



Components of Emotional Meaning: A sourcebook

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CHAPTER

9 Embodied emotions: The Bodily reaction component

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Abstract

The results of the statistical analyses of the bodily reaction features are described. Three cross-culturally stable component factors are identified: DISTRESS SYMPTOMS, AUTONOMIC AROUSAL, and BODY TEMPERATURE, accounting for 75.5% of the overall variance. These results confirm earlier hypotheses on bodily reaction patterning. Using the three factor scores as independent variables, 45.1% of the emotions can be correctly classified in a multiple discriminant analyses, suggesting that emotion word meanings reflect emotion-specific patterning of bodily reactions. We show evidence that the patterns of bodily reactions are well reflected in the major dimensions of feeling.

Keywords: [embodiment](#), [distress symptoms](#), [autonomic arousal](#), [body temperature](#)

Subject: [Developmental Psychology](#), [Social Psychology](#)

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Changes in the physiological support systems of an organism are an important component of emotion episodes, given that they help to prepare for adaptive responses to emotion eliciting-events. These physiological changes are generally perceived in the form of bodily reactions which, ever since William James (1884) insisted on their constitutive role for emotional experience, are considered a central component of emotion (see Chapter 1). However, there are only a limited number of verbal descriptions of bodily reactions in ordinary languages that are likely to be reliably used in everyday speech and that therefore qualify as features for the GRID questionnaire (it should be noted that reliable use does not mean that people are able to actually perceive the underlying physiological functions correctly; see Vaitl, 1996).

For the selection of the bodily reaction features, we relied on two sources. On the one hand, we looked at the work of Stemmler (2003) on psychophysiological reactions in emotion episodes. On the other hand, we looked for verbal expressions of bodily emotional reactions that are widely used in different languages. We adopted a set of bodily reaction descriptions that were successfully used in a large scale cross-cultural study of recalled emotional experiences in which self report data about typical patterns of bodily reactions, such as cardiovascular activity, tension of the striated musculature, gastric motility, and skin temperature were

obtained (Scherer, Wallbott, & Summerfield, 1986). The results were used to formulate concrete predictions of the expected bodily reactions for four major emotions (Scherer, 1986, p. 185). Based on these data, in a second cross-cultural experience recall study, which was run in 37 countries on five continents (Scherer & Wallbott, 1994), the following items were used to obtain a self report of bodily reactions: “lump in throat, change in breathing, stomach troubles, feeling cold /shivering, feeling warm /pleasant, feeling hot /cheeks burning, heart beating faster, muscles tensing /trembling, muscles relaxing /restful, perspiring /moist hands, other symptoms.” Based on the physiological literature, these physiological patterns were grouped into three major groups for the data analysis: sympathetic, parasympathetic, and felt temperature symptoms (Scherer & Wallbott, 1994, p. 314–5).

In line with prior work on physiological response patterning during emotion episodes, the bodily reaction descriptions in the GRID instrument were selected using the 18 features listed below. As we expected to replicate the structure of categorizing bodily reactions that was found in the earlier recall studies, this list is organized accordingly, differentiating between sympathetic, parasympathetic, and felt temperature reactions. However, it should be noted that this is a heuristic categorization without any claim about the underlying mechanisms. This is particularly true for the parasympathetic category (see Jänig, 2003), which we paraphrase here as “non-sympathetic, non-adrenergic AROUSAL,” to avoid making any claims as to underlying regulation systems.

Sympathetic AROUSAL:

- heartbeat slowing down
- heartbeat getting faster
- muscles relaxing (whole body)
- muscles tensing (whole body)
- breathing slowing down
- breathing getting faster
- perspiring, or having moist hands
- sweating

Parasympathetic AROUSAL (non-sympathetic, non-adrenergic AROUSAL):

- had stomach troubles
- a lump in throat
- felt shivers
- felt weak limbs
- got pale

Felt temperature:

- felt cold
- felt warm
- felt hot

- blushed

None:

- had no bodily symptoms at all

9.1 Results

The internal structure of the Bodily reaction component

In a first factor analysis of the bodily reaction features across all emotion words and all samples, the scree plot (see Figure SM 1) pointed to two main factors.² However, the investigation of the stability of the factor structure across four language groups showed three stable factors (see Table SM 1), accounting for 75.5% of the overall variance. Given the stability of the first three factors, we adopted this solution. The Procrustes rotated factor loadings toward the expected three-factorial structure are shown in Table 9.1.

