

Cognitive Processes Involved in Similarity Judgments of Emotions

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This article challenges the prevailing, semantic view of the cognitive processes underlying similarity judgments of emotions, which assumes that these judgments are based on a property comparison process. An alternative view is proposed, according to which judgments of emotion similarity reflect impressions of the degree of co-occurrence of emotions in everyday life. This *episodic model* of similarity judgments was compared in 2 studies with the main existing elaborations of the semantic view, the *dimensional model* and the *feature model*. Results were best in line with the episodic model. Study 1 revealed asymmetries in directional similarity judgments that were systematically related to episodic information (i.e., the frequency of emotions) but unrelated to semantic information (i.e., number of features of the emotion concepts). Study 2 replicated the central findings of Study 1 and showed that they held good at the level of individual participants. Findings add to other recent evidence supporting the episodic model of similarity judgments of emotions.

Ever since Wundt (1896) proposed his three-dimensional theory of emotions, structural analyses of emotions and models—that is, analyses aimed at elucidating the constitution of affects, and their interrelation—have fascinated psychologists (see, e.g., Larsen & Diener, 1992; Reisenzein, 1992, 1994; Russell, 1989; Shaver, Schwartz, Kirson, & O'Connor, 1987; C.A. Smith & Ellsworth, 1985). Two major empirical approaches to the problem have evolved over the years: (a) *covariance structure analysis*, that is, the analysis of the pattern of intercorrelations among self-ratings of affective states, typically by means of exploratory factor analysis (see, e.g., Larsen & Diener, 1992; Lorr, 1989; Watson & Tellegen, 1985); and (b) *similarity structure analysis*, that is, the analysis of the global similarities perceived to exist among emotions by lay people, typically by means of multidimensional scaling or hierarchical cluster analyses (see, e.g., Fillenbaum & Rapoport, 1971; Russell, 1980; Schmidt-Atzert &

Ströhm, 1983; Shaver et al., 1987; Storm & Storm, 1987). In this article, we are concerned with the second research approach. We focus on similarity judgments of *emotion words* (e.g., joy, euphoria, contentment), the stimuli most commonly used in these studies.¹

The seminal research in this area are studies by G. Ekman (1954, 1955) concerning the scaling of the mean judged similarities between Swedish emotion concepts (see also Fillenbaum & Rapoport, 1971). In the 40 years that have since passed, numerous other studies of this kind have been published, involving emotion terms from diverse languages (e.g., Boucher, 1980; Bush, 1973; Fillenbaum & Rapoport, 1971; Lutz, 1982; Russell, 1980; Russell, Lewicka, & Niit, 1989; Schmidt-Atzert & Ströhm, 1983; Shaver et al., 1987; Shaver, Wu, & Schwartz, 1992; Storm & Storm, 1987; Yoshida, Kinase, Kurokawa, & Yashiro, 1970).

Although different investigators have drawn different conclusions from these scaling analyses, nearly all have agreed on one basic assumption, namely that similarity judgments of emotions reflect *semantic knowledge*. More precisely, it has been assumed that similarity judgments of emotions are based on a comparison of emotions in terms of their defining or at least characteristic properties. Indeed, this assumption can be regarded as the funda-

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¹ What students of the similarity of emotion words are interested in is, of course, the similarity in the meaning of these words, that is, the similarity of the corresponding emotion concepts. Because these concepts represent the (quality) types of emotions distinguished by lay people, it makes little difference in the present context whether one speaks about similarity judgments of *emotion words* or *emotion concepts* or similarity judgments of *emotions* (as conceptualized by people). We use whatever formulation sounds most natural in a given context.

mental presupposition of the similarity scaling approach: The major reason why scaling analyses of emotion similarity judgments are conducted is because they are thought to yield information on the structure of lay people's emotion concepts. To some researchers, this conceptual structure is the central object of investigation, whereas others regard it as interesting mainly because they take it to approximately mirror the actual structure of emotions (see Russell, 1991, for further discussion). For those who accept this latter rationale, the analysis of emotion similarity judgments provides a straightforward, economic method for elucidating not only the salient properties and interrelations of emotions as they are conceptualized by people but also of emotions as they are in nature.

In this article, we challenge this traditional presupposition of similarity structure analyses of emotions—the prevailing, *semantic view* of similarity judgments—and propose an alternative. This alternative view holds that, first appearances notwithstanding, emotion similarity judgments are not based on a property comparison process but reflect intuitive impressions of emotion co-occurrence that are constructed from an episodic knowledge base (see also Conway, 1990; Conway & Bekerian, 1987). In support of this nonsemantic or *episodic model* of similarity judgments, we report two studies in which we compared the model with the two major existing elaborations of the semantic view, the *dimensional model* (e.g., Russell, 1980) and the *feature model* (e.g., Shaver et al., 1987).² In the following paragraphs, we describe the three models and give an overview of our studies.

Three Models of Similarity Judgments of Emotions

Each of the three similarity judgment models comprises representational as well as processing assumptions (cf. Palmer, 1978; E. E. Smith & Medin, 1981); that is, assumptions concerning (a) the representational format and content of the knowledge, be it linguistic or factual, on which similarity judgments of emotions are based and (b) the cognitive processes that operate on this knowledge to arrive at global similarity judgments of emotions.

The Semantic View of Similarity Judgments of Emotions

Dimensional model. Investigators of similarity judgments of emotions have frequently assumed that an obtained scaling solution straightforwardly reflects the format and content of people's mental representation of emotions and possibly, beyond that, the structure of emotions themselves. This is true for both major elaborations of the semantic view. For example, according to Russell (1980, 1989), the two-dimensional solution typically obtained in his scaling studies—the pleasure–arousal circumplex—can be regarded as both a model of the mental representation of the structure of emotions and as a model of that structure itself.

As concerns the former, which is of primary concern here, the theory holds that emotion concepts such as joy, euphoria, or disappointment are cognitively represented in a way that is isomorphic to a representation of the concepts as points (i.e., vectors) in a two-dimensional metric space. The coordinates of

this space represent degrees of pleasure–displeasure and degrees of arousal (presumably those associated with typical intensities of the emotions; see Reisenzein, 1994), and the distance between points reflects the (dis)similarity between the corresponding concepts. It follows that to judge the similarity between two emotion concepts, people must determine the distance between the concepts' locations in pleasure–arousal space. That is, when asked to judge the similarity of, for example, joy and euphoria, people presumably retrieve from memory the degrees of pleasure and of arousal experienced at typical intensities of these emotions and then compute the distance between joy and euphoria on these two dimensions.

How the implied distance-computing algorithm is implemented has not been spelled out by the dimensional theorists. However, one might conceive of several possibilities, such as a numerical computation process, a quasi-numerical, analog (e.g., imaginal) comparison, or a spreading activation mechanism (see, e.g., E. E. Smith & Medin, 1981).

Apart from pleasure–arousal theorists, this type of model of the similarity judgment process has also been suggested by other authors, including some who have been critical of pleasure–arousal theory as a theory of emotions (C. A. Smith & Ellsworth, 1985). Empirical support for the model stems primarily from multidimensional scaling studies of similarity judgments of emotions and from attempts to validate the obtained solutions through unidimensional scaling (Russell, 1978, 1980). However, obtaining interpretable dimensions in multidimensional scalings of similarities does not guarantee that these dimensions were used to make the similarity judgments. In fact, the pleasure–arousal structure has also been retrieved in multidimensional scaling of similarities derived from the overlap of associations to emotion words (Marx, 1982).

Feature model. The second major elaboration of the semantic view assumes that similarity judgments of emotions are based on the comparison or matching of features, that is, nondimensional properties (for more detail on the differences between dimensional and feature models, see E. E. Smith & Medin, 1981; Tversky, 1977). A feature model of the representation of emotion concepts was first proposed by Fehr and Russell (1984), who applied prototype theory (e.g., Rosch & Mervis, 1975) to the domain of emotion concepts. Subsequently, Shaver et al. (1987) suggested that a prototype model may also account for similarity judgments of emotions (see also Frijda, 1987; Ortony, Clore, & Collins, 1988). According to proponents of the feature model, the features of emotion concepts denote typical antecedents (events and event appraisals) and constituent responses (action tendencies and actions, expressive behaviors, and physiological changes) of emotion syndromes, and possibly also typical self-control attempts (e.g., Shaver et al., 1987).

In addition, several feature models assume that emotion concepts are organized in a hierarchy (e.g., Johnson-Laird & Oatley, 1989; Shaver et al., 1987). However, this latter assumption is clearly not an indispensable ingredient of the feature model (e.g., Frijda, 1987; Ortony et al., 1988). Therefore, to stay as

² Hybrid models that combine features and dimensions are logically conceivable but have not, to our knowledge, been explicitly proposed in the emotion literature.

general as possible, we take no position on this issue here, although we come back to hierarchical feature models in the General Discussion.

Shaver et al. (1987) did not describe in detail the feature comparison process assumed to underlie similarity judgments of emotions. However, this part of the feature model can be easily explicated by drawing on the work of Tversky (1977), who proposed two general feature comparison models of similarity judgments: the *contrast model* and the *ratio model*. Both these models assume that the similarity of two concepts is a function of the number of the common and distinctive (i.e., those unique to one of the two concepts) features of the concepts. Specifically, the similarity of two concepts increases with the number of their common features and decreases with the number of their distinctive features. Analogous to the dimensional model, one can think of several ways of how the proposed feature comparison process might be implemented; for example, as a numerical computation process (feature counting) or as a spreading activation mechanism (cf. E. E. Smith & Medin, 1981).

