Toward a dynamic theory of emotion:

The component process model of affective states

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Abstract

Emotion is described as a phylogenetically continuous mechanism for flexible adaptation, serving the dual purpose of rapid preparation of appropriate responses to events and of providing opportunities for re-evaluation and intention communication in the interest of response optimization. A definition is proposed which views emotion as a sequence of synchronized changes in five organismic subsystems following the evaluation of an event as significant for an organism's needs or goals. The differentiation of emotions is explained by a sequence of results of five stimulus evaluation checks on three levels of central nervous system processing. A componential patterning model is suggested which predicts specific interrelated patterns of physiological, motor expressive, motivational, and subjective feeling changes as a cumulative process determined by the respective stimulus evaluation checks. These predictions are discussed in the context of the available evidence and of possible approaches to further empirical tests of the theory. The notion of modal emotional states is introduced to account for prototypical, frequently recurring patterns of appraisal outcomes with corresponding response patterning. The relationship of these modal emotions to verbal emotion labels is discussed and specific hypotheses concerning appraisal and response patterning for verbally coded modal emotions are proposed. In concluding, applications to stress and emotional disturbance are evoked.

Overview

Psychology has had a hard time with emotion. Although popular opinion considers psychologists to be experts on affect, many of them have studiously overlooked or even openly denied the existence or the importance of the phenomenon. Others have attempted to subsume emotion under seemingly more straightforward categories such as motivation or activation. Those brave enough to venture a definition have usually reaped the disapproval of their colleagues who often proposed substantially different definitions. Reading through the collected definitions (Kleinginna & Kleinginna, 1981), one is forced to admit that none of them sounds entirely wrong; they all seem to capture some subset of the characteristics that are commonly associated with the term "emotion"[1]. It may be that the multi-faceted nature of emotion is responsible for our difficulties in explaining and conceptualizing the phenomenon.

This paper describes a dynamic model of emotion with detailed predictions concerning the differentiation of emotional states as a consequence of the results of a sequence of specified stimulus evaluation checks and the ensuing response patterning in several organismic subsystems. Preliminary versions of parts of the model have been presented at meetings and have appeared in related publications (Scherer, 1981, 1982, 1984a,b). In the course of the development of the theory details of the predictions as well as some aspects of the terminology have evolved. In the present paper, a systematic description of the most recent version of the theory including detailed predictions and a review of the available evidence is presented.

In the first section of the paper, adopting a functional approach, emotion is considered as an evolved, phylogenetically continuous, adaptation mechanism. It is postulated that the major functions of emotion correspond to the components of emotional states. Finally, emotion is defined as a process of synchronized state changes in these components and a component process model is described.

In the second section, the mechanisms of emotion-related appraisal are discussed. The existence of discriminable emotional states is explained by a sequence theory of emotional differentiation, which postulates a sequence of stimulus evaluation checks seen as operating on three levels of central nervous functioning. In contrast to exclusively cognitive theories it is suggested that part of the appraisal process may rely on automatic processing in the lower brain centers and that certain of the appraisal criteria are innate rather than learned. A case is made for sequential as compared to parallel processing on a macro level.

In the third section, based on the notion of sequential evaluation checks, a componential patterning theory is proposed which serves to predict the pattern of changes in the endocrine, autonomic, and somatic subsystems. Again, many of these response mechanisms are assumed to be phylogenetically continuous and partly innate. Subjective feeling state is viewed as the representation of all subsystem changes in a monitor system. Predictions are made as to which evaluation patterns are likely to be responsible for a number of subjective feeling states designated by standard language labels. The predictions are compared to evidence available in the literature and suggestions for possible experimental tests of the predictions are made.

In the fourth section, the observation that some specific outcome combinations of the evaluation checks seem to recur frequently and in a prototypical fashion is explained by the nature of the biological equipment of organisms and by the need to adapt to recurring environmental changes and to the constraints of social organization. The concept of "modal emotional states" is suggested for this phenomenon and the fact that these modal states seem to be verbally coded in many language communities is commented on. A number of detailed hypotheses on the typical appraisal patterns that are seen to produce these modal states and that call for the respective labeling are proposed, together with predictions on the patterning of the response modalities.

