



Components of Emotional Meaning: A sourcebook

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CHAPTER

5 The why, the what, and the how of the GRID instrument

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Abstract

This chapter explains how the construction of the GRID instrument has been guided by very different disciplinary perspectives and theoretical approaches, namely by the componential approach, the dimensional approach, and the basic emotion approach in emotion psychology, as well as by cultural comparative and linguistic perspectives. Insights from each of these disciplinary perspectives and theoretical approaches have guided the selection of the emotion words, the selection of the emotion features, the development of the instructions and the response scale of the GRID instrument. Moreover, analysis procedures are proposed that allow representing the data in ways that are relevant for each of the disciplinary perspectives and theoretical approaches that have guided the construction of the instrument.

Keywords: [Selection of emotion terms](#), [selection of emotion features](#), [response scale](#), [analysis procedures](#)

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In the present chapter, we present the operationalization of the GRID paradigm proposed in the first part of the book. The paradigm suggests defining the meaning of emotion words on the grounds of features pertaining to the various components of emotion investigated by several theories in the field. Consequently, the “GRID instrument” was designed as a simple grid table with rows representing the emotion words and columns representing pertinent emotion features. First, we summarize the issues raised and the hypotheses proposed in the first part of the book by the GRID paradigm in terms of different disciplinary perspectives: the psychological perspective (componential, dimensional, and basic-emotion approaches in the study of emotion), the cultural-comparative perspective, and the linguistic perspective. Then we present the development of the GRID instrument and how the various disciplinary perspectives and theoretical approaches have been taken into account. Third, we present the data-analytic procedures that have been used to investigate the research questions and hypotheses addressed in Part II and Part III, as well as in many of the chapters in the remaining parts of the book. A comprehensive overview of the issues and the hypotheses, as

well as how they have guided the construction of the GRID instrument and the selection of the analysis procedures can be found in Table 5.1.

Table 5.1 Embedding the operationalization of the GRID instrument and selection of data-analytic strategies into multidisciplinary perspectives on emotion

Disciplinary perspective	Issues/hypotheses	Operationalization via GRID instrument	Analysis strategy for GRID data
Psychological: Componential approach, GRID paradigm	All emotion components are involved in the meaning of emotion terms	Operationalization of all emotion components by specific theories	Comparing emotion components with respect to the standard deviations of their respective features across the 24 emotion terms
	Each emotion component is characterized by its own internal organization because each subsystem has its own function	Where possible, theories are operationalized that allow predicting the internal structure	PCA's per emotion component on component-specific features
	Each emotion component is systematically related to the other emotion components due to synchronization		Regression analyses per emotion component of rest factors (in which the respective emotion component was removed) on component-specific factors
Psychological: Dimensional approach	Three overall dimensions span the emotion domain		PCA on all features from all emotion components
	The three overall dimensions are stable		Per emotion component PCA's on all features except the features from the respective emotion component, and comparing the resulting rest factors with overall factors
	Impact of type of response scale on bipolarity	Implicit bipolar response scale	
	Distinction between emotion terms and feeling terms that represent the general quality of the emotional experience	Emotion terms are rated on features. Feeling terms that represent the general quality of the emotional experience are treated as features that operationalize the Feeling component	Check that the overall emotion structure is not dependent on the feeling features
Psychological: Basic emotion approach	Basic emotion terms have a more stable meaning across languages and cultures	Guarantee that basic emotion terms are included	Comparing emotion terms with respect to the stability of their feature profiles
	Emotion terms cluster into four basic emotion categories: a joy, an anger, a fear, and a sadness cluster		Hierarchical cluster analysis on average pattern similarities between emotion terms

	Profiles of features differentiate emotion terms		Discriminant analyses on overall and component-specific feature patterns
Cultural-comparative	Interpersonal emotion features	Adding interpersonal features in Appraisal and Action tendency components, and in regulation	
	Interpersonal emotion words	Adding interpersonal emotion words from cross-cultural free listing tasks	
	Overall and component-specific internal structures are stable across cultural and linguistic groups		PCA's on four language groups (Germanic, Latin, Slavic, and East-Asian) and Procrustes rotations of resulting structures toward overall structure
	Exploring differences in meaning of emotion words		Bootstrapping and ANOVA on emotion features
Linguistic	Studying decontextualized meaning of emotion words	Focus instructions on decontextualized meaning	
		Reliable identification of the meaning of words by lay persons	Reliability (Cronbach's alpha) of feature patterns per emotion word

5.1 Multidisciplinary perspectives

Psychological perspectives: The GRID paradigm

The GRID instrument is directly based on the GRID paradigm as proposed by Scherer in Chapter 1. The GRID paradigm entails applying the Component Process Model of emotions (CPM) to the feature profile view on the meaning of emotion terms (see Fontaine, Chapter 2). The feature profile view implies that the meaning of emotion terms is decomposed into a set of features that describe the emotion process. Which features describe the emotion process is determined by the CPM. According to the CPM, emotion is defined as *an episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism* (Scherer, 1984b, 2001, 2009c). Based on the CPM, the features that define the meaning of an emotion term should

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thus describe the state of each organismic subsystem (or emotion component) during the emotion (Scherer, 2005a).