Proponents of the feature model see a main source of empirical support for the model in the results of hierarchical cluster analyses of emotion similarities (e.g., Shaver et al., 1987; see also Johnson-Laird & Oatley, 1992; Storm & Storm, 1987) and in the results of content analyses of participants' reports of emotion episodes (Shaver et al., 1987). However, the most direct support available to date stems from research by Frijda (1987), who found that global emotion similarities could be rather well predicted statistically from information about two important classes of emotion features, namely the typical appraisals and action tendencies that people believe to be associated with the emotions. However, this evidence is again inconclusive, for reasons parallel to those spelled out for the dimensional model. For example, Schimmack and Reisenzein (1996) also obtained a typical categorical structure (separate sadness, anger, and joy clusters) in a hierarchical cluster analysis of similarities computed from ratings of emotions on the pleasure-displeasure and arousal dimensions.

A Nonsemantic View of Emotion Similarity Judgments: The Episodic Model

The episodic model of similarity judgments of emotion concepts, as we call it, was to our knowledge first suggested as a possibility by Conway and Bekerian (1987), although it constituted only a side issue in their article (see also Reisenzein, 1995). The basic assumption of the model is simply that similarity judgments of (nonsynonymous) emotion concepts reflect people's implicit beliefs of the degree of covariation of the emotions denoted by the concepts: Emotions that, according to the participant's experience, tend to co-occur (and possibly also emotions that tend to closely follow each other in time) are judged as similar, whereas those that co-occur infrequently or even exclude each other are judged as dissimilar. However, to deserve being called a similarity judgment model, this basic idea needs elaboration. In providing this elaboration in the following paragraphs, we hope to clear away a number of possible a priori objections that might prevent readers from considering

the episodic model a serious alternative to the semantic models described earlier.

To begin with, we propose that the covariation relations in question are not prestored in memory (e.g., as the result of previous abstractions or computations; cf. E. E. Smith & Medin, 1981) but are computed from episodic or exemplar knowledge—concerning one's own, other people's, or fictional characters' emotions—whenever the need arises; specifically, of course, when judgments of the covariation or similarity of emotions are asked for.³ This assumption is not meant to imply that we take people's emotion knowledge to be exclusively of an episodic nature. On the contrary, we readily grant that this knowledge may comprise abstract (generalized) representations, such as definitions of emotion concepts or emotion prototypes (cf. Conway & Bekerian, 1987; Shaver et al., 1987). Hence, it is not the assumed nonexistence of such abstract emotion representations that distinguishes the episodic model proposed here from the semantic models reviewed earlier, but the assumption that similarity judgments are not based on these abstract representations.

Second, we assume that the judgment process does not require the actual retrieval of emotion episodes from long-term memory into consciousness. Rather we propose that covariation (and similarity) judgments of emotions are based on intuitive impressions or feelings of emotion proximity; feelings that are produced from an episodic knowledge base by a mechanism analogous to the trace-echo mechanism suggested by Hintzman (1988) to underlie frequency judgments (see also E. R. Smith, 1991; E. R. Smith & Zárate, 1992) or that suggested by Metcalfe (1993) to underlie novelty-familiarity judgments. An extension of Hintzman's model to co-occurrence judgments has, in fact, been suggested by Greene (1990).

Third, to deflect a possible *prima facie* objection by the semantic theorists, the episodic model does not imply that the participants in studies of similarity judgment of emotions fail to comprehend their task (i.e., fail to understand that, by asking them to make similarity judgments, the investigator intends them to compare emotions in terms of their properties). Given that the cognitive processes involved in similarity judgments of emotions are largely inaccessible to introspection, these processes may well differ from what the participants (and the investigators) believe them to be: The participants may sincerely believe that they are intuitively comparing emotion concepts in terms of their properties, while in truth the feeling of proximity on which they base their ratings is constructed from an episodic base and reflects emotion co-occurrence (for more on this issue, see Study 2).

Finally, to prevent yet another possible misunderstanding, we

³ Note, however, that even if the covariation relations were assumed to exist prestored, the episodic model—although it may then no longer fully deserve this name—would still differ in decisive ways from the semantic models. For although covariation relations among emotions could be counted among the properties of emotion (in a wide sense of the term), they have not been considered as belonging to the salient properties of emotions by feature or dimensional theorists, let alone as being the primary or even the only ones on which similarity judgments of emotions are based.

emphasize that the episodic model does not exclude the possibility that the semantics of emotion concepts may have an indirect influence on similarity judgments, namely by determining, in part, the kind and number of emotion episodes activated in memory. In particular, if emotion episodes are accessed by means of emotion concepts, then—keeping other factors constant—presumably broad emotion concepts such as joy (cf. Hampson, John, & Goldberg, 1986; Storm, Storm, & Ratchford, 1987/1988) can be expected to activate more emotion episodes than presumably narrower concepts such as jealousy. More generally speaking, calling the episodic model nonsemantic is not meant to deny to semantics any role whatsoever in emotion similarity judgments. It is only meant to emphasize that this model rejects the fundamental assumption of the semantic models, namely that similarity judgments are based on a (dimensional or featural) property comparison process.

Objectives of the Present Studies

The aim of the two studies reported below was to compare the episodic with the two semantic models of emotion similarity judgments. As already hinted, the existing research on emotion similarity judgments consists nearly exclusively of scaling studies that, in our view, presuppose rather than test particular models of the cognitive processes involved. In contrast, the present studies tested differential predictions of the three models concerning asymmetries in directional similarity judgments (Tversky, 1977; Tversky & Gati, 1978).

Whereas in the typical, nondirectional similarity judgment task, participants are asked to indicate, for example, how similar the emotions joy and euphoria are to each other, in the directional judgment task used in the present studies, the participants were asked to state how similar joy is to euphoria and how similar euphoria is to joy. Our main interest concerned asymmetries in these directional similarity judgments—as would be present, for example, if euphoria were judged as more similar to joy than joy to euphoria. As explained in the following paragraphs, the analysis of such asymmetries provides for a powerful test of the three models.

Semantic Models

Dimensional model. A straightforward deduction from the dimensional model is that directional similarity judgments of emotions are symmetric (cf. Tversky, 1977). For according to this model, the (dis)similarity of emotions corresponds to their metric (e.g., Euclidean or city-block) distances, which are the same regardless of the endpoint from which they are measured. The existence of systematic asymmetries in directional similarity judgments would therefore indicate that the dimensional model is not true to the facts (cf. Tversky, 1977; Tversky & Gati, 1978).

Feature model. The feature model allows for the existence of asymmetries in directional similarity judgments. Specifically, Tversky (1977) suggested that directional similarity judgments are asymmetric when the two compared concepts have different numbers of features. This prediction is based on (a) the feature model together with (b) the so-called focusing hypothesis. This

hypothesis holds that when people are presented with a directional similarity question such as “How similar is North Korea to the People’s Republic of China?”, they will focus their attention on the *subject* (i.e., the first concept of the comparison, here North Korea) rather than on the *referent* (i.e., the second concept, here China) and that, as a result of this focusing, the features of the subject are given more weight in the similarity judgments. This implies, specifically, that the *distinctive* features of a concept (i.e., the features not shared by the other concept) decrease similarity more strongly if the concept serves as the subject than if it serves as the referent of the comparison. As a consequence, the similarity of concept A to concept B is judged lower than that of B to A whenever A has more distinctive features than B, and this is the case exactly if A has more features overall. In short, it is predicted that whenever the two compared concepts differ in feature richness, the richer concept is judged as less similar to the poorer concept than vice versa (rich-to-poor < poor-to-rich).

Empirical support for this hypothesis was obtained in a study by Tversky and Gati (1978) concerning similarity judgments of countries. In this study, for example, higher average similarity ratings were obtained in response to the question “How similar is North Korea to China?” than in response to “How similar is China to North Korea?” (presumably, China is the richer concept). Additional support, concerning social concepts, stems from studies of directional similarity judgments between the self-concept and other-person concepts (e.g., Holyoak & Gordon, 1983; Karylowski & Skarzynska, 1992; Srull & Gaelick, 1983). To illustrate the feature model’s prediction for emotion concepts, consider jealousy and disappointment. According to our data, jealousy had more features than disappointment (more detail is given later); therefore, according to the feature model, the judged similarity of jealousy to disappointment should be less than the similarity of disappointment to jealousy.

Episodic Model

For the episodic model, we also predicted asymmetries in directional similarity judgments. The basis of this prediction is an argument that runs closely parallel to that given for the feature model, except for the decisive difference that similarity judgments are assumed to be based on the (conditional) frequencies of emotion episodes rather than on the common and distinctive features of emotion concepts. More precisely, the judged similarity of two emotions is assumed to increase with the number of memory episodes in which they co-occur (common episodes) and to decrease with the number of episodes in which each emotion occurs alone (distinctive episodes). In this respect, then, our model is an episodic analogue to Tversky’s (1977) feature theory of similarity.

Following Tversky (1977), we next assumed that participants making directional similarity judgments would focus their attention on the first emotion of the comparison and weight the corresponding episodes more heavily. This implies, specifically, that the distinctive episodes of an emotion decrease similarity more if the emotion serves as the subject of the comparison. As a consequence, the similarity of emotion A to emotion B should be judged less than the similarity of B to A if there are more

distinctive episodes of A stored in memory, which is the case exactly if there are more stored episodes of A overall.

