.1	0.58
17. When I am in severe pain	3.6 \pm 1.1	0.53

Note. The 200 subjects were asked to rate how often their face went pale in each situation using a 5-point scale (1 = never; 2 = rarely; 3 = occasionally; 4 = often; 5 = always). The item number refers to its position in the scale. A difference between means of 0.3 or greater is statistically significant (Tukey's critical range test for $\alpha = 0.05$). Item-total correlations were computed with the item score deleted from the total score.

Table 2. Items rated for facial flushing and pallor

Situation	Anger expressed	Anger controlled
Your lecturer or supervisor accuses you of <i>cheating</i> .	You strongly deny that you cheated (item 2).	You do not defend yourself (item 1).
The driver of a car that has been <i>tailgating</i> you beeps you at traffic lights when you do not start immediately.	You stop your car in the middle of the road, get out and confront the other driver (item 9).	You take off more quickly than usual (item 10).
An irritating neighbour plays <i>loud music</i> late at night.	You bang loudly on his door (item 6).	You do nothing about it (item 5).
You are in a desperate hurry, but have not been able to <i>overtake</i> the slow, erratic driver in front.	You beep your car horn repeatedly (item 15).	You keep looking for an opportunity to pass (item 16).
Your lecturer or supervisor meanly <i>criticizes</i> your work, and accuses you of laziness.	You reply that the guidelines given for the work were not clear (item 18).	You accept this criticism silently (item 17).
An offensive acquaintance makes a <i>rude remark</i> about your clothes.	You reply with a similar remark about his or her appearance (item 12).	You do not reply (item 11).
A surly shop assistant <i>short-changes</i> you. A policeman pulls you over for <i>speeding</i> .	You demand the correct change (item 13). You point out that you were only 5 km/hr over the speed limit (item 3).	You accept the change (item 14). You wait silently while he writes out the ticket (item 4).
While at a party, you accidentally <i>spill your drink</i> on someone who then gets extremely angry.	You retort that it wasn't your fault (item 7).	You apologise (item 8).

Note. Items in this table, and in Fig. 1, are rank-ordered by respondents' anger ratings to the anger expressed condition.

RESULTS

Expression vs control of anger and facial colour ratings

The influence on ratings of the type of situation and whether anger was expressed or controlled was explored in analyses of variance, using the multivariate solution for repeated measures (MANOVA programme, SPSS). Significant interactions were investigated with planned contrasts between the expression and control of anger for each situation. Because this involved an analysis for each pair of questionnaire items, $p < 0.001$ was used as the criterion of statistical significance. Ratings for each item were obtained from 180 subjects.

As shown in Fig. 1, respondents reported that they would feel moderately angry or very angry in most situations; the rated intensity of anger depended, at least in part, on the type of situation and whether anger was expressed or controlled (interaction between the situation and expression or control of anger, $F(8,172) = 20.6$, $p < 0.001$). Investigation of this interaction indicated that anger