Table 9.1 Loadings of the bodily reaction features in a three-factorial Procrustes rotated structure

Bodily reaction features	DISTRESS SYMPTOMS	AUTONOMIC AROUSAL	BODY TEMPERATURE
felt weak limbs	0.87	0.09	−0.10
got pale	0.75	0.26	−0.51
felt shivers	0.65	0.19	0.34
had stomach troubles	0.65	0.42	−0.42
a lump in throat	0.60	0.16	−0.37
muscles tensing (whole body)	0.25	0.85	−0.15
breathing getting faster	0.13	0.77	0.42
perspired or had moist hands	0.45	0.75	0.21
sweat	0.43	0.73	0.21
heartbeat getting faster	0.09	0.58	0.70
muscles relaxing (whole body)	−0.12	−0.77	0.53
heartbeat slowing down	0.24	−0.80	−0.25
breathing slowing down	0.09	−0.91	0.08
felt warm	−0.37	0.11	0.75
blushed	−0.12	0.26	0.74
felt hot	0.05	0.63	0.61
felt cold	0.63	−0.01	−0.65
had no bodily symptoms at all	−0.40	−0.63	−0.26

Note: bold font indicates the feature was expected to have its highest loading on this factor.

p. 151 The results generally confirmed the expectations based on earlier findings reported above. The first factor is constituted by items that we have described above as “non-sympathetic, non-adrenergic AROUSAL” (“got pale, felt weak limbs, had stomach troubles, a lump in throat, shivers”). To avoid the problems involved in the distinction between the sympathetic and the parasympathetic branches of the autonomous nervous system (ANS) mentioned above, we chose more descriptive labels for the factors in this emotion component. Thus, we will refer to this factor as DISTRESS SYMPTOMS. The second factor shows high loadings for sensations that are usually perceived in cases of high AROUSAL of the ANS (“muscles tensing, heartbeat and breathing getting faster, sweating and perspiring”) and will be labeled AUTONOMIC AROUSAL. The third factor is a temperature factor (“felt hot, felt warm, blushed”) and thus labeled as BODY TEMPERATURE.

It should be noted that high cross-loadings indicate that the features “felt hot” and “heartbeat getting faster” are jointly contributing to the AUTONOMIC AROUSAL and the BODY TEMPERATURE factor. The mechanisms and subdivisions of the ANS have been much debated in physiology and there is little work on the relationship between self report of physiological symptoms and actual physiological measurement (due to the fact that it is

difficult to induce strong emotions with marked physiological changes in the laboratory). In consequence, the labels used to refer to the factorial structure reported above should be considered in a heuristic sense rather than a description of the underlying physiological processes, until more theoretically anchored empirical studies using precise physiological assessment are available.

The means of the bodily reaction factor scores for the various emotions are reproduced in Table SM 2 and plotted in Figure 9.1 and Figure 9.2. The graphs allow examining the relative position of the 24 emotions in the three-dimensional space formed by the bodily reaction factors. Figure 9.1 shows that especially anger and fear terms score high on AUTONOMIC AROUSAL, while sadness terms (e.g., sadness and disappointment) score low on this factor. Sadness and fear terms (e.g., sadness and fear) score high on DISTRESS SYMPTOMS, while anger, and especially positive emotion terms, tend to score low on this factor (e.g., interest and pride). Figure 9.2 shows a separation between positive and negative emotions at a middle range of autonomic involvement, suggesting a central role of BODY TEMPERATURE in distinguishing them. Here the emotions of sadness and disappointment are of interest, being rather cold and having very low values on the AUTONOMIC AROUSAL factor.

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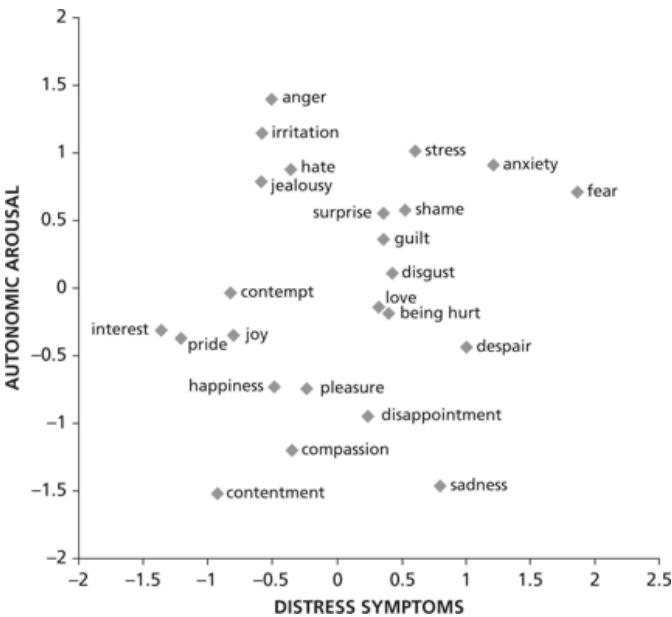


Figure 9.1 Plot of the average factor scores for the 24 emotion words on DISTRESS SYMPTOMS and AUTONOMIC AROUSAL.