In short, we predicted that whenever the two compared emotions differ in frequency of experience, as represented in memory, the more frequent emotion will be judged as less similar to the less frequent emotion than vice versa (frequent-to-infrequent < infrequent-to-frequent). To illustrate, according to our data (see below), disappointment is a more frequent emotion than jealousy; therefore, the similarity of disappointment to jealousy should be rated lower than the similarity of jealousy to disappointment. Note that this prediction is exactly opposite that of the feature model for the same emotion pair.

Furthermore, because according to Bayes's theorem, $p(A) > p(B)$ exactly if $p(A|B) > p(B|A)$ (see, e.g., Wiggins, 1973), the episodic model predicts, equivalently, that the similarity of A to B should be rated less than the similarity of B to A whenever $p(A|B) > p(B|A)$. That is, asymmetries in directional similarity judgments should parallel asymmetries in the conditional frequencies of stored emotion episodes. To illustrate, the probability of feeling disappointed if one feels jealous should be higher than the probability of feeling jealous if one feels disappointed. If one assumes, as we do, that these conditional frequencies are reflected with reasonable accuracy in conditional probability judgments, this provides for an alternative test of the episodic model: The similarity of A to B should be rated less than the converse similarity whenever the probability of B, given A, is judged less than the probability of A, given B. That is, asymmetries in directional similarity judgments should parallel those in conditional probability judgments.

In fact, from the viewpoint of the episodic model, directional similarity judgments differ from conditional probability judgments only in the weight associated with the distinctive episodes of the referent: When responding to directional similarity questions ("How similar is A to B?"), the distinctive episodes of the referent emotion B are less heavily weighted; whereas when responding to conditional probability questions ("If one feels A, how likely is it that one feels B?"), the distinctive episodes of emotion B are entirely ignored (weight = 0). Hence, the episodic model also predicts that asymmetries in conditional probability judgments should be more extreme than the parallel asymmetries in the similarity judgments.

In sum, the dimensional model predicts an absence of systematic asymmetries in directional similarity judgments of emotions, whereas the feature and the episodic models predict their existence but attribute them to different causes, namely to differences in the feature richness versus the frequency of experiences of the compared emotions, respectively. The absence of asymmetries would therefore speak in favor of the dimensional model; whereas if asymmetries are present, the crucial question becomes whether they can be predicted better from differences in feature richness (feature model) or from differences in the perceived frequency of the compared emotions (episodic model). To decide these issues, one should ideally study a set of emotions that (a) differ sufficiently in both feature richness and frequency of occurrence and (b) for which these two predictor variables are uncorrelated. The set of emotions used in Study 1 met these requirements reasonably well: It contained emotions that differed clearly in both feature richness and fre-

quency of experience (more detail is given later), and the correlation between these two variables was only .40.

Time Measurements

In addition to the directional similarity judgments, we also measured the time needed to make these judgments. This was done for two reasons: First, we thought that the judgment times would speak to the question of whether or not participants retrieve emotion episodes during the similarity judgment task. Second, because Karylowski (1990) found asymmetries in judgment times of directional similarity judgments involving the self-concept, we wanted to explore whether such asymmetries also exist for emotion concepts.

Study 1

Method

Participants

The participants of the main experiment were 47 undergraduate psychology students and 17 students from other disciplines at the Free University Berlin. The psychology students were given course credit for participation, whereas the other participants received about \$6. Two additional groups of 28 and 30 introductory psychology or educational students provided, respectively, judgments of emotion frequency and free associations to emotion words.

Procedure and Materials

The stimulus material consisted of 12 emotion words, of which 4 each belonged to three distinct clusters of emotion (e.g., Shaver et al., 1987): (a) Joy (German: *Freude*), contentment (*Zufriedenheit*), thankfulness (*Dankbarkeit*), and euphoria (*Euphorie*); (b) sadness (*Traurigkeit*), depression (*Deprimiertheit*), hopelessness (*Hoffnungslosigkeit*), and disappointment (*Enttäuschung*); and (c) anger (*Ärger*), jealousy (*Eifersucht*), hate (*Haß*), and contempt (*Verachtung*).

The experiment was conducted on personal computers. First, the instructions explaining the directional similarity judgment task were displayed on the monitor, and the participants were familiarized with the 12 emotion words. Then, the similarity judgments were begun. A computer program controlled the sequence and order of the emotion pairs and recorded the responses and judgment times. All pairs of emotion words were presented in both directions (e.g., "How similar is joy to euphoria?" and "How similar is euphoria to joy?") to all participants; hence, each participant made a total of 132 directional similarity judgments. The presentation of the emotion pairs was divided into two blocks of trials, each of which comprised one half (66) of the similarity judgments. Within each block, each item pair (e.g., joy-contentment) appeared only once. After the first block, the participants were informed that the emotion pairs would now be presented again in reverse direction, and the second block was started. Half of the participants were first presented with Block 1 and then with Block 2, whereas for the remaining participants, the order was reversed. Each block was divided into 12 trials comprising 5 to 6 similarity judgments. Within each trial, 1 of the 12 emotion words (e.g., joy) was consistently presented as the subject of the comparison and was directionally compared with five or six referent words (e.g., thankfulness, anger, sadness, jealousy, and euphoria). In contrast, in the comparisons to the remaining five or six emotion words, the target word (e.g., joy) appeared always as the referent. This procedure guaranteed that, within each block, each emotion word appeared about the same number of times as the subject and the referent

in a comparison. The order of trials within each block, as well as the order of the five or six referents within trials, was randomly determined by the computer, separately for each participant. At the beginning of each trial, the participants were informed about the emotion word that served as the subject of the comparison for the duration of the trial and were asked to think briefly about this emotion, because there is evidence that thinking about the subject of the comparison can lead to more pronounced asymmetry effects (Karylowski & Skarzynska, 1992). Subsequently, participants pressed a key to start the similarity judgments belonging to this trial.

Throughout a trial, the upper part of the screen displayed the sentence "Emotion X is similar to _____", where X was one of the 12 emotion terms, displayed in bigger letters to increase its salience. At the bottom of the screen a 9-point rating scale that ranged from 1 (*very dissimilar*) to 9 (*very similar*) was displayed. Responses were made by entering the appropriate number on the keypad. The display of the referent emotion was delayed for 2 s to give the participants some time to focus on the subject of the comparison. The computer measured the time elapsed between the display of the referent and the participants' responses to the nearest millisecond. Participants were not informed of the measurement of the judgment times and could take as much time as they wanted to make their judgments.

Indexes of feature richness. A free-association method was used to determine the feature richness of the 12 emotion concepts. The participants received a booklet with instructions on the front page, followed by the 12 emotion terms, each on a separate page. They were instructed to list free associations to the emotion terms, with the target emotion term always serving as the reference word for each new association (discrete associations; cf. Strube, 1984). The emotion words were presented in random order, with the restriction that concepts from the same cluster (the joy, anger, and sadness cluster) never appeared immediately after each other. On average, each participant produced from 4.2 (disappointment) to 11.5 (joy) associations per emotion term (for more detail, see also Table 2). These results are similar to those obtained by Fehr and Russell (1984) with an attribute listing task. A classification of the associations by the first author, who used a predesigned category system based on previous classifications of emotion aspects (e.g., Mesquita & Frijda, 1992), revealed that the following associations were given most frequently: (a) aspects of emotion episodes, such as particular objects (e.g., child, money) or happenings (e.g., flirt, farewell; 30%), (b) appraisals (e.g., success, insult; 22%), (c) actions (e.g., hitting; 15%), and (d) other emotion terms (10%). In contrast, physiological symptoms (e.g., blushing) and vocal or facial expressions of emotion (e.g., frowning) were mentioned rarely (4%). These results are in line with those of earlier studies in suggesting that information about the elicitors of emotions, including appraisals, are prominent aspects of emotion knowledge (e.g., Conway & Bekerian, 1987; Reisenzein & Hofmann, 1990, 1993; Reisenzein & Spielhofer, 1994; Shaver et al., 1987).

To test the feature model, we computed from these free-association data two indexes of concept richness that have been previously used in the literature. These were (a) the absolute number of associations given to each emotion concept (e.g., Holyoak & Gordon, 1983; note that this index implicitly weights the features by their frequency of mention) and (b) the number of distinct associations (Noble, 1952; e.g., *friends* was counted only once as a feature of joy, even though it had been mentioned by several participants). However, the two indexes turned out to be highly correlated (.89) and produced virtually identical results. Therefore, and because it is the theoretically more adequate index, only the results for the absolute number of associations are reported.

Beliefs about emotion covariation and frequency. The episodic model was tested in two independent ways. The first test made use of asymmetries in conditional probability judgments of the emotions, which had been collected in an earlier study (Reisenzein, 1995). The second

test was based on direct estimates of the frequency of the emotions. For this purpose, 28 participants were asked to rank order the 12 emotions under investigation, plus 13 other emotions, according to the frequency with which they had been experienced during the past year. These rank orders were averaged to determine differences in the frequency of the 12 emotions.