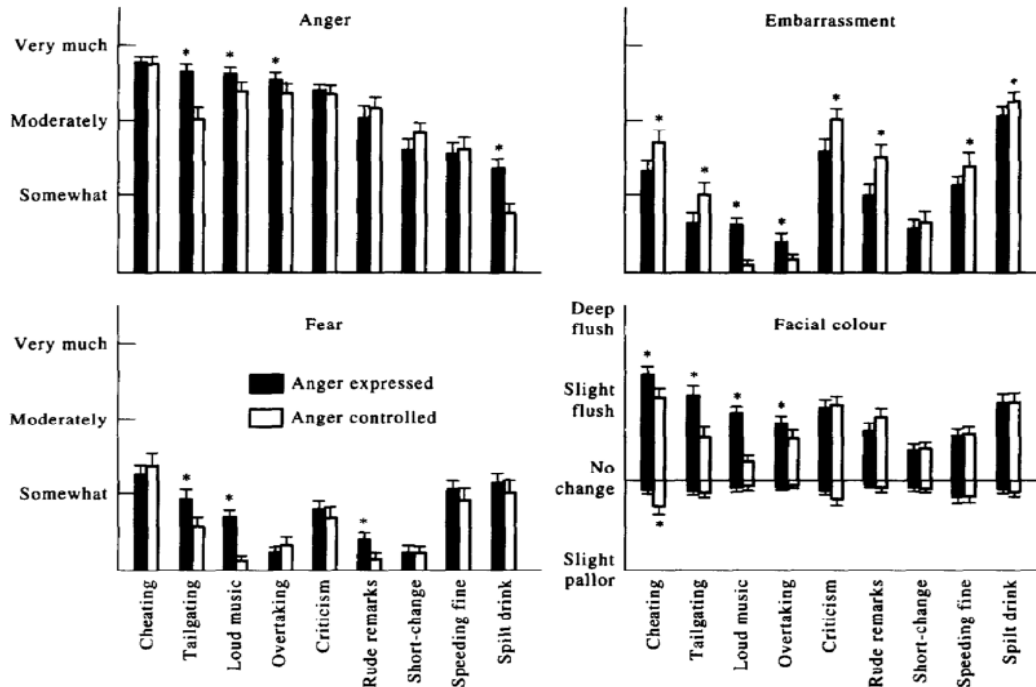


Fig. 1. Ratings to the situations listed in Table 2. Solid bars represent ratings to situations involving the expression of anger, whereas the open bars represent ratings to situations where anger was controlled. Error bars represent the 95% confidence interval; all ratings were significantly different from 0. Asterisks indicate that ratings differed significantly between situations where anger was expressed or controlled ($p < 0.001$).

ratings were higher ($p < 0.001$) for situations involving an aggressive stance (confronting a driver who was following too closely; banging loudly on the door of a neighbour who was playing loud music; tooting the car horn while attempting to overtake a slow erratic driver; denying blame in an angry confrontation over a spilt drink) than when anger was controlled.

Whether anger was expressed or controlled also interacted with the situation to influence ratings of embarrassment and fear (for ratings of embarrassment, $F(8,172) = 24.0$, $p < 0.001$; for fear $F(8,172) = 15.3$, $p < 0.001$). Planned contrasts indicated that embarrassment ratings were higher ($p < 0.001$) for situations where anger was controlled than where it was expressed (after being accused of cheating or laziness; being tooted by a driver who was following too closely (tailgating); being the target of an offensive remark or receiving a speeding fine; and after spilling a drink on someone else); however, embarrassment ratings were minimal for situations where an angry confrontation was avoided (choosing to ignore a neighbour playing loud music late at night; waiting for an opportunity to overtake a slow, erratic driver) (Fig. 1). In general, fear ratings were lower if anger was controlled than if anger was expressed (Fig. 1).

As shown in Fig. 1, flushing was rated much more frequently than facial pallor for each situation; in addition, whether anger was expressed or controlled interacted with the type of situation to influence ratings of facial flushing ($F(8,172) = 21.7$, $p < 0.001$) and pallor ($F(8,172) = 4.6$, $p < 0.001$). Respondents thought that their face would flush more deeply when anger was expressed than when anger was controlled ($p < 0.001$) in the following situations: defending themselves against a false accusation of cheating, confronting a tailgating driver or a neighbour playing loud music, or tooting their car horn while attempting to overtake a slow, erratic driver. Respondents considered the most potent stimulus for facial pallor to be accepting a false accusation of cheating, and thought that pallor would be less if they protested against the accusation than if they accepted it silently ($p < 0.001$). In each of the situations listed above, the association between facial colour and the expression vs the control of anger was independent of ratings of emotion, as determined by analyses

Table 3. Relationship between mood and facial colour ratings

Situation	Flushing				Pallor			
	Anger expressed		Anger controlled		Anger expressed		Anger controlled	
	r ²	Predictors	r ²	Predictors	r ²	Predictors	r ²	Predictors
Cheating	0.15***	A(++) E(++)	0.06*	E(++) F(-)	0.03		0.08**	F(++)
Tailgating	0.11***	A(++)	0.15***	A(+++) E(++)	0.02		0.08**	A(-) F(++)
Loud music	0.07**	A(+) E(+)	0.07**	A(++)	0.03		0.05*	F(++)
Overtaking	0.12***	A(+++)	0.10***	A(+++)	0.04		0.07**	F(+++)
Criticism	0.21***	A(+++) E(+)	0.17***	E(+++)	0.07**	A(-)	0.06*	F(++)
Rude remark	0.22***	A(+++) E(++)	0.26***	A(+) E(+++)	0.01		0.10***	F(+++)
Short-change	0.15***	A(+++) E(++)	0.12***	A(+) E(+++)	0.06*	F(++)	0.04	
Speeding fine	0.13***	A(+) E(+++)	0.11***	A(+++) E(++)	0.06*	F(+++)	0.06*	E(++)
Spilt drink	0.11***	E(+++)	0.15***	E(+++)	0.03		0.13***	E(-) F(+++)

Note. r² statistically significant (* p < 0.05; ** p < 0.01; *** p < 0.001). The predictors were ratings of anger (A), embarrassment (E), and fear (F). The direction and strength of the prediction is shown in parentheses (beta weight statistically significant: +++ p < 0.001; ++ or -- p < 0.01; + or - p < 0.05).

of covariance where anger, embarrassment and fear ratings were entered as covariates for facial flushing and pallor ratings.