Three related hypotheses about the features that define emotion words arise from the GRID paradigm. The first hypothesis is that the features from all five human subsystems are constitutive of the meaning of emotion terms. Thus, emotion terms are hypothesized to refer at the same time to Appraisals (cognitions), Bodily reactions, Expressions (facial and vocal), Action tendencies, and Feelings. The second hypothesis is that the features from each subsystem are characterized by their own internal organization, because each component is assumed to fulfill its own function. However, this does not mean that the features are unrelated across subsystems. On the contrary, because of the assumption of the CPM that the subsystems react in an organized, synchronized way during an emotion episode, the third hypothesis is that, within the emotion domain the features from the different subsystems are substantially related.

Psychological perspectives: The dimensional approach

The most important hypothesis from the dimensional approach to the study of emotion in psychology is that the emotion domain can be robustly represented by a three-dimensional structure, with valence, power, and arousal as the three main dimensions (e.g., Fontaine et al., 2002; Osgood, May, & Miron, 1975; Shaver et al. 1987; 1992).

Moreover, two other issues require attention. A first issue is the nature of the response scale that is used to judge emotion terms. As explained in Chapter 2, the response scale itself can have a substantial impact on whether or not bipolarity between positively and negatively valenced emotion terms will be observed (Russell & Carroll, 1999). For bipolarity to emerge a bipolar, rather than a unipolar response format, should be used. The bipolar and unipolar response formats differ with respect to the neutral point on the response scale. In a unipolar response scale one end is defined by the neutral point (which refers to the absence of the emotion) and the other end by the presence of the emotion (e.g., not happy to happy). In a bipolar response scale the neutral point is in the middle, while one end refers to the presence of the emotion and the other end to the presence of an opposite emotion (e.g., sad—neutral—happy, strong disagreement to strong agreement). If the underlying construct is bipolar, unipolar response scales lead to highly skewed distributions that reduce the possibility to observe negative correlations between opposite emotions.

A second issue is which terms belong to the domain of emotion words. A comparison between the dimensional, the basic emotion, and the componential approaches to the study of the meaning of emotion terms revealed that the dimensional approach considers a broader domain of words as relevant by including feeling terms that define the overall quality of the emotional experience, like *calm* (e.g., Russell, 1983) or *strong* in the PANAS (Watson, Clark, & Tellegen, 1988), instead of only those that can be more narrowly defined as “emotion” terms (see the design feature definition in Chapter 1).

Psychological perspectives: The basic emotion approach

According to the basic emotion approach in the study of affect, emotion terms refer to a few categorically different and evolutionary selected emotion programs (e.g., Ekman, 1999; Izard, 1977, 2007). Within this approach, a distinction can be made between basic emotion terms that have these basic emotions as their referent and non-basic emotion terms. In older theorizing in the basic emotion domain, these “non-basic” emotions would be variations of the basic ones in terms of intensity, in terms of context, or in terms of blending with other basic emotions (e.g., Fontaine et al., 2002; Plutchik, 2001). In more recent theorizing also other types of non-basic emotions are allowed for, for instance on the basis of emotion schemas (e.g., Izard, 2007). The first hypothesis stemming from this line of theorizing is that basic emotion terms will have a more stable meaning across cultural groups and languages, as they refer to universal, biologically rooted affect programs. Conversely, cultural and linguistic factors are assumed to have a substantial impact on the other emotion terms, as they refer to specific intensity differences, specific contexts, and specific forms of blending that get encoded in language (e.g., Shaver et al., 1992), or to emotion schemas that are developed in a specific cultural context.

A second hypothesis, based on existing similarity research with emotion terms, is that it is possible to identify four basic clusters of emotion terms, namely a joy, a sadness, a fear, and an anger cluster (e.g., Fontaine et al., 2002; Shaver et al., 1987; 1992). Joy, sadness, fear, and anger are also identified as basic emotions by all basic emotion theories.

Not only basic emotion theory predicts the existence of key emotion categories in language. The CPM framework (Scherer 1994, Chapter 1), also predicts the existence of key emotion categories reflecting “modal emotions”. The assumption is that typical, frequently occurring appraisal profiles exist that have adaptive functions in dealing with quintessential contingencies in life. The emotion processes these frequent appraisal profiles trigger are called modal emotions, and are likely to have been encoded in language. According to this framework, emotion words are expected to have a well-defined position in the emotion domain, as they mostly refer to (quasi-)universal contingencies of life. This implies that it should be possible to identify an emotion term on the basis of its feature profile.

Cultural-comparative perspectives

Two broad issues have been raised by cultural studies on the emotion words around the world. The first issue has to do with the features different cultural groups employ to represent emotions. According to some anthropological and cross-cultural perspectives, emotions are anything but natural kinds (e.g., Lutz, 1988). Emotion processes are seen as culturally construed. The organizing principles of the emotion domain are assumed to differ between cultural groups. Two cultural differences have received particular attention in the anthropological and cross-cultural domain. First, it has been suggested that some cultural and linguistic groups define the emotional experience primarily in somatic terms and others more in psychological terms (e.g., Mumford, 1993). Another, and probably even more important, difference concerns the interpersonal nature of emotions. In non-Western cultural groups emotions would be conceptualized as interpersonal processes, whereas in Western cultural groups the intrapersonal aspects of emotions would be much more salient. This cultural difference in the emotion domain has been linked to broad cultural dimensions of collectivism (versus individualism) and interdependent (versus independent) constructions of the self (e.g., Markus & Kitayama, 1991).