Results and Discussion

The intraclass correlation (ICC), an index of interrater agreement (cf. Shrout & Fleiss, 1979), of the mean directional judgments was $ICC(2, 64) = .99$ for both blocks of trials; it was .98 for the 34 same-valence emotion pairs (e.g., sadness-anger or joy-gratitude) and .90 for the 32 different-valence emotion pairs (e.g., joy-sadness), averaged across judgment direction. Furthermore, the ratings correlated .99 with nondirectional similarity judgments of the same emotions collected by Reisenzein (1995). The participants needed on average 4.65 s to make a directional similarity judgment ($SD = 0.69$). There was also evidence of asymmetries in judgment times: Judgments were faster if an infrequent emotion was compared with a frequent one than vice versa. However, we forego a detailed reporting and discussion of these results because they were not replicated in Study 2.

Asymmetries in Similarity Judgments

The mean similarity judgments for the two directions of judgment are shown in Table 1 above versus below the diagonal.

The feature and episodic models were tested by examining whether the directional similarity judgments showed asymmetries corresponding to those predicted by the two models. The dimensional model was not tested separately, because a confirmation of either the episodic or feature model is simultaneously a disconfirmation of the dimensional model. Statistical tests were furthermore conducted separately for same-valence emotion pairs and for different-valence emotion pairs (e.g., joy-sadness). Significant effects were obtained only for the same-valence pairs. This is, however, unsurprising because the different-valence pairs were all judged as highly dissimilar ($M = 1.84$, $SD = 0.41$), leaving little room for asymmetry effects to emerge. In fact, there were hardly any asymmetries in different-valence pairs, even for the conditional probability judgments (Reisenzein, 1995).

Feature model. Following Tversky and Gati (1978), the hypothesis that asymmetries in similarity judgments are determined by the feature richness of the compared concepts was tested as follows (for the 34 same-valence emotion pairs): The 34 means of the similarity judgments of the richer (R) emotion concept (e.g., jealousy) to the poorer (P) concept (e.g., disappointment), that is, the R-P means, were assigned to one variable, whereas the corresponding P-R means were assigned to a second variable, and the two variables' means were compared by a dependent *t* test. There was no significant difference between R-P judgments ($M = 5.48$, $SD = 1.27$) and P-R judgments ($M = 5.48$, $SD = 1.25$), $t(33) = 0.07$, $p = .95$. Also, the number of asymmetries that were in the predicted direction (18) was not significantly different from the number of those that went in the wrong direction (16), $\chi^2(1, N = 34) = 0.12$,

Table 1
Mean Directional Similarity Judgments for 12 Common Emotions, Study 1

Subject	Referent											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Contentment	—	6.97	6.03	5.05	1.69	1.56	1.61	1.61	1.63	1.77	1.56	1.80
2. Joy	6.73	—	6.02	7.31	1.94	1.59	1.38	1.19	1.84	2.11	1.95	1.86
3. Thankfulness	6.22	5.89	—	4.91	1.89	1.72	1.94	1.67	2.06	1.69	1.66	1.63
4. Euphoria	5.52	7.47	4.75	—	1.97	1.87	1.55	1.47	2.53	2.39	3.22	2.81
5. Sadness	1.92	1.73	2.03	1.91	—	7.17	7.23	6.84	4.13	3.50	3.58	4.70
6. Disappointment	1.56	1.56	1.80	1.73	7.08	—	7.02	6.55	5.70	5.06	5.16	5.20
7. Depression	1.53	1.38	1.78	1.56	7.41	6.98	—	7.66	4.56	3.89	3.81	4.06
8. Hopelessness	1.42	1.36	1.77	1.41	7.25	6.81	7.55	—	4.31	3.31	3.73	4.20
9. Anger	1.70	1.73	1.84	2.59	4.44	6.41	4.92	4.03	—	5.19	5.81	6.09
10. Contempt	1.81	1.80	1.52	2.61	4.16	5.00	3.61	3.92	5.55	—	6.97	4.72
11. Hate	1.81	1.78	1.56	3.25	4.22	5.42	4.16	3.89	6.25	7.27	—	5.91
12. Jealousy	1.72	1.61	1.64	2.89	4.89	5.66	4.92	4.30	6.19	5.38	6.05	—
Rank	2	2	1	1	6	5	4	4	4	4	1	0

Note. Participants were asked the following: "How similar is [row emotion] to [column emotion]?" Emotions are ordered by valence and inferred frequency of occurrence. For same-valence emotion pairs, the direction of comparison yielding higher similarities is printed in boldface type. Rank values are the number of times, for the same-valence submatrices, that a row dominated a column (cf. Dunn-Rankin, 1983); they are comparable only within emotion concepts having the same valence.

$p = .73$. Additional analyses were conducted to check whether the findings were consistent across different participants (cf. Tversky & Gati, 1978). For this purpose, the similarity ratings for the 34 same-valence item pairs were averaged separately for each participant and direction of comparison, resulting in a total R-P and P-R directional score for each participant; these averaged scores were then again compared by t and chi-square tests. Once more, both tests were nonsignificant, $t(63) < 1$ and $\chi^2(1, N = 64) < 1$.

Episodic model. The episodic model was tested in two independent ways. First, we tested the prediction that the asymmetries in the similarity judgments parallel asymmetries in the conditional probability judgments obtained by Reisenzein (1995). For this purpose, the means of the 34 same-valence similarity judgments were arranged into two new variables. The first variable consisted of the directional similarities A to B, for which the conditional probability $p(B|A)$ was greater than the conditional probability $p(A|B)$, and hence presumably so the frequency of B was greater than the frequency of A. The second variable consisted of the converse similarities. The means of the two variables were then compared. A significant effect in the predicted direction was obtained: Similarity was lower for the F-I judgments if more frequent (F) emotions were directionally compared to less frequent (infrequent, I) emotions ($M = 5.36$, $SD = 1.29$) than if the converse comparison was made ($M = 5.60$, $SD = 1.22$), $t(33) = 4.51$, $p < .01$. Twenty-five asymmetries were in the predicted direction, $\chi^2(1, N = 34) = 7.53$, $p < .01$. These results held up when participants rather than items were used as the units of analysis, $t(63) = 3.88$, $p < .01$, with 44 participants showing asymmetries in the predicted direction, $\chi^2(1, N = 64) = 9.00$, $p < .01$.

In the second test of the episodic model, we used the direct frequency estimates of emotions to predict the direction of the asymmetries. Once more, predictions were borne out: Similarity

was smaller for F-I judgments ($M = 5.40$, $SD = 1.29$) than for I-F judgments ($M = 5.56$, $SD = 1.22$), $t(33) = 2.56$, $p < .05$, with 23 item pairs having asymmetries in the predicted direction, $\chi^2(1, N = 34) = 4.24$, $p < .05$. Both tests were also significant for individuals as units, $t(63) = 3.25$, $p < .01$, with 47 participants showing asymmetries in the direction predicted by the direct frequency judgments, $\chi^2(1, N = 64) = 14.06$, $p < .01$.

Comparisons of Rank Orders

In the foregoing data analyses, the emotions' rank orders with respect to feature richness and frequency of experience were used to predict asymmetries in the similarity judgments. This type of analysis can be reversed; that is, one can first derive the rank order of the emotions implied by the asymmetries in the similarity judgments and then compare this derived rank order with the (directly obtained) rank orders of feature richness and frequency of experience. We report this analysis here as well, because it provides for an instructive alternative perspective on the data and describes in a parsimonious way the results obtained for two other potential semantic predictors of asymmetries in similarity judgments.

For reasons mentioned earlier, we analyzed again only the similarities of same-valence emotion pairs. As a consequence, we could only derive separate rank orders for pleasant and unpleasant emotions. The derivation procedure is best explained by recourse to Table 1. Note that in this table, the similarities of the same-valence item pairs are printed in boldface type whenever the column-to-row direction of comparison yielded a higher value than the row-to-column comparison. A rank value for each emotion was obtained by simply counting how often the column dominated the row, that is, by counting the boldface coefficients in each column (cf. Dunn-Rankin, 1983). If all asymmetries were determined by a single property of the emo-

Table 2
Semantic and Nonsemantic Characteristics of the Emotion Concepts, Study 1

Emotion concept	SIM	CPJ	FRE		NA		TYP	PN
			<i>M</i>	Rank	No.	Rank		
Unpleasant								
Sadness	6	7	17.36	8	328	8	5.30	17
Disappointment	5	6	15.45	6	125	1	5.04	20
Depression	4	5	13.91	5	220	3	5.04	44
Hopelessness	4	4	12.16	4	252	4	4.11	0
Anger	4	3	16.17	7	280	7	4.74	49
Contempt	4	2	7.27	2	178	2	3.33	2
Hate	1	1	6.27	1	256	5	5.41	31
Jealousy	0	0	8.71	3	264	6	5.67	3
Pleasant								
Contentment	2	3	17.37	3	252	3	3.85	14
Joy	2	2	20.38	4	347	4	4.96	90
Thankfulness	1	1	13.24	2	210	2	5.33	0
Euphoria	1	0	12.59	1	197	1	3.52	17

Note. Higher numbers indicate higher ranks. SIM and CPJ are the rank orders of emotions derived from, respectively, the directional similarity and the conditional probability judgments. FRE is the mean rank order of emotion frequency obtained from a ranking of the frequency of experience of 25 emotions. NA, the number of total associations, was used as the measure of feature richness. TYP are mean judgments of the typicality of the affects for the category *emotion* taken from Schimmack and Siemer (1995). PN are production norms taken from Mannheim (1983).

tions, such as their feature richness or their frequency of experience, and if measurement error were negligible, this procedure would yield a perfectly consistent rank order without ties. Because the actual rank orders derived for pleasant and unpleasant emotions from the asymmetries in the similarity judgments had several ties (Table 2), these conditions were not fully met; however, most asymmetries were found to be transitive. The same procedure was also applied to the conditional probability judgments of same-valence emotions. In this case, two perfectly consistent rank orders without ties were obtained.