Relationship between ratings of emotion and facial colour

The relationship between ratings of emotion and ratings of facial flushing and pallor for each situation was investigated in multiple regression analyses, using the forced entry method. As shown in Table 3, anger or a combination of anger and embarrassment was associated with high ratings of facial flushing in most situations. In contrast, high ratings of facial pallor were usually associated with high fear ratings.

Individual differences in facial colour ratings

Means and standard deviations for each item of the Blanching Scale are presented in Table 1. Ratings of facial pallor were highest for items concerned with pain, injury or threat. Principal components analysis of the 18 items identified four factors with eigenvalues greater than 1, with the first factor accounting for 33% of the total variance. Since each item correlated at least 0.3 with the sum of all the other items (range 0.33 to 0.60, mean 0.53), and Cronbach's alpha for the scale was 0.87, a one-factor solution was chosen. As shown in Table 4, scores on the Mutilation and Blushing Propensity scales correlated moderately with the Blanching score. The Blanching score correlated weakly but significantly with Trait Anger and its two subscales (Angry Temperament and Angry Reaction), the Anger Expression scale, and correlated negatively with Anger Control; however, scores on the Anger Expression Inventory did not predict Blanching scores independently of Blushing Propensity and Mutilation Questionnaire scores in a multiple regression analysis (Table 4). The Blanching score was higher in females than in males (45 ± 11 vs 40 ± 10, t(198) = 2.81, p < 0.01), but was unrelated to the respondent's age.

Predictors of individual differences in facial flushing and pallor ratings were investigated in multiple regression analyses, using the forced entry method. The criteria in these analyses were

Table 4. Correlations between the Blanching Score and other self-report measures

Measure	Mean ± SD	Correlation
Blanching score	44 ± 11	—
Mutilation questionnaire	11 ± 6	0.46 ^a
Blushing propensity	37 ± 9	0.48 ^a
Trait anger	20 ± 5	0.27*
Angry temperament	7 ± 3	0.18*
Angry reaction	10 ± 2	0.26*
Anger-in	17 ± 4	0.13
Anger-out	16 ± 4	0.13
Anger control	22 ± 5	-0.14*
Anger expression	27 ± 9	0.19*

^a Correlation with the Blanching score statistically significant (p < 0.05).

* Beta weight statistically significant (p < 0.05).

Table 5. Correlations with facial flushing and pallor ratings for anger-provoking situations

	Flushing	Pallor
Blushing propensity	0.43 ^{*a}	0.03
Trait anger	0.27 [*]	0.03
Angry temperament	0.21 [*]	0.04
Angry reaction	0.31 ^{*a}	0.06
Anger-in	0.16 [*]	-0.02
Anger-out	0.10	0.02
Anger control	-0.07	-0.11
Anger expression	0.16 [*]	0.03
Blanching score	0.28 [*]	0.27 ^{*a}
Mutilation questionnaire	0.15 [*]	0.12

^{*} Correlation statistically significant ($p < 0.05$).

^a Beta weight statistically significant ($p < 0.05$).

ratings of flushing or pallor, averaged over the 18 questionnaire items involving the expression or control of anger. The predictor variables were the scale and subscale scores from the State-Trait Anger Expression Inventory, and the Blushing Propensity, Mutilation Questionnaire, and Blanching scores. Table 5 shows that Blushing Propensity and Angry Reaction ratings combined to predict facial flushing ratings ($r^2 = 0.26$, $F(10,163) = 5.85$, $p < 0.001$). In contrast, the Blanching score was the only significant predictor of facial pallor ratings ($r^2 = 0.11$, $F(10,163) = 1.94$, $p < 0.05$).

DISCUSSION

Methodological issues

The questionnaire survey was carried out on a predominantly female sample of university students studying psychology, a group who might be more aware of bodily changes during emotions such as anger, embarrassment and fear than most other people. Perhaps for this reason, the study succeeded in identifying links between expected facial colour and the type of emotional experience. How accurate these observations are will require further study. For instance, the results were probably influenced by expectations based upon current social norms and observing emotional reactions in other people. Some individuals may be quite inaccurate in predicting their own psychophysiological reactions. For example, increases in forehead blood flow during embarrassing situations (singing a nursery rhyme and failing to solve arithmetic problems) were found to be largely unrelated to ratings of blushing propensity (Drummond, 1997). Clearly, the associations identified in the present study require validation in other samples, preferably in real-life settings using more sensitive and accurate measures of facial blood flow than self-report. Nevertheless, the points discussed below provide a useful focus for the development of hypotheses concerning the influence of psychological factors on vascular reactions in the face.