A second, frequently raised issue in cross-cultural research is the existence of language-specific emotion terms. Taking English as a point of reference, it has been demonstrated that English emotion terms exist that cannot be translated into other languages (e.g., *sadness* into Tahitian), that there are emotion terms that cannot

be translated into English (e.g., Portuguese *saudade*), and that there can be shifts in meaning even for translation equivalent words (e.g., Russell, 1991a).

An instrument that studies the meaning of emotion words from a multidisciplinary perspective should take into account that there can be cultural differences in the relative salience of the emotion features that define an emotion, and even that the emotion domain itself is possibly structured in a different way. Moreover, no translation equivalence can be a priori assumed, and it should be possible to investigate the meaning of language-specific emotion terms. In terms of the GRID paradigm this means that there can be cultural differences in the features that define emotions and how they are related to one another, as well as differences in the meaning of translation equivalent emotion terms.

Linguistic perspectives

As an instrument to study meaning, the GRID is essentially a psycholinguistic tool. Many of the issues and hypotheses formulated in the previous sections are linguistic in nature, since they deal with the meaning of emotion terms. Here we want to draw attention to two issues that are particularly relevant for the GRID from a linguistic methodological perspective. A first issue concerns the object of the questions asked. In psychological research, people are typically asked to report on their own (and sometimes on others') emotional experience. A shared understanding of the meaning of emotion words is taken for granted. Instead, in the GRID instrument people are asked to report on the meaning of emotion terms, and not on their own emotional experiences. A second very important issue is the utility of "lay" people to define the meaning of words. The GRID instrument works with a typical psychological methodology, namely a sample of persons from a cultural group is asked to answer survey questions. This is not a traditional methodology in linguistics, which typically relies on language use observations. The question that needs to be addressed is thus whether lay people can be used to reliably identify the decontextualized meaning of emotion words.

5.2 The development of the GRID instrument

The fundamental design of the GRID instrument is extremely simple: It is a simple grid table with rows representing the emotion words and columns representing the emotion features that are assumed to define these emotion words. The operationalization of this simple design into a usable instrument, however, is the result of a complex process in which the issues from the different theoretical approaches and the different disciplines have been taken into account. The operationalization of the GRID instrument is a further elaboration of the proposal by Scherer (2005a) to use the Component Process Model to study the semantic fields of affect words (see Chapter 1). We first present the selection of the emotion terms, then the operationalization of the emotion features, then the response scale participants used to rate the features with respect to each of the emotion terms, and we end by presenting how the research is framed for the participants in the instructions.

The selection of emotion words

The general aim of the selection process was to select a set of emotion terms that could be universally considered as relevant for and representative of the emotion domain. The selection of words took into account the issues raised by the dimensional, basic emotion, and componential approaches to the study of emotion in psychology, as well as the concerns voiced by cultural-comparative studies, as illustrated above. First, in keeping with the basic emotion approach it had to be assured that those emotion words that are consensually considered to refer to basic emotions were included in the set (e.g., *joy*, *sadness*, *fear*, and *anger*). Secondly, only words could be selected that are considered emotion words by all three theoretical approaches in psychology. For that reason, feeling words that only refer to the general quality of the emotional experience were not included. Finally, consistent with the cultural-comparative perspective, it had to be guaranteed that not only intrapersonal, but also interpersonal emotion terms were represented in a balanced way.

p. 89 In total, 24 emotion terms (nouns) were selected, which were representative and relevant for both emotion research and daily language use of emotion words, on the basis of three criteria. First, 12 emotion words were selected that are often used in emotion research, namely *anger*, *contempt*, *disgust*, *fear*, *guilt*, *interest*, *joy*, *pleasure*, *pride*, *sadness*, *shame*, and *surprise*. With this selection criterion it was guaranteed that the terms that are consensually considered as basic emotion terms were included in the research, as they attracted most research in the past decades. Second, eight terms were added that were reported with some frequency by at least 2% of the respondents in a large scale study carried out in Switzerland (Scherer, Wranik, Sangsue, Tran, & Scherer, 2004); the terms were *anxiety*, *compassion*, *contentment*, *despair*, *disappointment*, *happiness*, *irritation*, and *stress*. This criterion contributed to the representativeness of the set of emotion terms. Third, *being hurt*, *hate*, *jealousy*, and *love* were added, four typical interpersonal emotion terms that have been reported with some frequency in free-recall and prototypicality rating tasks across very different cultural groups (e.g., Fehr & Russell, 1984; Fontaine et al., 2002; Shaver et al., 1987; Shaver et al., 1992; Shaver et al., 1987, 1992; Van Goozen & Frijda, 1993). This criterion ensured that the set of terms was representative of the emotion domain across cultures. In total, eight of the 24 emotion terms were explicitly interpersonal in nature (namely, *contempt*, *guilt*, *shame*, *compassion*, *being hurt*, *hate*, *jealousy*, and *love*).