In Table 2, these two derived rank orders of the emotions are shown in columns 1 and 2, side by side with the frequency rank order obtained from the direct judgments (column 3) and the total number of associations given to each emotion concept (feature richness; see column 4). In addition, Table 2 contains two other measures of semantic properties of the emotion concepts that might be considered relevant to a semantic explanation of asymmetries in similarity judgments and that have been previously associated with the structure of the affective lexicon (e.g., Fehr & Russell, 1984; Shaver et al., 1987), namely typicality ratings (taken from Schimmack & Siemer, 1995; see column 5) and production norms (taken from Mannheim, 1983; see column 6).

As can be seen, for the four pleasant emotions, the rank order derived from the asymmetries in similarity judgments (column 1) agreed moderately well with both the frequency-based rank orders (columns 2 and 3) and those derived from association overlap. However, the results obtained for the eight unpleasant emotions clearly supported the episodic model. A quantitative comparison of the rank orders for these emotions is shown in Table 3. It is apparent that all variables that, according to the episodic model, are related to the frequency of experience of the emotions—

the direct frequency judgments, the rank order derived from the conditional probability judgments, and the rank order derived from the similarity judgments—were strongly correlated, whereas they were largely uncorrelated to the other, semantic variables.

In sum, there were asymmetries in similarity judgments of emotion concepts, and these were significantly related to asymmetries in conditional probability judgments and to direct estimates of the frequencies of emotion experiences but not to feature richness. Furthermore, the rank order derived from asymmetries in the similarity judgments was consistent with that obtained from direct frequency judgments and with that derived from the conditional probability judgments, but it was unrelated, at least for unpleasant emotions, to any of the examined semantic properties of the emotion concepts (feature richness, typicality, and production norms).

Study 2

Because the episodic model emerged as the best supported of the three similarity judgment models from the first study, we

Table 3
Correlations Between the Rank Orders of the Eight Unpleasant Emotions From Study 1

Variable	1	2	3	4	5
1. Similarities	—				
2. Conditional probabilities	.94††	—			
3. Frequency of experience	.76†	.79†	—		
4. Number of associations	-.08	-.07	.36	—	
5. Typicality	-.34	-.20	-.06	.43	—
6. Production norms	.03	.12	.33	.19	.24

† $p < .05$, one-tailed. †† $p < .01$, one-tailed.

focused on this model in Study 2. The main aim of the study was to replicate, generalize, and test the robustness of the central findings of Study 1 favoring the episodic model, namely that directional similarity judgments of emotions show asymmetries that parallel asymmetries in conditional probability judgments and that can be predicted from the frequency of experience of the emotions. The second aim of the study was to show that these relations between asymmetries and emotion frequencies, which in Study 1 had been documented only at the group level (i.e., for averaged judgments), can also be found at the level of individual participants. In this context, we also investigated whether individual differences in perceived emotion frequencies are related to individual differences in the asymmetries in similarity and conditional probability judgments (see below). The final aim of Study 2 was to explore how yet another type of judgment that is relevant in the context of the present investigation, namely direct estimates of the number of features of the emotion concepts (cf. Goldberg, 1986), would perform in predicting asymmetries. Proponents of the semantic models will probably regard this type of judgment as another, perhaps less precise, measure of feature richness, whereas we suspected that it might in fact be just another measure of episode frequency (i.e., we thought that the participants would base these ratings on intuitive impressions of emotion frequency). This expectation was based on drawing an analogy to the episodic model's account of similarity judgments: We reasoned that if similarity judgments of emotions do not reflect feature comparison but rather are covert judgments of emotion co-occurrence, then direct judgments of the number of features of emotion concepts might likewise be covert judgments of emotion frequency.

Method

Participants

Forty-two psychology students, 20 from the Free University Berlin and 22 from the University of Bielefeld, Germany, participated in this study in return for course credit.

Material

Because Study 1 found only few asymmetries for comparisons of different-valence emotions, only same-valence (specifically, unpleasant) emotions were used in Study 2. The restriction to same-valence emotions had the added advantage that, in contrast to Study 1, the participants could use the whole range of the 9-point similarity scale for same-valence comparisons and thus could make finer similarity distinctions between these emotions. As a consequence, the chances for asymmetries to emerge should have been increased (cf. Tversky & Gati, 1978). Ten typical emotion terms that, according to the results of a different study (Schimmack, 1997), cover a broad spectrum of experience frequencies were selected. Six of them (anger, sadness, disappointment, hopelessness, jealousy, and hate) were used in Study 1. The remaining 4 were fear (German: *Angst*), helplessness (*Hilflosigkeit*), embarrassment (*Verlegenheit*), and guilt (*Schuld*).

Procedure

Because one aim of Study 2 was to demonstrate asymmetries at the level of individuals, all participants made both the directional similarity and the conditional probability judgments and, in addition, constructed

rank orders of the emotions according to experience frequency and number of features. The data were collected in two sessions separated by at least 1 day. In the first session, half the participants began with the directional similarity judgments, and the other half began with the conditional probability judgments. Subsequently, all participants rank ordered the 10 emotions according to (a) the frequency with which they had been experienced in the previous month and (b) estimated number of features. In the second session, the participants performed the other judgment task and then repeated the frequency and the number of feature rankings to permit an estimation of their retest reliability.

Similarity and conditional probability judgments. The similarity judgment task was analogous to that of Study 1, with the following differences. First, the participants were explicitly told that their task was to judge the similarity in the meanings of the emotion concepts and that this amounted to comparing the concepts with respect to their common and distinct attributes. To further clarify the task, we provided an example from another conceptual domain: The concept *car* was compared with that of *bus*, and it was pointed out that the two concepts are similar in meaning because both comprise properties such as "having four wheels", "having an engine", and so forth, but are not identical because each one also has distinct attributes. This was done to test whether the (presumed) use of covariation information to judge similarities is a strategy that can be abandoned at will. Second, the 90 similarity judgments were divided into 10 blocks of 9 comparisons each, in which the same emotion served as the subject and was compared to the 9 remaining emotions. The order of the referent concepts was determined randomly for each participant by the computer, with the exception that the subject of the previous block did not appear as the referent within the first five trials. Third, prior to each block, the participants were instructed to think about the meaning of the emotion concept that served as the subject during the following judgments, and the similarity ratings were this time formulated as a question ("How similar is A to B?").

The procedure of the conditional probability judgment task was analogous, except that the participants were instructed to judge the co-occurrence of the emotions rather than their similarity; at the beginning of each block, participants were to think about previous experiences of the subject emotion. Participants responded to items of the sort "If I experience [emotion] A, I also experience [emotion] B" by using a 9-point rating scale anchored at the lower end (1) by *very unlikely* and at the upper end (9) by *very likely*. As an additional measure intended to prevent a confusion of the similarity and the conditional probability judgments, the background color of the screen was changed from blue to green.

Rankings for frequency of experience and number of features. The participants received small index cards with the names of the 10 emotions and were asked to rank order them (in decreasing order) according to (a) frequency of experience in the previous month and (b) number of features. The specific instructions for number of features were modeled after those used by Goldberg (1986).

Results

The time needed to make the directional similarity judgments was similar to that found in Study 1 ($M = 4.97$, $SD = 0.47$). Conditional probability judgments were made significantly faster ($M = 4.59$, $SD = 0.38$), $t(44) = 5.21$, $p < .01$. In contrast to Study 1, however, asymmetries in both judgment times were not significantly related to emotion frequency. There was also no significant relationship to estimated number of features.

Table 4
Directional Similarity and Conditional Probability Judgments for All 45 Item Pairs in Study 2