In the fifth section, the model is compared to existing emotion theories, both in terms of underlying theoretical assumptions and specific predictions. The paper concludes with an outlook on the potential use of the theory to in research on stress and affective disorders, with particular emphasis on individual differences in appraisal and coping strategies.

The approach adopted here is admittedly eclectic. Since most, if not all, of prior theorizing is probably at least partly correct, the author has adopted notions from psychobiologically oriented functional theories, from physiological approaches, as well as from cognitive and social learning traditions. However, none of these labels correctly describes the model proposed in this paper. Since some of the terminology in the paper may sound "cognitivistic" (for lack of more neutral terms) it should be stressed at the outset that the author assigns a major role to biological predispositions and that many of the mechanisms described are not assumed to be cognitive or learned. The model proposed can be described as a multi-component, multi-level, and multi-determinant approach.

The aim is to provide a theoretical framework that allows comparing heterogeneous approaches, to account for conflicting empirical findings, to reconcile apparently contradictory claims and to propose a set of integrated hypotheses that can help to guide future empirical research.

Among the theoretical issues and controversies that emotion theorists have been arguing (see Scherer & Ekman, 1984), the following will be addressed, and the potential of the proposed model to bring together conflicting views or to help to sharpen the issue in such a way that empirical tests become viable will be discussed:

Ever since Plato's trifurcation of the human soul into cognition, affect, and motivation (conation) philosophers and psychologists have been worrying about the fact that these faculties while conceptually distinct nevertheless seem interrelated to such an extent in their functioning that it has proven exceedingly difficult to disentangle them.

The relationship between emotion and cognition has been paramount among the topics debated in the recent history of the psychology of emotion. In particular, the question of how much cognition, if any, is necessary to produce emotion is hotly debated. More specifically, one needs to ask which antecedent factors determine emotion differentiation and which mechanisms are involved. Conversely, it is debated to what extent emotional processes influence cognition and whether, indeed, totally affect-free cognitive processes exist.

The relationship between emotion and motivation is similarly troublesome. The interaction of the two is so close that many theorists consider emotion as a particular subsystem of the motivational system with shared neurophysiological structures, a point of view which other theorists consider as blurring the conceptual distinction.

A particularly vexing issue concerns the number and kinds of emotions. On the one hand there seem to be a fairly small number of phenomenologically distinct fundamental or basic emotions as reflected in the limited number of emotion terms in most if not all languages and a restricted number of clearly identifiable facial expression patterns. On the other hand, most people, but poets in particular, are able to experience and describe (although this may take more than a single adjective) a myriad of clearly differentiated emotional states many of which cannot easily be accounted for by a process of "blending" of basic emotions.

Controversies about the degree of differentiation of emotion are closely linked to the issue of number and kind. The remarkable degree of differentiation in feeling qualities but also in expressive manifestations has thus far not been confirmed by objective measurements of physiological state. It has been claimed therefore that it is only the degree or intensity of physiological arousal which objectively differentiates phenomenologically different emotions. This in turn raises the thorny problem of the very definition of emotion—given that feeling, expression, physiological responding, and overt behaviors seem to follow different laws: which of these are the necessary and sufficient ingredients of emotion?

Apart from the importance of the necessary components for the emotion construct, the issue of the relationships between these components has engendered much controversy. Can pure arousal induce cognitive processes which produce feeling states that are in line with situational demand characteristics (Schachter-Singer hypothesis)? Can artificially produced facial muscle innervations release biologically prewired emotion response programs (facial feedback hypothesis)? Does outward expression of emotion amplify or reduce the intensity of feeling states and/or physiological responding (feedback amplification vs. catharsis hypotheses)?

Underlying most of the issues discussed so far has been the role of the biological and evolutionary roots of emotion. This point is at the center of the debates concerning species and culture comparison. Psychologists and ethologists disagree on whether animals have emotions, and if so, how they are different from human emotions. If the emotions are part of our biological equipment, the capacity for emotional responding should be innate and consequently universal. Yet, we find many examples for cultural differences in the elicitation and the response patterning of emotional processes. In addition to cultural differences one finds very sizeable individual differences in emotional responses in highly similar situations, again raising the question of the strength of biological determination.