Moreover, to further contribute to the cultural relevance of the emotion terms, collaborators were offered the possibility to add emotion terms (in blocks of four) that they considered particularly relevant in their cultural group (or in which they were personally interested). The ratings obtained for these additional words are not included in the cross-cultural analyses reported in the present part of the book, but they are reported in the chapters that specifically focus on those languages and cultural groups.

Emotion concepts can be lexically encoded as nouns, adjectives or verbs across languages. In the GRID instrument only one form was used, namely the nouns. This is also the form that has been mostly used in psycholinguistic studies on categorization of emotion words across languages (e.g., Fehr & Russell 1984; Fontaine et al., 2002; Shaver et al., 1987, 1992).

For reasons of feasibility, participants were invited to rate the meaning of only four of the 24 emotion terms in a single session (see also Chapter 6). To assure that the heterogeneity of the emotion terms to be rated was more or less comparable between participants, the set of 24 emotion terms was divided into four a priori groups of terms: *contempt*, *disgust*, *anger*, *irritation*, *hate*, *jealousy* (group 1); *fear*, *anxiety*, *stress*, *despair*, *surprise*, *interest* (group 2); *joy*, *pleasure*, *pride*, *happiness*, *contentment*, *love* (group 3); and *disappointment*, *compassion*, *guilt*, *shame*, *sadness*, *being hurt* (group 4). Each participant received, at random, one term from each of these four groups.

The selection of emotion features

The Component Process Model (CPM) was operationalized into 142 emotion features. These features represent the five human subsystems (or emotion components) that constitute the emotion process according to the CPM: (1) *Appraisal* (cognitive evaluation on different levels of processing), (2) *Bodily reaction* (physiological changes or symptoms), (3) *Expression* (face, voice, gestures), (4) *Action tendency* (motivational changes), and (5) *Feeling* (subjective experience). Features referring to intensity, duration, and the possibility of lasting changes in the experiencer, as well as to the *regulation* of the expression and experience of the emotion were also included.

The relevance of the GRID instrument for the different disciplinary perspectives and theoretical approaches was guaranteed by the operationalization of the emotion components. Their operationalization was based on very different theories from the dimensional, the basic emotion, and the componential approaches to the study of emotion in psychology. The cultural-comparative perspective was also taken into account. By merely relying on the CPM some cultural issues were automatically addressed. For instance, the CPM includes somatic, as well as psychological features, allowing us to investigate whether there are cultural differences in the salience of the somatic component. Moreover, in the operationalization of the emotion components additional interpersonal features were formulated over and above the features suggested by each of the component-specific psychological theories, particularly in the Appraisal component (see Chapter 12), Action tendency component (see Chapter 11), and with the inclusion of regulation features (see Chapter 10).

In the selection of relevant features and their operationalization a number of constraints had to be taken into account. The most important one was the necessity to formulate the chosen features in such a way that the description would be comprehensible to laymen in the cultures to be studied. This excluded the use of *technical terms* as they abound in physiology, psychology, acoustics, and other sciences involved in the study of emotion.

We will now present the theoretical frameworks that were used to operationalize each emotion component. For more in-depth information about the theoretical background and the operationalization of each specific component, the reader is referred to the component-specific chapters of part III in the volume (see Chapter 8 for Feeling, Chapter 9 for Bodily reaction, Chapter 10 for Expression and regulation, Chapter 11 for Action tendency, and Chapter 12 for Appraisals). A complete version of the full GRID questionnaire is reproduced in Appendix 2 of this volume.

For the operationalization of the *Feeling component* we have relied on the dimensional approach to the meaning of emotion terms. Special care was taken to differentiate feeling terms that refer to the general quality of the emotional experience from emotion terms. It was already indicated that the dimensional approach typically treats both types of terms as belonging to the same category. Within the CPM, these terms are clearly differentiated: according to the CPM, emotion terms refer to the whole process of synchronization between emotion components, while feeling terms that represent the general quality of the emotional experience refer to a low-level mapping of these complex emotion processes into (sub)consciousness. The Feeling component was thus only operationalized by “feeling” terms that represent the general quality of the emotional experience, and not by emotion terms (which would lead to tautological results). Given the diversity of dimensional models in the literature, an attempt was made to present all important dimensional models in the operationalization of the Feeling component. Thus, six models were taken into account: the one-dimensional hedonistic model (e.g., Frijda, 1986), four two-dimensional affect models (namely, positive–negative affect (Watson & Tellegen, 1985), pleasure–arousal (Russell, 1980), pleasantness–activation (Larsen & Diener, 1992), and tense arousal–energetic arousal (Thayer, 1996)), and the three-dimensional evaluation–potency–activation model (Fontaine, Poortinga, Setiadi, & Markam, 2002; Osgood et al., 1975; Shaver, Schwartz, Kirson, & O’Connor, 1987). The Feeling component was operationalized by 20 feeling features representing the valence dimension (e.g., felt good), two arousal dimensions (e.g., felt nervous and felt energetic), and the power dimension (e.g., felt strong).