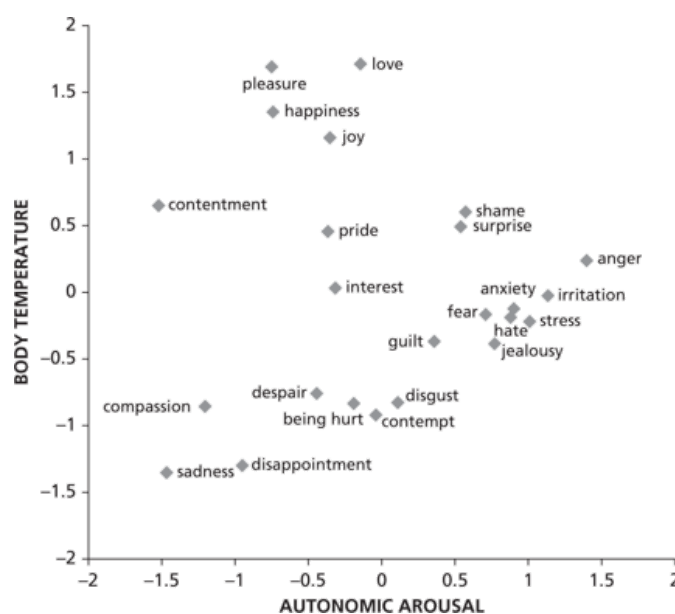


Figure 9.2 Plot of the average factor scores for the 24 emotion words on AUTONOMIC AROUSAL and BODY TEMPERATURE.

Mapping the bodily reaction structure onto the overall structure

To further explore the relationships between the overall factorial structure and the internal structure of the Bodily reaction component, we regressed the three bodily reaction factors on the four overall factors (after omitting all bodily reaction features). Table 9.2 shows the standardized regression weights and R^2 of the bodily reaction factors regressed on the four overall factors. The values for R^2 showed that VALENCE was predicted best (mostly by BODY TEMPERATURE), followed by POWER (by absence of DISTRESS SYMPTOMS) and AROUSAL (by AUTONOMIC AROUSAL symptoms).

Table 9.2 Standardized regression weights and R^2 of the bodily reaction factors regressed on the four overall factors

Overall factors	β DISTRESS SYMPTOMS	β AUTONOMIC AROUSAL	β BODY TEMPERATURE	R^2
VALENCE	-0.32 ^{***}	-0.46 ^{***}	0.63 ^{***}	0.70
POWER	-0.60 ^{***}	0.30 ^{***}	0.20 ^{***}	0.49
AROUSAL	0.21 ^{***}	0.61 ^{***}	0.21 ^{***}	0.46
NOVELTY	0.26 ^{***}	0.04	0.22 ^{***}	0.11

Note: * $p < 0.05$.

** $p < 0.01$.

*** $p < 0.00$. The bodily reaction features were removed from the four overall factors.

Emotion category differentiation based on the Bodily reaction component

p. 153 Having identified the factorial structure for this component, we examined to what extent the three bodily reaction factors allowed the discrimination of the 24 emotion terms, that is, classify them correctly on the basis of the three factor scores (as compared to classification success based on all 18 bodily reaction features). The results of a Multiple Discriminant Analysis (MDA) revealed three discriminant functions, explaining 73.1%, 20.7%, and 6.3% of the variance, respectively. Each of these functions showed correlations with more than one bodily reaction factor, making it difficult to label them unequivocally. The classification accuracy is shown in Table 9.3. Using the three factor scores as independent variables, 45.1% of cross-validated grouped cases can be correctly classified, a result that is far above chance level (1/24, or 4.2%). The results for the MDA classification that uses all 18 component features as independent variables achieved correct classification of 62.4% of cross-validated grouped cases. This represents a clear improvement (an increase of 17.9%) in classification accuracy. The last column of Table 9.3 allows the inspection of the patterns of the most frequent errors in the classification based on all features. There are particularly frequent confusions between happiness and joy, and pleasure and joy for the positive emotional reactions. For the negative emotional reactions there are frequent confusions between a) stress and anxiety, and fear and anxiety, b) jealousy and hate, and hate, anger, and irritation. Being hurt and despair are frequently confused with disappointment. Thus, all major confusions in the MDA classification occurred between emotional reactions that share at least some emotion family resemblance. However, not all emotion family members are mutually confused, but generally only a specific subgroup of emotional reactions.