All of these issues are hotly debated in the field. While the present model will not be able to solve these problems, it is hoped that the theoretical framework provided allows to view some of these questions in a more integrative fashion, to specify the conditions under which particular mechanisms are likely to operate, and to formulate research questions to settle some of the controversies. The last point is of particular importance. As Öhman (1987, p. xxx) has pointed out, most theories of emotion “are formulated in such a way that makes disproof difficult if not impossible” and “most theorists appear to say the same things now as they did one or two decades ago. Moreover, the ones who have changed their theories have typically done it for theoretical reasons rather than a result of empirical findings”. The model advocated here attempts to lay the groundwork for a rapprochement between theory and empirical research in the area of emotion.

The component process model

The functions of emotion

It has been suggested that by adopting a functional approach we should be able to focus on the essential characteristics of emotion and, more specifically, that an analysis of the phylogenetic origin of emotion may be the key to understanding the affect mechanism (see Hamburg, Hamburg, & Barchas, 1975; Plutchik, 1980; Öhman & Dimberg, 1984; Tomkins, 1962/63). Following these earlier suggestions, the author has described emotion as an evolved, phylogenetically continuous, mechanism which allows increasingly flexible adaptation to environmental contingencies because of a decoupling of stimulus and response that creates a latency time for response optimization (Scherer, 1979, 1981, 1984a, 1985). As in other areas of organismic functioning, emotion interacts with, rather than replacing, phylogenetically older response mechanisms such as reflexes and fixed action patterns. More specifically, emotion is seen as serving five major functions for the individual organism and its social environment: 1) the evaluation of stimulus events in terms of their relevance for the individual’s well-being, 2) the regulation of internal states to prepare the organism for action, 3) the activation of specific motives and action tendencies, 4) the expression and communication of reaction and intention, 5) the monitoring of and focussing on changes in organismic states.

One discovers a close parallelism between these functions and the components, features, or aspects of emotion as postulated by most major theorists (see review in Kleinginna & Kleinginna, 1981). The evaluation of stimulus events in terms of relevance and discrepancy detection as well as the appraisal of the coping potential (see below) is characteristic of the cognitive component of emotion (which, as will be shown, does not necessarily imply neocortical processing). The regulation of the organismic system, the internal milieu, and the supply of energy for behavioral activity correspond to the neurophysiological component whereas the preparation and direction of specific action tendencies can be seen as belonging to the motivational component. The expressive component directly corresponds to the communication of reaction and intention. Reflection and monitoring can be linked to the subjective feeling component. It seems, then, that the different aspects or components of emotion are specialized in the service of specific functions.

Description of organismic subsystems

While some authors restrict the components of emotion to a “response triad” consisting of physiological reaction, motor expression, and subjective feeling, the present author includes cognitive appraisal and motivated action tendencies among the components of the emotion construct. In order to conceptualize these components they are functionally defined as five organismic subsystems, each of which is assumed to serve one of the major functions of emotion. While these subsystems also subserve other functions (e.g. temperature regulation, instrumental action, etc.), emotion is considered to consist of concomitant changes in the states of all five systems. Table 1 provides a summary of the relationships between functions, subsystems, and components.

Table 1 about here

The information processing subsystem is responsible for internal and external stimulus evaluation. The system is seen as continuously scanning the environment and internal feedback signals in order to determine the significance of stimulus events or internal state changes for the organism. Its physiological substratum consists mainly of the peripheral sensory apparatus and the central nervous system (CNS). It should be noted that the evaluation can be mediated by a variety of structures of the CNS including brain stem and limbic system. The terms “information processing” and “evaluation” must not be interpreted to mean that the participation of the neocortex is presumed in all cases; similarly, the term “cognitive component” is used here extremely broadly, equating cognition with information processing. Given the persisting lack of a consensual definition of cognition in psychology, it seems to be preferable to use wide categories. The subsystem state can be specified by a description of the results of perception, recall, prediction, or evaluation of situations, relationships, facts, events, or actions.

The support subsystem functions in the service of the internal regulation of the organism, particularly the generation of energy resources for action. This subsystem is served mainly by neuroendocrine and autonomic nervous system (ANS) structures and its states can thus be described by a specification of endocrine and ANS parameters. The executive subsystem, with various CNS structures as substratum, is involved in planning, decision making, and the preparation of action, as well as arbitrating between conflicting motives or plans. The functions of the action subsystem are related to the communication of reaction and intention through motor expression and the execution of skeletal movement for purposeful action. The substratum is the somatic nervous system, and the states of this subsystem can be described by the differential innervation of the striated musculature.