Item pair		Similarity judgments			Conditional probability judgments		
More frequent emotion (F) ^a	Less frequent emotion (I)	F-I	I-F	Asymmetry	F-I	I-F	Asymmetry
Helplessness	Embarrassment	5.02	6.48	-1.46	4.67	6.05	-1.38
Disappointment	Jealousy	4.40	5.64	-1.24	3.86	6.76	-2.90
Helplessness	Guilt	3.40	4.62	-1.22	2.79	5.26	-2.47
Disappointment	Hate	3.33	4.55	-1.22	4.14	5.64	-1.50
Sadness	Guilt	3.29	4.50	-1.21	3.05	5.55	-2.50
Embarrassment	Guilt	3.83	4.95	-1.12	4.33	5.02	-0.60
Helplessness	Hate	2.64	3.74	-1.10	2.62	4.26	-1.64
Anger	Hate	6.24	7.21	-0.97	5.60	7.57	-1.97
Sadness	Anger	2.71	3.52	-0.81	3.33	4.00	-0.67
Anxiety	Hate	2.76	3.57	-0.81	2.93	3.33	-0.40
Hopelessness	Guilt	2.81	3.55	-0.74	3.07	3.67	-0.60
Guilt	Hate	2.29	3.02	-0.73	2.48	3.10	-0.62
Anxiety	Embarrassment	3.69	4.40	-0.71	3.10	3.52	-0.42
Disappointment	Hopelessness	5.48	6.17	-0.69	4.93	6.14	-1.21
Hopelessness	Jealousy	3.24	3.90	-0.66	2.55	4.57	-2.02
Helplessness	Jealousy	4.76	5.38	-0.62	2.79	6.02	-3.23
Disappointment	Anxiety	3.26	3.86	-0.60	3.81	3.10	0.71
Sadness	Disappointment	6.88	7.45	-0.57	6.02	7.38	-1.36
Anger	Guilt	2.55	3.12	-0.57	2.86	5.10	-2.24
Anger	Embarrassment	2.31	2.88	-0.57	2.10	3.45	-1.35
Disappointment	Embarrassment	2.71	3.21	-0.50	2.55	3.05	-0.50
Helplessness	Hopelessness	6.98	7.48	-0.50	6.31	7.69	-1.38
Anger	Anxiety	2.57	3.05	-0.48	2.83	3.24	-0.41
Sadness	Embarrassment	2.45	2.93	-0.48	1.74	3.19	-1.45
Sadness	Hopelessness	6.62	7.07	-0.45	6.21	7.33	-1.12
Anger	Jealousy	5.86	6.29	-0.43	3.60	6.83	-3.23
Anxiety	Jealousy	4.98	5.40	-0.42	3.05	5.33	-2.28
Disappointment	Guilt	2.79	3.21	-0.42	2.71	4.36	-1.65
Hopelessness	Hate	2.21	2.60	-0.39	2.62	2.57	0.05
Sadness	Hate	2.07	2.40	-0.33	2.21	3.62	-1.41
Anxiety	Guilt	3.74	4.05	-0.31	3.36	4.71	-1.35
Sadness	Anxiety	3.98	4.12	-0.14	4.74	4.40	0.34
Jealousy	Hate	6.69	6.74	-0.05	5.29	4.26	1.03
Anger	Disappointment	5.71	5.74	-0.03	5.90	6.50	-0.60
Jealousy	Guilt	3.07	3.07	0.00	2.93	1.62	1.31
Anger	Helplessness	3.21	3.19	0.02	4.45	4.26	0.19
Sadness	Jealousy	4.29	4.26	0.03	3.38	5.86	-2.48
Anxiety	Helplessness	6.64	6.60	0.04	6.64	6.17	0.47
Embarrassment	Hate	1.69	1.60	0.09	1.93	2.14	-0.21
Embarrassment	Jealousy	2.38	2.24	0.14	1.90	2.93	-1.03
Anger	Hopelessness	2.55	2.33	0.22	3.00	3.83	-0.83
Sadness	Helplessness	5.95	5.71	0.24	6.74	6.50	0.24
Disappointment	Helplessness	4.98	4.69	0.29	5.43	4.98	0.45
Embarrassment	Hopelessness	2.90	2.48	0.42	2.90	2.62	0.28
Anxiety	Hopelessness	5.90	5.24	0.66	5.02	6.24	-1.22

Note. The item pairs are arranged according to the magnitude of the asymmetries in the similarity judgments in ascending order.

^a This emotion was more frequently experienced than the emotions in the second columns according to the frequency judgments gathered in Schimmack (1997).

Asymmetries in the Judgments

Table 4 lists the mean directional judgments (F-I vs. I-F) and asymmetries obtained for the 45 emotion pairs, rank ordered according to the size of the asymmetries in the similarity judgments. As can be seen, the asymmetries were in part fairly pronounced, and most were stronger than those obtained in Study 1. This was most likely due to the fact that the participants of Study 2 could use the whole scale range for the same-valence

comparisons. However, in line with the episodic model (see above), for 33 of the 45 item pairs the asymmetries in the conditional probability judgments were more pronounced than those in the similarity judgments.

In accord with the main aim of Study 2—to replicate and generalize the central finding of Study 1 favoring the episodic model—the first set of statistical analyses focused on the mean judgments. As in Study 1, the directional similarity judgments were assigned to two new variables comprising, respectively,

the F-I and the I-F comparisons according to the averaged frequency rank order produced by the participants. The means of these variables were then compared by a dependent *t* test.⁴ As predicted, similarity was less for F-I comparisons ($M = 4.03$, $SD = 1.56$) than for I-F comparisons ($M = 4.47$, $SD = 1.57$), $t(44) = 5.94$, $p < .01$, with 34 of the 45 item pairs showing asymmetries in the predicted direction, $\chi^2(1, N = 45) = 11.76$, $p < .01$. These results were confirmed when individuals rather than items were treated as the units of analysis, $t(44) = 6.68$, $p < .01$, with 36 of the 42 participants showing asymmetries in the predicted direction, $\chi^2(1, N = 42) = 21.43$, $p < .01$.

Nearly identical results were obtained when the asymmetries in the similarity judgments were predicted from the asymmetries in the conditional probability judgments. Because these analyses are largely redundant with the comparisons of rank orders reported in the following section, they are not described in detail.

Comparison of Rank Orders

In a second set of analyses, also analogous to Study 1, Dunn-Rankin's (1983) procedure was again used to derive rank orders of the emotions from the asymmetries in the similarity and conditional probability judgments, which were then compared with the direct rankings of the emotions. In contrast to Study 1, however, the derived rank orders were first determined separately for each participant and were only subsequently averaged. This procedure resulted in mean rank orders that were highly similar (rank correlations were .99 and .96, respectively) to those derived, as in Study 1, from the averaged similarity and conditional probability judgments, but they also allowed us to estimate the reliabilities of the averaged rank orders.

The two derived and the two direct averaged rank orders of the emotions are shown in Table 5. All four rank orders had nearly perfect reliabilities, all ICCs[2, 42] = .99. In addition, Table 5 contains the mean emotion frequencies computed from

Table 5
Derived and Direct Rank Orders of the Emotions, Study 2

Emotion	SIM	CPJ	FRE	NAE	FRD
Sadness	9	10	10	9	9
Anger	7	8	9	8	10
Disappointment	8	6	8	7	8
Helplessness	10	9	6	4	7
Anxiety	5	7	7	10	6
Hopelessness	6	5	5	6	4
Embarrassment	3	4	4	1	5
Jealousy	4	1	3	5	2
Guilt	1	2	2	3	3
Hate	2	3	1	2	1

Note. Higher numbers denote higher ranks. SIM and CPJ are the rank orders of emotions derived from, respectively, the directional similarity and the conditional probability judgments; FRE and FRD are the frequency of emotion rank orders obtained in, respectively, the retrospective frequency rankings of Study 2 and the diary study of Schimmack and Hartmann (in press); NAE is the rank order obtained in the number-of-attributes estimation task in Study 2.

Table 6
Spearman Rank Correlations Between the Derived and Direct Rank Orders, Study 2

Variable	1	2	3	4	5
Mean judgments					
1. SIM	—				
2. CPJ	.85**	—			
3. FRE	.82**	.87**	—		
4. FRD	.78**	.87**	.95**	—	
5. NAE	.56	.61	.81**	.64	—
Individual data					
1. SIM	—				
2. CPJ	.31	—			
3. FRE	.30	.49	—		
4. FRD				—	
5. NAE	.17	.33	.49		—

Note. SIM and CPJ are, respectively, the rank orders derived from the asymmetries in similarity judgments and conditional probability judgments; FRE and FRD are the two measures of emotion frequency obtained in, respectively, Study 2 and the diary study of Schimmack and Hartmann (in press); NAE is the rank order obtained in the number-of-attributes estimation task in Study 2. The upper panel shows the correlations for averaged data, whereas the lower panel contains the averaged correlations of the 42 individual participants (the individual correlations were Fisher's *Z* transformed before averaging). There are no individual correlations involving FRD because these data were not available for the participants of Study 2.

** $p < .01$, two-tailed.

a diary study in which 80 participants were asked to indicate twice daily for a period of 2 weeks how often they had experienced each of the emotions in the preceding half of the day (Schimmack & Hartmann, in press). Inasmuch as these short-term frequency judgments can be assumed to be relatively free of possible memory distortions, the mean emotion frequencies computed from these judgments can be regarded as relatively precise estimates of the true frequencies of the emotions under investigation. Therefore, they can serve to validate the retrospective frequency judgments.

The intercorrelations of the rank orders are shown in the upper panel of Table 6. As can be seen, all five rank orders were quite similar. The high correlations among the emotion rank orders derived from the similarity and conditional probability judgments and the direct frequency rank orders replicate the results of Study 1 and extend them to different emotions and to

⁴ Task order (similarity judgments before vs. after the conditional probability judgments) was ignored because preliminary analyses of variance, in which task order had been included as a second independent variable, showed that it did not interact with direction of comparison, $F(1, 44) < 1$ (parallel findings were also obtained for the conditional probability judgments as dependent variables). Task order did, however, have a significant main effect, $F(1, 44) = 92.50$, $p < .01$, reflecting that similarity judgments were generally higher ($M = 4.47$, $SD = 1.63$) when they were made before the conditional probability judgments (after: $M = 3.88$, $SD = 1.50$). A parallel main effect was also obtained for the conditional probability judgments.

different measures of emotion frequency. Note in particular the high correlations to the diary-based frequency measure. This finding constitutes strong corroboration of our assumption that the frequency and conditional probability judgments indeed reflect (conditional) emotion frequencies. Furthermore, the six emotions that were included in both studies show very similar rank orders in Studies 1 and 2.