Expression vs control of anger

Anger ratings were higher for situations where anger was expressed aggressively than for situations where anger was controlled or expressed assertively, presumably because respondents thought that they would have to be very angry indeed to display aggression. Current theories of aggression postulate that nonspecific arousal, frustration or discomfort can prime hostile thoughts and aggressive inclinations, which surface in the presence of appropriate cues (Berkowitz, 1989; Anderson, 1989). Conversely, emotions such as embarrassment help to enforce socially-acceptable behaviour (Modigliani, 1971), and blushing and other signs of embarrassment act as appeasement signals (Leary, Landel & Patton, 1996). A limiting effect of embarrassment on the expression of anger could explain why ratings of embarrassment were higher for situations where anger was controlled than for situations where anger was expressed. In addition, subjects may have thought that they would have to feel very embarrassed to control their anger in situations where it would be appropriate to be angry (e.g., being criticized unjustly or being the target of a rude remark).

Most respondents thought that their face would flush more readily than it would blanch in anger-provoking situations, and that flushing would be greatest when anger was expressed. The link between flushing and the expression of anger was independent of ratings of anger, embarrassment

and fear, suggesting that some other component of anger expression might induce the flushing reaction. The silent acceptance of a false accusation of cheating was thought to induce more facial pallor than protesting against the accusation; again, this effect was independent of ratings of anger, embarrassment and fear, indicating that these ratings did not capture the full situational influence on subjects' expectations of facial pallor. Exactly what situational factors influence vascular reactions in the face during threatening interpersonal situations remains uncertain; however, the expression of anger seems to be one potential moderator.

Relationship between ratings of emotion and facial colour

Respondents thought that their face would flush most readily during situations where they felt embarrassed as well as angry. Importantly, however, respondents thought that anger would influence flushing independently of embarrassment in most situations and would be the sole influence during situations associated with considerable anger but little embarrassment (confronting a tailgating driver; putting up with a neighbour's loud music late at night; and trying to overtake an erratic driver) (see Table 3 and Fig. 1).

Respondents thought that facial pallor would develop in response to fear but not to anger alone. In fact, the association between low anger ratings and facial pallor scores for some situations suggests that fear and anger might have opposing effects on facial blood flow. Surprising, respondents who thought that they would be very embarrassed when silently receiving a speeding fine expected that their face would turn pale, indicating that respondents did not necessarily associate embarrassment with blushing.

Individual differences in flushing and facial pallor

Scores on the Blushing Propensity scale and scores on the Angry Reaction subscale of the Anger Expression Inventory independently predicted facial flushing ratings for anger-provoking situations. Thus, respondents who thought that they blushed easily and those who thought that they had a quick temper when provoked reported the highest flushing ratings. The association between blushing with embarrassment and flushing with anger is consistent with the notion of autonomic response-stereotypy (i.e. underlying psychological or physiological factors influence the expression of psychophysiological responses to a variable extent in different individuals). For example, a high density of β -adrenoceptors in facial blood vessels might increase blushing and flushing propensity (Mellander, Andersson, Afzelius & Hellstrand, 1982); alternatively, social anxiety which increases threats to self-esteem might predispose individuals to blushing and facial flushing during a range of emotional experiences.

Analysis of the Blanching scale items suggested that facial pallor develops more often during fear, pain and injury than during excitement. Not surprisingly, respondents who were afraid of blood and injury had the highest scores on the Blanching scale; in addition, respondents with a high score on the Blanching scale saw themselves as having a propensity for facial pallor in threatening situations. More surprising was the association between blanching and blushing propensity, because these would seem to be opposing responses. Since blushing and facial pallor are both evoked by strong emotions, high scores on both scales might reflect an underlying dimension of emotionality such as neuroticism. Blushing propensity relates closely to anxiety in social situations (Edelmann & Skov, 1993; Leary & Meadows, 1991); the relationship between facial pallor and neuroticism has not been investigated, but the close association between scores on the Blanching, Blushing Propensity and Mutilation questionnaires hints at neuroticism in respondents who thought that their face would blanch readily.

In conclusion, respondents thought that facial flushing was associated with anger, and facial pallor with fear but not anger. Since most interpersonally-threatening situations probably evoke a mixture of emotions such as fear, embarrassment and anger, the type of vascular response in any particular context would be difficult to predict from situational cues alone. However, people with a propensity for blushing reported a propensity for facial flushing when angry; conversely, people who thought that they would blanch during angry encounters also thought that facial pallor would develop in response to pain, fear and injury, possibly because the emotional experience is similar. If this analysis is correct, facial colour during anger might depend, at least in part, on situational

cues and personality attributes which amplify threats to social standing or self-esteem (inducing flushing), or heighten a sense of danger (inducing pallor).

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