The monitoring subsystem is conceptualized as a control system, served by CNS structures, that reflects the current states of all other subsystems (thus integrating information from central and peripheral subsystems). The monitoring subsystem has a dual function: first, it serves to focus attention on an unresolved situation requiring an adaptive response, and second, to integrate information about external and internal events, facilitating representation in memory as well as learning.

It should again be stressed that these subsystems are here defined in terms of functions, not in terms of substrata. Given our present knowledge, it would be premature to attempt to specify in detail the organs and pathways involved. Different functions within a single subsystem, i.e. involuntary motor expression and voluntary motor acts in the action system, may be mediated by different substrata (e.g. extrapyramidal and pyramidal motor systems). Since the states of the subsystems play a major role in the definition of emotion proposed below and in the operationalization suggested for empirical investigation, some indications are given concerning the likely role of the CNS and the ANS, in order to allow predictions concerning the emotion response modalities. This point is discussed in greater detail in the section on the componential patterning theory.

Emotion as process of subsystem changes

The theoretical analysis presented above, in particular the assumption of a continuously operating evaluation process suggests that the components are multiply interrelated and that changes in one component will lead to corresponding changes in others. This point of view seems to be well supported by evidence in the literature. Thus, it seems reasonable to view emotion as a process with constantly changing component states. The term component process model has been proposed for this particular psychological construct of emotion (Scherer, 1981, 1982).

Averill (1984) pointed out that all of the components in this model also occur in non-emotional states and that emotion theory will have to specify under which conditions the combination of different response system changes constitutes emotion and under which not. The following definition is to specify the conditions to hold for the states of these subsystems during the episode or time slice in the stream of subsystem state changes which is considered to represent an "emotional state".

In the framework of the component process model, emotion is defined as a sequence of interrelated, synchronized changes in the states of *all* of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to central concerns of the organism. The major features of this definition will now be discussed in greater detail.

Response to events. It is suggested that the term "emotion" be reserved for organismic states produced by discrete events, actual or imagined, that have happened or are expected to happen. This excludes long or medium term processes such as slow changes in external or internal milieu, e.g. feeling hot or hungry (see below for the distinction made between change and process). This is not to say that these processes cannot produce emotion. However, the emotion occurs only if an event prevents normal regulation of such imbalanced states; for instance the thought that one might not be able to find anything to eat. Thus, events do not have to be external, they can consist of internal incidents such as a sudden insight or the recall of an episode from memory. States that resemble emotion in terms of the feeling quality but which are not based on specific events are generally called "mood" (cf. Ekman, 1984). For example, a depressed mood could be due to an endocrine imbalance and therefore independent of specific events. Similarly, persistent affective stances toward objects and persons, such as like/dislike, hate/love, which one might call "emotional attitudes", do not fall under the definition offered above. This does not exclude the possibility that emotional states can give rise to moods or produce emotional attitudes, or vice versa (see Frijda, 1986, p. 252-3).

Evaluation of relevance. It is suggested that only those events that are evaluated by the organism as being relevant to its needs and goals can serve as elicitors of emotion. Thus, emotions always imply egoinvolvement (organism-involvement?). Therefore, rather than the objective features of an event it is the nature of the subjective evaluation of these events that determine the emotion response (see also Buck, 1984; Frijda, 1986).

Effect on all subsystems. It is suggested that the term "emotion" be used only if there are corresponding changes in the state of all the subsystems. If a stimulus evokes evaluations of esthetic preference that do not affect any of the other systems, except the monitor system, one might want to use the term "attitude" rather than "emotion". This could be the case for "admiration", for example. However, it should be noted that changes in the subsystems, particularly the support and action systems, can be very subtle and need not always be directly observable (e.g. slight changes in the muscle potential of the facial musculature or in the endocrine secretions). The requirement that all subsystems (including, obviously, the monitor subsystem) be involved concurs with the common assumption that the presence of a subjective feeling state is a sine qua non for an emotion. However, it is debatable whether the individual must be conscious of the change in the monitor system in order for the episode to qualify as an emotion. Clearly, one would not require that the individual be able to code or report these changes verbally. Given the lack of consensus on the nature of consciousness, it is difficult to specify to what extent "subjective feelings" must by definition be conscious. If so, and if one favors the notion that individuals may not always be conscious of an ongoing emotion process, a different term for changes in the monitoring system that do not reach consciousness but satisfy the conditions of the definition given above, will have to be found (on the complex question of consciousness see Mandler, 1984; on consciousness in animals Crook, 1980; Griffin, 1976/1981).