Finally, we found that the rank order of the direct number-of-features estimates was also correlated with the other rank orders. However, the correlations to the rank orders derived from the asymmetries in similarity and conditional probability judgments (a) were smaller than those for the frequency-of-experience rank orders, (b) were not statistically significant, and (c) explained only 2% additional variance ($p > .30$) in a hierarchical regression analysis in which the frequency-of-experience rank order was entered first. In contrast, when the number-of-features rank order was entered first, frequency of experience explained more than 30% additional variance ($p < .05$). Hence, the simple correlation between the number-of-features and the similarity-based rank orders appears to be due to the overlapping variance between the rank orders of number of features and frequency of experience. This finding indicates that the support for the feature model is spurious. Furthermore, it is consistent with the assumption that participants' number-of-features ranking were based on frequency-of-experience information. This interpretation is additionally supported by the finding that the number-of-features estimate from Study 2 showed little agreement ($r = .40$) with the feature richness index computed from the associations (across the six overlapping emotions) in Study 1.

Single Participant Analyses and Interindividual Differences

The second aim of Study 2 was to test whether the relations between asymmetries and emotion frequencies can also be demonstrated for individual participants. The answer to this question is contained in the lower panel of Table 6, which shows how the two derived and the two direct emotion rank orders correlated, on average, for individual participants (the correlations were Fisher's Z transformed before averaging). As can be seen, the pattern of these correlations was similar to that obtained for the averaged rank orders, although their size was much lower, which is unsurprising, given that the individual judgments are bound to have lower reliabilities. For the two direct rank orders these reliabilities could be estimated from the correlations between individual participants' rank orders constructed in the first and second session. This correlation was, on average, .79 ($SD = .41$) for the frequency and .74 ($SD = .55$) for the number-of-features rank order.

Additional analyses revealed that very low or missing intraindividual correlations between the direct and the derived emotion rank orders were partly due to the fact that the similarity or conditional probability judgments of the respective participants contained either no or no consistent (as indexed by the number of transitive triples) asymmetries. Specifically, we found that the more consistent the asymmetries contained in the similarity judgments were, the higher were the rank orders derived from these asymmetries correlated with the rank orders derived from

the conditional probability judgments ($r = .46$, $p < .01$) and the rank orders of the frequency of experience ($r = .44$, $p < .01$), but not with the rank order of the number of features ($r = .16$, $p = .31$). Hence, at least some of the participants whose data did not seem to conform to the episodic model simply made too many symmetric judgments to permit the derivation of a reliable rank order. This could reflect measurement problems, a failure to focus the participants' attention on the subject of the comparison, or less pronounced differences in the frequency of experience of the compared emotions for these participants.

As a further test of the episodic model, we examined the relation between interindividual differences in the rank orders of the emotions. These analyses were based on an extension of the episodic model to individual differences. If, as the episodic model contends, asymmetries in similarity judgments and in conditional probability judgments are based on frequencies of stored emotion episodes, then individual differences in the rank orders derived from these asymmetries should likewise reflect individual differences in the frequency of emotion episodes (and these, in turn, should at least in part reflect individual differences in the true frequency of experience of the emotions). This analysis was meaningful because, notwithstanding the substantial agreement among participants on the rank orders of the emotions, there was still some reliable individual variation left (see below).

This prediction was tested as follows (see Rokeach, 1973, for an analogous procedure in a different research area): We intercorrelated, separately for each of the 10 emotions, the four rank values of this emotion (i.e., its standing in the two derived and the two direct frequency rank orders) across the 42 participants. To clarify this procedure, assume that positive intercorrelations were obtained for guilt: This would indicate that, the more frequently guilt was reported to have been experienced by a participant, the higher was its frequency rank derived from the conditional probability and similarity judgments.

To estimate the reliability of the individual differences in the emotion rank orders, analogous correlations were first computed between the emotion ranks of the two frequency rank orders and the emotion ranks of the two number-of-features rank orders (i.e., those constructed in the first and second session). Most of the test-retest correlations of the 10 emotions were significant (mean $r = .62$ for the frequency rank orders; mean $r = .55$ for the number-of-features rank orders). Hence, there was clearly some reliable variance in the individual differences.

Concerning the central issue at stake—the relation between the participants' emotion ranks on the direct frequency rank orders and those derived from the asymmetries—six significant correlations were obtained. The frequency-of-experience ranking was significantly correlated with the rank order derived from the conditional probability judgments for hopelessness ($r = .51$), guilt ($r = .50$), and hate ($r = .40$), and with the rank order derived from the similarity judgments for embarrassment ($r = .45$) and guilt ($r = .35$). For guilt, the number-of-features ranking was also significantly related to the rank order derived from the conditional probability judgments ($r = .45$). Hence, five of the six significant correlations supported the episodic model. As to guilt, individual differences in the number-of-feature ranks were also highly correlated with the frequency of

experience ranks ($r = .58$), and a multiple regression analysis revealed that the latter variable was the only significant predictor. Thus, although only few significant correlations were obtained, all of them were consistent with the predictions of the episodic model.

In sum, the results of Study 2 replicated the central finding of Study 1, namely that there are asymmetries in similarity judgments of emotion that parallel asymmetries in conditional probability judgments and that can be predicted from the frequency of emotions. Second, Study 2 demonstrated that these relations can also be found at the level of individual participants and obtained evidence that individual differences in judged emotion frequencies are related to individual differences in the asymmetries (respectively, the rank orders derived from them). Third, both the direct and derived frequency rank orders of emotions were found to be strongly correlated to an index of actual emotion frequencies obtained in a diary study (Schimmack & Hartmann, *in press*), a finding that validates their interpretation in terms of the episodic model. Finally, it was found that direct estimates of the number of features of the emotion concepts were also associated with the asymmetries, but less strongly so than the frequency-of-experience measures. In addition, direct estimates of feature richness were strongly related to the frequency-of-experience variables but largely unrelated to feature richness as determined in Study 1. Taken together, this pattern of results supports the hypothesis that (a) asymmetries in similarity and conditional probability judgments are due to differences in frequency of experience and (b) direct estimates of the number of features are, in truth, also based on frequency information.

General Discussion

In Study 1, we investigated asymmetries in directional similarity judgments of 12 emotion concepts. We found that such asymmetries existed and could be predicted from asymmetries in conditional probability judgments of emotion occurrence as well as from direct rankings of the frequency with which the emotions were experienced; however, they could not be predicted from feature richness or two other semantic attributes of the emotion concepts (typicality ratings and production norms). In Study 2, this finding was replicated and extended to different emotions and to the level of individual participants. In addition, the finding's episodic interpretation was corroborated by showing that both the direct and derived frequency rank orders of emotions were strongly correlated with an index of actual emotion frequencies obtained in a diary study (Schimmack & Hartmann, *in press*). We now turn to the implications of these findings for the compared models of similarity judgments of emotions, as well as for scaling analyses of emotion similarities.

Semantic Models

We believe that our findings pose a serious challenge to the semantic view of similarity judgments of emotion concepts.

Dimensional Model

At least in its present form, the dimensional (pleasure–arousal) model cannot account for the finding that there are

asymmetries in the similarity judgments and that these asymmetries are related to emotion frequencies. When taken together with other problematic findings (e.g., Gerrig, Maloney, & Tversky, 1991; Reisenzein & Schimmack, 1997; Roberts & Wedell, 1994) and other explanatory problems of the dimensional model mentioned below, the conclusion that substantial empirical and theoretical work is now needed to rescue this model in its original form seems warranted.

It must be emphasized, however, that even if the present findings could be taken as a refutation of the dimensional model of similarity judgments of emotions, this would not imply that pleasure–arousal theory is likewise amiss as a theory of the nature or constitution of emotions (at least their affective core; cf. Reisenzein, 1994; Russell, 1980). That is, the findings clearly do not imply that pleasure–displeasure and arousal are not essential components, or at least typical correlates, of emotional experiences. Nor do the findings imply that people lack (implicit) knowledge of these components or correlates of emotions. On the contrary, the reliable dimension ratings obtained in several previous studies (e.g., Reisenzein, 1994; Russell, 1980) indicate that there is in fact a fair degree of consensus among people concerning the typical degree of pleasure and arousal associated with different emotions. What the present data suggest is only that similarity judgments of emotions are not based on this implicit knowledge—that is, on comparisons of pleasure–arousal dimension values of different emotions—but on exemplar-based covariation estimates. Nonetheless, if correct, this would be sufficient (a) to rob the dimensional model of emotion representation of a major source of support—namely the multidimensional scaling studies of emotion similarities—and by implication, (b) to render the support that these scaling studies give to the pleasure–arousal theory of emotions much more indirect—as indirect, in fact, as is the support for that theory provided by analyses of the correlations among self-ratings of emotions (e.g., Larsen & Diener, 1992; Lorr, 1989).

If similarity judgments are not based on pleasure and arousal but on knowledge about emotion covariation, then the substantial association of pleasure and arousal values with emotion similarities obtained in previous studies (e.g., Russell, 1980) needs to be reinterpreted. In fact, a plausible alternative interpretation consistent with the episodic model is not hard to find: There is a tendency for pleasant (high-arousal) emotions to be experienced together but not with unpleasant (low-arousal) emotions and vice versa. Furthermore, it may well be that, as implied by the bipolarity assumption of pleasure–arousal theory, these covariational tendencies are due, at least in part, to an incompatibility or mutual inhibition of the mechanisms underlying the production of pleasure–displeasure and arousal (cf. Diener & Iran-Nejad, 1986; Reisenzein, 1992). If so, pleasure–arousal theory considered as a theory of emotions would still provide at least a partial explanation of similarity judgments of emotions. That is, pleasure and arousal influence the actual co-occurrence of emotions, which is reflected in the stored memories of emotional experiences on which the similarity judgments are based. Clearly, however, this explanation is very different from that given by the dimensional model of similarity judgments described earlier.