For the operationalization of the *Bodily reaction component* we looked at the psychophysiological emotion literature (e.g., Stemmler, 2003b). We especially based the operationalization of this component on earlier cross-cultural emotion research by Scherer, Wallbott, and Summerfield (1986). They made a distinction between three types of bodily reactions in an emotion process, namely reactions with ergotropic arousal elicited by the sympathetic system, reactions with trophotropic arousal elicited by the parasympathetic system, and more general reactions referring to sensations of warmth and coldness. The Bodily reaction component was operationalized in 18 features (e.g., had the feeling of a lump in his/her throat, felt his/her heartbeat getting faster, felt cold).

p. 91 For the operationalization of the *Expression component* the basic emotion literature was taken into account (e.g., Ekman, 1972, 1984). The operationalization of the features was based on the extensive cross-cultural study of Scherer, Wallbott, and Summerfield (1986). Facial expressions were operationalized in nine features (e.g., frowned, smiled). For vocal expressions, there were 12 features (e.g., changed the melody of his/her speech, spoke louder). The gestural component was operationalized by five features (e.g., made abrupt body movements, moved toward people or things).

The work of Frijda, on action tendencies, was used as the basis to operationalize the *Action tendency component* (Frijda, 1986, 1987; Frijda, Kuipers, & ter Schure, 1989; Frijda, Markam, Sato, & Wiers, 1995). The 16 action tendencies proposed by Frijda (approach, avoidance, being-with, attending, rejection, indifference, antagonism, interruption, dominance, submission, apathy, excitement, exuberance, passivity, inhibition, and helplessness) were operationalized in 40 action tendency features (e.g., wanted to do damage, hit, or say something that hurt; wanted to sing and dance). Of the 40 action tendency features, 12 included an explicit reference to interpersonal motivations (e.g., wanted someone to be there to provide help or support).

The appraisal theory proposed in the CPM (Scherer, 2001) (see Chapter 1 for a detailed description) formed the basis for the operationalization of the *Appraisal component*. Despite minor differences in terminology, there is a large degree of convergence between a core set of appraisal theorists, and thus the choice for the appraisal features of the CPM is representative for the core group of appraisal theories (see Ellsworth & Scherer, 2003; Scherer, 1999). Each appraisal check of the CPM was operationalized by at least one feature: 22 features (e.g., caused by the person's own behavior, consequences predictable) operationalized the CPM appraisal model. In addition to the features representing the appraisal checks, two more global situation descriptors were added in the form of core relational themes (Lazarus, 1991a) (irrevocable loss and being in danger). Finally, seven interpersonal Appraisal features were added to represent the interpersonal nature of emotions (e.g., had negative consequences for somebody else, was in the center of attention), in order to address the hypothesis from the cultural-comparative perspective that emotions are more interpersonally oriented in non-Western cultural groups.

As indicated above, some features were also selected concerning *regulation*. The selection was made on the basis of Ekman and Friesen's model (1969, 1975), which distinguishes neutralization, deamplification, amplification, masking, and qualification as possible regulatory strategies of emotion. Moreover, the effort to regulate both the internal experience of the emotion and the expression of the emotion were taken into account. The regulation of expression focused on the interpersonal aspect of emotion regulation. Regulation was operationalized by four features (tried to control the intensity of the emotional feeling; showed a stronger degree of emotion than he/she actually felt; showed the emotion to others more than s/he felt it; and hid the emotion from others by smiling).

To complete the picture, participants were asked to rate the *intensity* (the person was in an intense emotional state), the *duration* (the person experienced the emotional state for a long time), and the potential *lasting impact* of the emotional experience (the person will be changed in a lasting way due to the emotional experience).

Finally, two items were added to the set of 142 features about the *cultural prevalence* (how frequently is this state generally experienced in your society), and the *social acceptability* of the emotion (to what extent is it socially accepted to experience this emotional state in your society) in their own cultural group. As these two last features do not describe the emotion process itself, they were not included in most of the analyses reported in this book.

p. 92 The response scale

Because it has been empirically and statistically demonstrated that the response scale itself has a decisive impact on the observation of bipolarity in the emotion domain, special attention was devoted to its construction. The response scale has been designed as an implicit bipolar response scale (Russell & Carroll, 1999), because it offered the possibility of observing strong bipolarity in the emotion domain (unlike unipolar response scales), while not imposing bipolarity on the data (unlike explicit bipolar scales).

Participants were asked to rate each emotion word on how likely it was that each of the features would apply if a speaker of their language used the emotion word to describe an emotional experience. Participants were asked to evaluate this likelihood on a nine-point response scale ranging from: 1 “Extremely unlikely”, through 5 “Neither unlikely, nor likely”, to 9 “Extremely likely.”

The instructions

Special attention was paid in the instructions to clarify that the study was about the meaning of emotion terms, and not about what people experience themselves. It was made clear that they should rate how likely each feature was when a speaker of their language (thus somebody else) uses the emotion terms to describe an emotional experience. Participants were informed at the beginning of the study that questions would follow about each of the five emotion components, as well as about regulation (plus some extra questions). Each component was briefly described. Participants were first asked to rate the features of the Appraisal component, then the Bodily reaction component, followed by the Expression component, the Action tendency component, the Feeling component, and finally they were asked to evaluate the regulation features and the two general questions.