Interrelated changes. Change refers to a deviation from a baseline or prior steady state. It should be noted, though, that the baseline should not be taken as some kind of resting state or zero line (e.g. complete absence of activation) but rather as a type of equilibrium state susceptible to long-term variations in level. Actual states are considered as dampened oscillations around this equilibrium level. The notion that the changes in the different subsystems are interrelated by synchronization is an even more important part of the definition proposed above than the requirement that all systems be involved. As will be shown in detail below, the emotion-eliciting event is postulated to provoke an alignment, or an interdependence of the processes in the different subsystems (normally functioning independently of each other) which serves to focus the organism's resources on the emotion-producing event.

Regardless of whether the responsible event is external or internal, the onset of the emotion starts with the beginning of the evaluation by the information processing subsystem. However, according to the definition above, a full-blown emotion happens only when the initial evaluation has led to changes in all subsystems. It would be premature to attempt a prediction of the sequence in which changes in one subsystem lead to changes in the others. One would expect a very complex pattern of feedforward and feedback chains, an assumption supported by the existence of multiple ascending and descending pathways between CNS, ANS, and SNS.

Similarly, the requirement of synchronization does not entail that all subsystem processes follow the same rhythm in the change produced by the eliciting event. Given differential response latencies and temporal organization patterns of the different subsystems, as well as the mutual influences of the subsystems on each other, the important notion is the interdependence of the state changes, rather than the homogeneity and simultaneity of the actual change parameters.

The findings in the experiments by Schachter & Singer (1962) and Zillman (1971) on excitation transfer constitute a special case (which, however, may well occur outside of the laboratory). If the states to which pre-existing arousal is transferred are to become real emotions—as compared to purely cognitive attribution exercises—a re-synchronization of the support system (ANS arousal) with the other emotion-relevant subsystems must take place. Clearly, the prior state of the subsystems will need to be integrated into any kind of subsystem synchronization produced by a potentially emotion-inciting event. Thus, initial high arousal of the support system should yield a different result compared to low initial arousal.

While the onset and the process of emotion are relatively straightforward, it seems difficult to define the end of an emotion, given the existence of rather protracted emotional episodes with somewhat fuzzy endings. The emotion is assumed to peter out as the subsystem processes begin to desynchronize and to return to an independent mode of functioning. It is no longer the case that all subsystems are involved when the information processing system has turned to the evaluation of a new, unrelated event, and/or the support and action systems have returned to baseline, and/or the executive subsystem has ceased to process action tendencies related to the original event, and/or the monitor subsystem has directed the focus of attention elsewhere. Whether these changes are coordinated in a similar fashion as in the emotion onset or whether each subsystem changes at its own pace after the coordination constraint is released, is a question for empirical research. The reason for the protracted ending of some emotional episodes is likely to be due to repeated recall of the original event from memory. This will start another sequence of evaluation and lead to bouts of reexperiencing the original episode with progressively lower intensity.

The definition proposed above entails that the changes in the cognitive subsystem, i.e. the evaluation process, is considered to be part of the construct of emotion. In other words, emotion is used as a superordinate concept of which cognitive processes can be a part (see Leventhal & Scherer, 1987, for a more detailed discussion of the relationship between emotion and cognition). Since cognitive processes are also involved in non-emotional states of the organism, the problem is to distinguish emotion from other such states. The same is true for motivation. Contrary to Buck’s (1984) suggestion to view emotion as a pure “readout” system for motivation, the motivational subsystem, just like the cognitive, information processing one, is here considered to be a component of emotion (both as an aspect of appraisal and as a response tendency). As discussed above, the requirement of synchronized change patterns in all subsystems is one differentiating factor. This implies that emotion occupies a sizeable portion of the organism’s internal monitoring activity. Emotion can co-exist with other activities, of course. It seems reasonable, though, to restrict the use of the term to cases in which the monitor system actively processes the state changes that constitute the emotion, at least as part of its activity. This would be suggested by the functional view of emotion as focussing the organism’s attention on events and situations of major importance to its well being. While, for humans, this will often be conscious, and fall within the span of attention, this is not necessarily the case. Given that conscious attention is only part of the monitoring activity, the tip of the iceberg, so to speak, it would seem that monitoring could also occur outside of awareness.