Feature Model

The feature model also failed to account for the obtained asymmetries in emotion similarity judgments. It could be argued, however, that these findings are not quite as problematic for the feature model as for the pleasure–arousal model, because in the case of the feature model, the negative results of Study 1 could be attributed to inadequate feature elicitation. However, we think that the effectiveness of this consideration as a defense of the feature model is rather limited, for three reasons:

1. For the prediction of asymmetries, only the relative number of concept features is relevant, not their specific nature. Hence, all that is required of the association method used in Study 1 is that it give the correct rank order of feature richness.

2. Several alternative methods of determining concept richness, both empirical and theoretical, did not improve the results for the feature model. Concerning empirical methods, we tried various subsets of the associations obtained in Study 1, but this did not change the findings because the number of features in the different categories were strongly correlated. Concerning theoretical methods of feature determination, the most interesting that comes to mind is to assume that, as proposed in Johnson-Laird and Oatley's (1989) hierarchical model of the emotion lexicon, joy, anger, sadness, and fear have fewer (defining) features than do the other emotion words (which are conceived of as their hyponyms). However, given the consistent support for the episodic model's prediction of asymmetries in Studies 1 and 2, this alternative determination of feature richness is a priori doomed to failure. The reason for this is that the episodic and this version of the feature model of similarity judgments make exactly opposite predictions for all pairs of emotion concepts that stand in a classical hierarchical relation: In such a hierarchy, the superordinate emotion concepts have fewer features than the subordinate ones but cover more episodes because all instances of nonbasic emotions are also instances of basic emotions. In addition, the model cannot explain asymmetries in emotion pairs that are not hierarchically related (e.g., disappointment and jealousy).

3. Most important, the findings of Studies 1 and 2 show that, whatever the true identity of the emotion features presumably underlying similarity judgments, for the feature model to be correct they would have to be such that the rank order of feature richness of the emotions coincides with their frequency rank order. This constraint seems difficult to meet by any feature model.

Even if our results cannot be accounted for by the feature model as it now stands, it might be suggested that they can be accommodated by a suitably refined model—that is, by a *hierarchical* feature model (e.g., Johnson-Laird & Oatley, 1989; Schmidt-Atzert & Ströhm, 1983; Shaver et al., 1987). Hierarchical semantic relations between two emotion concepts imply asymmetries in conditional probability judgments involving these concepts (Johnson-Laird & Oatley, 1989); therefore, could they not also account for asymmetries in similarity judgments? However promising this proposal may seem at first, closer examination reveals it to be untenable. There are two main reasons for this. First, as long as the similarity judgment process remains identical to that assumed so far (feature com-

parison), the hierarchical versus nonhierarchical organization of the knowledge base on which this process operates does not make for a difference in predictions of asymmetries. Therefore, to the degree that the present results speak against a nonhierarchical semantic model, they speak equally against a hierarchical model. Second, the hierarchical models also face other empirical problems (see Reisenzein, 1995; Russell & Fehr, 1994). Perhaps the most important of these is that the empirical asymmetries in conditional probability and similarity judgments of emotions are much more numerous than the hierarchical models predict, and many of them concern emotion concepts that nobody would claim to be hierarchically related.

If similarity judgments are based not on a feature comparison process but on knowledge of emotion covariation, then, as in the case of the dimensional model, two conclusions can be drawn. First, feature models of emotion representation (which are typically also hierarchical models; e.g., Johnson-Laird & Oatley, 1989; Shaver et al., 1987) lose a major source of support, namely the results of hierarchical cluster analyses of emotion similarities. By implication, the support provided by such scaling results for associated categorical and hierarchical theories of emotion becomes no more direct than that provided by analyses of the correlations among self-ratings of emotions. Second, the substantial association between feature overlap and judged emotion similarities found in previous studies (e.g., Frijda, 1987; Marx, 1982; Schimmack & Reisenzein, 1996) needs to be reinterpreted. Again, a plausible alternative interpretation consistent with the episodic model readily suggests itself: There is a tendency for emotions sharing the same features to be experienced together, but this is not the case with emotions having different features. The reasons for this are, however, more numerous than in the case of the dimensional model, for, as mentioned, the concept *emotion feature* has been used broadly by the feature theorists. Specifically, emotions may co-occur because their antecedents tend to co-occur or because they have common components; they may tend to exclude each other because their antecedents tend to exclude each other or because they have components that mutually exclude or inhibit each other.

Episodic Model

In contrast to the semantic models, the episodic model can account for the obtained asymmetries in the similarity judgments: Two independent measures of episodic information—direct rankings of the frequency of experience and asymmetries in conditional probabilities—were reliably related to these asymmetries. These findings add to other recent evidence supporting an episodic representation of emotions (Conway & Bekerian, 1987; Reisenzein & Schimmack, 1997) and of social information in general (e.g., E. R. Smith, 1991; E. R. Smith & Zárate, 1992).

First, and most generally, the model is in accord with findings that suggest that an important component of people's memory representations of emotions consists of episodes (concerning oneself or others) of emotions (e.g., Conway & Bekerian, 1987; Reisenzein & Hofmann, 1993; Shaver et al., 1987), that such episodic memories may be more easily retrieved than abstract

emotion knowledge (Conway, 1990; Conway & Bekerian, 1987), and that the co-occurrence of several emotions is the rule rather than the exception in everyday emotion episodes (e.g., Reisenzein & Hofmann, 1993; Schwartz & Weinberger, 1980). Second, the episodic model explains in a natural fashion the strong correlation between similarity and conditional probability judgments of emotions. Third, it can also give a plausible explanation of the association of these variables to pleasure–arousal distances and feature similarities. In contrast, it is difficult to conceive of a consistent explanation of this data pattern on account of semantic information alone. The most obvious strategy would be to attempt to explain the conditional probability judgments, too, as being semantically based, that is, as being based on the comparisons of concept dimension values or features (Shweder, 1982). However, we found that the rank order of emotions derived from the conditional probability judgments was strongly related to several direct estimates of the frequency with which these emotions are experienced (Schimmack & Hartmann, in press), which is evidently not a semantic property of emotion concepts. Therefore, the suggestion that conditional probability judgments are disguised semantic judgments is simply implausible. In addition, it is unclear what the semantic process that presumably underlies conditional probability judgments might look like. In particular, it cannot simply be a radicalization of the directional feature-comparison process described earlier, given that the asymmetries predicted by this process are different from those actually obtained. Finally, as we have extensively documented in a recent set of studies (Reisenzein & Schimmack, 1997), mean similarity judgments of emotions and moods allow an excellent prediction of the correlations among self-ratings of affects in hypothetical scenarios and in real life (intermatrix correlations were around .90). Again, this finding can easily be explained by the episodic model. One only has to assume that, when aggregated across a sufficient number of participants and situations, the covariation judgments presumably reflected by the similarities are a valid estimate of the true covariation of emotions (as determined from self-ratings). In contrast, the semantic models once more face, in our view, a difficult explanatory problem.

In the description of the episodic model given earlier, we suggested that similarity judgments are derived from an episodic knowledge base without actually retrieving the episodes into consciousness. Support for this suggestion can be seen in the finding that the similarity judgments were on average made within 5 s, whereas the mean retrieval time for a single autobiographic memory of an emotional experience seems to be at least 7 s (Fitzgerald, Slade, & Lawrence, 1988). These time relations make it unlikely that co-occurrence estimates are based on the conscious retrieval of exemplars. As noted earlier, this leaves as possibilities that estimates of emotion co-occurrence are pre-stored in memory (see, e.g., Hasher & Zacks, 1984), or, as we suggested, computed “on-line” from episodic memory traces (Greene, 1990; Hintzman, 1988). Differentiating between these two possibilities is a topic of future research.

To conclude, the results of the present studies, in concert with a variety of other findings, suggest the episodic model as an inference to the best explanation. It is apparent that, when asked to compare the similarity of two emotions, people rely on im-

pressions of emotion covariation. Because these impressions are fairly accurate, similarity judgments correlate strongly with actual emotion covariation. This knowledge base is presumably also accessed when people make conditional probability and possibility (Reisenzein, 1995) judgments as well as frequency judgments (Schimmack, 1997) of emotions, thus explaining the systematic relations among these various judgments. In addition, it seems to be at least a conjecture worthy of consideration that episodic knowledge is also crucially involved when people make pleasure–displeasure, arousal (Reisenzein, 1994), and cognitive appraisal judgments (e.g., Reisenzein & Spielhofer, 1994); when they give free associations to emotion concepts (Marx, 1982; Reisenzein & Schimmack, 1997); and when they list emotion features (Conway & Bekerian, 1987; Fehr & Russell, 1984). If so, the episodic model may not only provide the theoretical basis for a unification of the two traditions of structural analyses of emotion mentioned earlier (covariance structure analysis and similarity structure analysis), it may also serve as a bridge to other approaches to the analysis of emotions and emotion concepts.

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