5.3 Data-analytic procedures for the GRID data

In this last section, we present the data-analytic procedures that have been applied to analyse the GRID data. Like the design of the GRID instrument, the data-analytic procedures have been selected in order to deal with the issues and to test the hypotheses raised by the very different disciplinary perspectives and theoretical approaches that have guided the construction of the GRID instrument. Because a key goal of the GRID is to be useful and understandable by emotion researchers from very different backgrounds a decision was made to select well-known and easy to grasp analytic procedures. We start by introducing the data that have been used for most of the analyses reported in this and the next part of the book, as well as in many other parts of the book. Then we present the analysis procedures that have been used to deal with the hypotheses and issues put forward by the dimensional, the basic emotion, and the componential approaches in the psychological study of emotion, as well as by the, cultural-comparative and linguistic perspectives. Because it is characteristic for the GRID instrument to jointly take these disciplinary perspectives and theoretical approaches into account, it is not always possible to neatly separate the data-analytic procedures according to disciplinary perspectives and theoretical approaches. Therefore cross-references are made regularly.

Format of the GRID data

For each emotion word in each sample the data consisted of a matrix of N rows, with N corresponding to the number of participants that evaluated the meaning of that emotion word, and 142 columns representing the 142 features rated. Two additional features, which referred to cultural prevalence and social acceptability, were not included in the analyses, as they did not describe the emotion process itself. As the focus of the GRID instrument is meaning, an average profile was computed for each emotion word across all the participants that at least moderately agreed on its feature profile. The ratings of a participant were taken into account for the computation of the mean profile if the correlation of the participant's profile with the average profile of the other participants was at least 0.20. Moreover, in order to control for differences in acquiescent response styles between participants within samples, but especially across samples and cultural groups, the data were centered per emotion term: across the 142 features an average score was computed for each emotion term and that average score was subtracted from all 142 feature scores of the respective term.

Three data-levels were distinguished for the analyses, namely the sample level, the language family level, and the overall level including all samples. At the sample level, the analyses were executed on the sample-specific two-way matrix consisting of 24 rows representing the 24 emotion terms and 142 columns representing the 142 features, with each cell containing the average centered likelihood score of an emotion feature for an emotion word.

Across the 34 samples analysed (cf., Chapter 6), four larger language families could be identified with at least four student samples, namely the Germanic language family consisting of English-, German-, and Dutch-speaking samples; the Latin language family consisting of French-, Spanish-, and Italian-speaking samples; the Slavic language family consisting of Russian-, Ukrainian-, Polish-, and Slovak-speaking samples; and the East-Asian language family consisting of Chinese- and Japanese-speaking samples. The intermediate level of language families was taken into account for reasons of stability. A sample-specific matrix consists of 3408 (24×142) cells, which are on average estimated on the basis of 120 to 150 participants. The sample-specific matrices can thus not only differ because of meaning differences in the emotion domain, but also because of random sampling fluctuation, as well as because of differences in motivation to collaborate and because of the composition of the specific samples (ranging from exclusively linguistics or psychology students, to students from all possible majors at university, as well as a few non-student samples). The language family level was considered a good trade-off between cultural and linguistic variability on the one hand and stability and replicability of the 3408 emotion by feature estimates on the other hand. Per language family, one average two-way matrix was computed with 24 rows representing the 24 translation equivalent terms, and 142 columns representing the 142 features, with the averaged centered score for an emotion term on an emotion feature, across the student samples in that language family, in each cell.

Third, there is the overall level of analysis in which all 34 samples are included. For these analyses a large matrix was constructed consisting of 816 rows representing the 24 emotion terms in the 34 samples and 142 columns representing the 142 features. Thus, in the overall analyses no assumption was made about translation equivalence of the 24 emotion terms, as each term in each sample was treated as a separate observation.

To summarize, most analyses were executed on three types of data sets, namely: on (one or more of) the 34 sample matrices (24 terms by 142 features); or on the 4 language family matrices (24 terms by 142 features); or on a single overall matrix consisting of 816 terms (24 by 34 samples) and 142 features.

Analysis procedures from a linguistic perspective

As already indicated, the GRID instrument is essentially a psycholinguistic instrument and all analyses have been designed to reveal information about the meaning of terms. There is, however, one very basic question, already raised above, which is particularly important from the linguistic perspective, namely whether lay people are capable of identifying the meaning of emotion terms. This amounts to the question of whether lay people agree on the meaning profile of an emotion term and can jointly generate a consensual meaning pattern. From an assessment perspective this question refers to the reliability of lay people's assessment of meaning. This was investigated in a simple way by computing the internal consistency (Cronbach's alpha) of the meaning profile of a term across all participants that evaluated the term in a specific sample. Moreover, the agreement of a participant with the other participants was computed as the correlation of the participant's profile with the average profile of the other participants. Only when the correlation was at least 0.20 was the participant included for the final computation of the mean profile of a term. Reliabilities of 0.80 and higher were considered as good. All reliabilities are reported in Chapter 6.

Analysis procedures from a CPM pattern profile approach

The most basic and most central hypothesis arising from the CPM is that all emotion components define the meaning of emotion terms. This implies that the involvement of the emotion components changes depending on the specific emotion a word refers to. Thus, the more an emotion component is involved in defining the meaning variation within the emotion domain, the more the scores on the features of that component will change across the 24 emotion terms. For each feature the standard deviation was computed across the 24 emotion words in each of the 34 samples. It was first investigated whether that standard deviation differed from zero for each component. Then a repeated measures ANOVA was executed with the emotion components as the between-subjects variable and the samples as the within-subjects variable in order to test whether or not each component differentiates the 24 emotion terms to the same extent. Moreover, using Tukey's pairwise comparisons, it was investigated on which emotion component the emotion terms were most differentiated. This analysis is reported in Chapter 7.