The differentiation of emotional states

So far, the discussion of the nature of emotion has been rather abstract and no mention has been made of how the differentiation of discrete emotions is viewed within the framework of the component process model. In short, the theory presented here postulates that specific results of stimulus evaluation processes in the information processing subsystem produce differentiated patterns of change in the other subsystems and that these multicomponent processes correspond to the emotion states that we commonly describe with verbal labels such as fear, anger, or joy. The apparent discreteness of these states may be due in part to the conventionalized categories of the semantic fields created by the words for emotion in different languages (see pp. xx).

Almost all theories of emotion assume, at least implicitly, that the specific kind of emotion experienced depends on the result of an evaluation of a stimulus event in terms of its significance for survival and well being of the organism. The nature of this evaluation process is rarely specified, though. Arnold (1960) and Lazarus (1966) placed major emphasis on the evaluative aspect of emotion and were the first to attempt a more explicit description of the appraisal process. Originally, they focused mainly on the positive or negative result of the appraisal, without analyzing the criteria used in the evaluation process. Later, Lazarus and his collaborators proposed a distinction between primary and secondary appraisal, the latter reflecting the organism's coping ability (Lazarus, 197?; Lazarus, Kanner, & Folkman, 198?). Building upon these earlier approaches, the author suggested a set of five criteria (called stimulus evaluation checks, SECs), that are likely to be used in assessing the significance of a stimulus event for an organism. Since the operation of some of these checks depends on the results of prior checks, it is postulated that organisms appraise stimulus events by performing these SECs in a fixed sequence. Based on these assumptions, a sequence theory of emotional differentiation which predicts differentiated emotional states on the basis of characteristic patterns of results in the SEC sequence is formulated below.

Table 2 about here

Table 2 shows an overview of the SECs and the sequence in which they are expected to occur. The functions of these SECs and the mechanisms involved will be discussed in greater detail below. Following this description, a justification for the choice of a sequential rather than a parallel processing model will be provided.

The sequence theory of emotional differentiation

The mechanisms of appraisal

Appraisal is not a one-shot affair. Very early, Lazarus (1966; Lazarus, Averill, & Opton, 1970) pointed out that appraisal is followed by "re-appraisal" serving to correct the evaluation results based on new information or more thorough processing. One can use the analogy of a radar antenna to refer to the fact that organisms constantly scan their environment (and their internal state) to detect and re-evaluate changes. Consequently, we expect events or internal changes to trigger cycles of appraisal running through the evaluation checks proposed here until the monitoring subsystem signals termination of or adjustment to the stimulation which triggered the appraisal episode.

Given our limited knowledge about the neural substratum of information processing, it would be premature to attempt a detailed specification of the mechanisms which constitute these appraisal cycles, and in particular, the SECs. However, it is necessary to discuss this issue to avoid misunderstandings. For many, terms like appraisal or evaluation seem to connote an implicit assumption that the processing occurs on a conscious cognitive level, with strong neocortical involvement. This assumption is definitely not made in the present theoretical approach, and the terms appraisal and evaluation are used in a functional sense without any a priori judgment as to the underlying mechanisms. The term "check" has been specifically chosen to minimize the impression of cognitivism and to highlight the process -- the comparison of features of an event and its outcomes with internal criteria of the organism. Such comparisons can be based on innate, hard-wired feature detection mechanisms as well as on highly cortical, conceptual or symbolic processing. The author has postulated that the level and the complexity of stimulus evaluation increase during both phylogenetic and ontogenetic development (Scherer, 1984a, p. 313-314).

The issue of the appraisal mechanisms and their role in emotion elicitation has been at the root of the controversy between Zajonc (1980, 1984) and Lazarus (1984a,b) on cognition-emotion interrelationships. Recently, Leventhal and Scherer (1987) have elaborated on this issue, pointing to the need to go beyond the semantic problem of defining emotion and cognition by specifying the details of emotion-antecedent information processing. They propose a preliminary description of how the stimulus evaluation checks can occur on all three levels of the emotion processing system postulated by Leventhal -- the sensory-motor, the schematic, and the conceptual level (Leventhal, 1984; see also Buck, 1984).