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Table 9.3 Classification accuracy (in percent) for the 24 emotion words in discriminant analyses based on the bodily reaction factors and the bodily reaction features

Emotion words	Classification based on <i>factors</i>	Classification based on <i>features</i>	
	Accuracy	Accuracy	Confusion > 15% with
being hurt	17.6	38.2	disappointment
sadness	61.8	76.5	
shame	44.1	91.2	
guilt	67.6	73.5	
compassion	58.8	76.5	
disappointment	52.9	61.8	
love	70.6	73.5	
contentment	61.8	55.9	
happiness	11.8	35.3	joy
pride	38.2	73.5	
pleasure	52.9	64.7	joy
joy	47.1	26.5	happiness, pleasure
interest	52.9	79.4	
surprise	11.8	82.4	
despair	38.2	58.8	disappointment
stress	55.9	73.5	anxiety
anxiety	41.2	50.0	stress, fear
fear	79.4	82.4	anxiety
jealousy	17.6	44.1	hate
hate	20.6	47.1	irritation
irritation	20.6	47.1	hate, anger
anger	58.8	47.1	irritation
disgust	50.0	79.4	
contempt	50.0	58.8	
Total	45.1	62.4	

9.2 Discussion and conclusions

We conclude that the data for the Bodily reaction component confirm earlier assumptions about the internal structure of this component. The three predicted factors could be almost perfectly identified across the four language groups.

When looking at the relationships between the bodily reaction factors and the overall factors (from which the bodily reaction features have been removed), it is striking that all four overall factors are related to bodily reactions (although NOVELTY only to a limited extent). The fact that the overall AROUSAL factor is best predicted by the AUTONOMIC AROUSAL factor was to be expected. The features that define AUTONOMIC AROUSAL, also defined the AROUSAL factor in the overall structure. Even when the bodily reaction features are removed from the overall structure (see also Chapter 7), the third factor still refers to emotional reactions that imply a strong bodily activation or deactivation. It was surprising, however, that overall POWER and overall VALENCE would be related as much or even more strongly to bodily reactions, respectively. The substantial relationship of DISTRESS SYMPTOMS with the overall POWER factor (in which the bodily reaction features have been removed) throws a new and important light on the interpretation of the overall POWER factor. The POWER dimension has been interpreted, by many emotion researchers, as a social psychological submissiveness–dominance dimension (e.g., Russell & Mehrabian, 1977) or as an interpersonal engagement–disengagement dimension (e.g., Kitayama, Markus, & Kurokawa, 2000). While we find clear evidence that interpersonal features (such as feeling submissive and feeling dominant) do define the overall POWER factor, this factor is clearly not restricted to interpersonal features, but is as well defined by pure bodily experiences. The fact that overall VALENCE is also strongly related to bodily reactions, throws an interesting light on the debate in psychology about the origins of VALENCE and AROUSAL. Some authors consider VALENCE to be mental and AROUSAL to be psychophysiological, while others hold that VALENCE and AROUSAL have both mental and psychophysiological origins (e.g., Russell, 2003). For the three major dimensions in the emotion domain, we find evidence for the latter perspective. VALENCE, POWER, and AROUSAL are all related to both mental and to psychophysiological features.

Overall, the 24 emotional reactions are well differentiated by individual bodily reaction features. Using the three component factors for classification causes a decrease of accuracy, but still allows for a relatively good differentiation. These results support the classic idea that there is some degree of emotion specific patterning of bodily reaction features, at least as far as shared semantic meaning of emotion words is concerned. So far, empirical research on psychophysiological variables of emotional reactions has failed to demonstrate emotion specific physiological response patterning, except for anger (Levenson, 2003; Stemmler, 2003). However, most of the psychophysiological experiments have been conducted in laboratory settings as they require psychophysiological measurement equipment and experimental control of unwanted factors. These requirements make it unlikely that the psychophysiological patterns of strong emotional reactions can be studied in a laboratory setting. In consequence, it remains an open research question to determine to what extent bodily reaction specificity is a stereotype represented by semantic meaning structure, or whether semantic meaning represents at least a part of the underlying mechanisms and response patterns of emotional reactions.

Notes

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- 2 All supplementary materials (SM) are available at the GRID website: <http://www.affective-sciences.org/GRID>. See Appendix 1 (“Availability”) for further details.