If all components are involved in defining the meaning of the 24 emotion terms, then the second hypothesis can be investigated, namely that each emotion component is characterized by its own internal structure. This hypothesis was investigated by looking at the internal structure of each emotion component in the overall data matrix. The internal structure was investigated by applying a Principal Component Analysis on all features of the respective component across all 816 observations. Principal Component Analyses were applied instead of Exploratory Factor Analyses in order to use the same internal structure analysis for all structural questions at all levels. Because in a single sample there are more features than terms for most emotion components, an exploratory factor analysis could not be executed on the sample-specific data. In the sample-specific data there are less observations than variables (which leads to a non-positive definite data matrix). A Principal Component Analysis, which is in essence a data reduction technique, does not require a positive definite data matrix and can thus be applied in an analysis with more variables than observations (e.g., Tabachnick & Fidell, 2007). Often Principal Component Analysis and Exploratory Factor Analysis converge, especially on the most important factors of a domain (which form the focus of the current study). Moreover, although 24 observations (namely the 24 emotion terms) look small for executing Principal Component Analyses, it can be well defended for the current data because the 24 terms have been selected in a highly systematic way to represent the variability ↴ in the emotion domain. Moreover, the feature scores for these 24 emotion terms are very reliable for most samples (see Chapter 6). For the overall analyses, there is no problem as there are 816 observations (24 terms in 34 samples), which implies that there are 5.7 times more observations than the total number of features (142).

The number of factors that has been retained was jointly decided on the basis of three, and where available four, criteria: (1) the scree plot of the eigenvalues (Cattell, 1966), (2) the replicability of the structure across the four language families (see section entitled “Analysis procedures from a cultural-comparative perspective,” for details of this criterion), (3) the interpretability of the resulting structure, and (4) where available, the a priori expectations about the structure.

When there was no a priori theory available about which feature had to load on which factor, the factor structure was VARIMAX rotated². However, when an a priori theory was available, the factor structure was orthogonally Procrustes rotated toward the a priori expected structure and it was investigated whether each feature had its highest loading on the predicted factor.

For some components, a first general factor or superfactor of valence emerged on which most features of that emotion component had either a substantial positive or negative loading, an observation that is not uncommon in psychology (e.g., “g” in intelligence, Sternberg & Grigorenko, 2002; or extraversion and neuroticism in personality, Strelau & Zawadzki, 1997). For two emotion components, namely the Appraisal and the Action tendency components, it was further explored whether the general factor concealed interesting residual variation. To that end, residual feature scores were computed in which the features that defined the general factor were partialled out. The remaining relationships among these residualized features were further explored.

The internal structures of the Feeling component, the Bodily reaction component, the Expression component, the Action tendency component, and the Appraisal component are reported in Chapters 8, 9, 10, 11, and 12, respectively.

The third hypothesis stemming from the CPM, namely that each component is substantially related to all other components because of the synchronization during the emotion process, was investigated by regressing each component-specific factor on the four overall factors in which the component itself had been removed (see section “Analysis procedures from the dimensional approach”). The regression analyses for the Feeling component, the Bodily reaction component, the Expression component, the Action tendency component, and the Appraisal component are reported in Chapters 8, 9, 10, 11, and 12, respectively.

Analysis procedures from the dimensional approach

The key hypothesis from the dimensional approach is that the meaning of emotion terms can be represented in a three-dimensional space, with *valence*, *power*, and *arousal* spanning this space. To investigate this hypothesis a Principal Component Analysis was executed on the 142 features across the 816 terms. As in the case of the PCA's on the individual emotion components, the number of factors was jointly decided on the basis of four criteria: (1) the scree plot of the eigenvalues (Cattell, 1966), (2) the replicability of the structure across the four language families (see section “Analysis procedures from a cultural-comparative perspective” for details of this criterion), (3) the interpretability of the resulting structure, and (4) the a priori expected ↴ three-dimensional structure. As there was no a priori theory available to accurately predict for all features which one had to load on which factor, the resulting structure was VARIMAX rotated. The results of this analysis are reported in Chapter 7.

An important research question is whether and to which extent the overall structure is sensitive to removing the indicators of specific emotion components. If an emotion process consists of a synchronization between five human subsystems, then it can be expected that information about four of these subsystems would already convey most of the information about the overall structure. This was investigated by applying five times a Principal Component Analysis on all features except the features of the Appraisals, Bodily reaction, Expression, Action tendency, and Feeling component, respectively. These five reduced structures were then orthogonally Procrustes rotated toward the full overall structure. The stability of the reduced structures was investigated by

means of both the congruence between the factor loadings and the correlations of factor scores in the reduced and the full structures. The results of these analyses are reported in Chapter 7.

Analysis procedures from a basic emotion perspective

A hypothesis stemming from basic emotion theory is that the meaning of basic emotion terms will be more stable than the meaning of non-basic emotion terms. The stability of the meaning of a term was investigated by correlating the meaning profile of a term in each of the 34 samples with the average meaning profile for that term (thus generating 34 correlations). Subsequently, it was investigated which emotion terms differed in stability on the basis of paired-sample t-tests. This analysis is reported in Chapter 7.

The second hypothesis stemming from basic emotion theory is the existence of four basic clusters of emotion, namely a joy, an anger, a sadness, and a fear cluster. This was investigated by first computing an average dissimilarity matrix between the 24 emotion terms on the basis of their emotion profiles (average Euclidian distances were computed on the basis of the standardized features). An average linkage hierarchical cluster analysis was executed on this dissimilarity matrix. This analysis is reported in Chapter 7.

Based on the categorical meaning perspective in general, emotion words are not just considered arbitrary points in an emotion space, but categories that take a well-defined position in the emotion domain. This implies that it should be possible to identify an emotion term on the basis of its feature profile. This was investigated through discriminant analyses where the classification accuracy was investigated for the 24 emotion terms across the 34 samples. With 24 terms, complete random classification would lead to a classification accuracy of only 4.2%. Four types of discriminant analyses were executed: (1) on the basis of all 142 features; (2) on the basis of the factor scores on the overall factors that represent the major sources of variability across the 142 features; (3) on the basis of the features of each component separately; and (4) on the basis of the factor scores on the factors that represent the major sources of variability in each emotion component separately. We only report the cross-validated classification accuracy. In cross-validation each emotion term from each sample is classified on the basis of discriminant functions that are derived from all other emotion terms in all samples (thus in which the respective emotion term is not included).

Analysis procedures from a cultural-comparative perspective

A first question from a cultural-comparative perspective is whether the internal structure of a language family or of an individual sample is comparable with the overall structure across all samples and emotion terms. This is investigated by Principal Component Analysis on each language family or on a sample-specific data matrix with the same number of factors as in the overall structure. The specific structure is then orthogonally Procrustes rotated toward the overall structure and the congruence between the factors is investigated (e.g., Fischer & Fontaine, 2011). To interpret the congruence, the following rules of thumb are used: A Tucker's phi of at least 0.85 is considered acceptable, one of at least 0.90 is good, and at least 0.95 is excellent. Next to the congruence measures, it is also investigated whether each feature has its highest loading on the predicted factor after Procrustes rotation.

Finally, there is the issue of comparing profiles of terms between different samples and between different languages. Often no a priori hypotheses exist about the differences in meaning of translation equivalent terms (and of pairs of terms more generally), and the feature profiles of two terms are just exploratively compared in order to generate hypotheses about possible meaning differences. In order to take sampling fluctuations into account when identifying potentially relevant features, we have worked with 99% confidence intervals computed on the basis of a simple bootstrap procedure with replacement (e.g., Davison & Hinkley, 1997; Efron & Tibshirani, 1993; Manly, 1997). Furthermore, a visual approach was used to identify those features that differed between two terms. This approach is referred to as the "Visual Hypothesis Testing with Confidence Intervals"

in the remainder of this book. When the confidence intervals are non-overlapping, it has been demonstrated that means can be considered significantly different (e.g., Cumming, 2008; Cumming & Finch, 2005; Schenker & Gentleman, 2001). When the mean of at least one of the terms is within the other's confidence interval, it has also been demonstrated that the means do not differ significantly (e.g., Cumming, 2008; Cumming & Finch, 2005; Schenker & Gentleman, 2001). There is, however, debate about the situation when the confidence intervals are overlapping, but the means themselves are situated outside the other mean's confidence interval. According to some, this condition is sufficient to consider the means as statistically different (Smith, 1997). However, it has been shown that the size of the overlap between the confidence intervals has to be taken into account. The rule of thumb that has been proposed is that the proportion of overlap of the margins of error (one half of the confidence interval) has to be smaller than 0.50 for the difference to be significant (Cumming, 2008; Cumming & Finch, 2005; Schenker & Gentleman, 2001). As we often deal with non-normal distributions and compare the means of emotion terms that have been judged by a different number of participants (non-balanced design), it is not clear to what extent the proposed rule of thumb applies to the current data. Therefore, we decided to use the visual testing approach in a conservative way. The difference between means is considered significant only if the confidence intervals were non-overlapping. In cases where the confidence intervals were overlapping, but the means were outside the other term's confidence interval, the difference is only considered interesting for further exploration. For instance, it could be investigated whether features with a comparable content all differed in the same direction, which would then substantiate an interpretation of a real difference in meaning. When the mean of one of the terms was within the confidence interval of the other term, the difference was not further considered.

5.4 Conclusion

The GRID instrument is based on a straightforward idea: it is possible to describe the meaning of words as a grid table where the rows contain emotion words and the columns emotion features, and where the cells contain a score indicating the likelihood of each feature to describe the meaning of each word. While the basic idea is simple, its operationalization and the selection of data-analytic procedures is more complex and has taken into account very different perspectives from the major disciplines working on or with emotion words. The goal was to study the hypotheses and issues raised by each discipline using a unifying theoretical framework and a common empirical tool.

Notes

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- 2 To improve interpretation and meaningfulness of the factors and factor scores, bipolar factors have been systematically oriented according to their common interpretation in the literature. For instance, the valence factor has been systematically scored in such a way that the positive pole referred to positive valence and the negative pole to negative valence.