On the lowest, sensory-motor, level, checking occurs through largely innate feature detection and reflex systems that are specialized for the processing of specific stimulus patterns. On the schematic level, checking criteria are composed of schemata based on the learning history of the individual which can be conceptualized as abstract representations of learned responses to specific stimulus patterns. On the conceptual level, finally, propositional memory storage provides the criteria for evaluation and conscious, reflective (rather than automatic) processing is used for checking. In terms of possible CNS substrata, the authors link the three levels proposed to the notion of a "triune brain" as described by McLean (1970).

Table 3 about here

Table 3 shows examples for the different forms the SECs can take depending on which of the three levels they are processed. In line with the definition of the levels, it is assumed that the checking mechanisms are mostly genetically determined at the sensory-motor level, the criteria consisting of appropriate templates for pattern matching and similar mechanisms (correspondingly, sets of prewired autonomic-somatic response integrations are expected to be activated quasi-automatically). For example, prototypic unconditioned fear eliciting stimuli, such as they are discussed in terms of "biological prepared-ness" (see Öhman, 1987), would be expected to be processed on this level. On the schematic level, the schemata forming the criteria for the SECs are expected to be largely based on social learning processes and much of the processing at this level can be expected to occur in a fairly automatic fashion, outside of consciousness. It is likely that response integrations are stored along with the schema-eliciting criteria. On the conceptual level, the SECs are seen to be processed via highly cortical, propositional-symbolic mechanisms, requiring consciousness, and involving cultural meaning systems. Here, responses are probably largely determined by volitional action.

With a similar intention of clarifying the nature of information processing in emotion generation, Öhman (1987) has proposed a dual track model involving both automatic and controlled processing. He links the type of affective phenomena on which Zajonc (1980, 1984) bases the claim for affect system priority to automatic processing (Shiffrin & Schneider, 1977), involving information processing routines which work rapidly, effortlessly, and holistically, in a parallel fashion, outside of awareness, and unavailable to volitional modification. Öhman proposes that these unconscious "meaning analysis" pro-cesses can activate or prime the autonomic and motor subsystems. The occurrence of autonomic arousal (due to discrepancy or interruption of thought or behavior processes, or the elicitation of an orienting response following exposure to a significant stimulus) is seen as recruiting controlled processing to deal with situations that cannot be handled on the level of automatic processing. Controlled processing, occurring in the center of awareness, i.e. requiring focal attention, is seen as depending on volitional intentions, requiring effort, and being slow, analytical, sequential, and "creative" rather than routinized.

The multi-level, multi-check model proposed by Leventhal & Scherer (1987) shares the assumption that "higher" levels, allowing more sophisticated yet slower processing, are called into action only when the "lower" levels, relying on automatic and biologically prewired routines, cannot solve the problem. However, they raise the question whether the term emotion should be used if entirely automatic, reflex-like regulation is taking place (p. 17). Furthermore, the two types of processing postulated by Öhman seem to represent two extreme cases of a potential continuum of information processing patterns. Rather than adopting a typological approach, it is suggested here that emotion-generating information processing can vary on several dimensions: level of CNS structures involved, allotment of attention, degree of awareness, amount of effort and speed, holistic vs. analytic, and parallel vs. sequential.

It is suggested that the appraisal mechanism shown in Table 3 can explain the elicitation of the whole range of emotions from the most rudimentary forms in animals and neonates to the most complex forms found in sophisticated adult exemplars of homo sapiens. The nature of the emotion elicited by the appraisal process is seen to depend on the nature of the processing and the respective outcomes of the checks. This in turn depends on the availability of certain levels and characteristics of processing and on the capacity for performing certain SECs. Consequently, the emotional response is determined 1) by the complexity of the information processing equipment available to the organism, and 2) how much of this equipment is needed to produce an appropriate adaptive response (given the functional definition of emotion).

The availability of the equipment is particularly salient with respect to animal and infant emotions. With respect to the phylogenetic continuity of emotion (which has been postulated above), one can argue that the complexity of the emotion system of a species depends on the capacity of its information processing system, i.e. on which of the levels and which of the SECs are available. A similar idea has been expressed very early by Hebb (1949) who postulated that the degree of emotionality of a species is correlated with the phylogenetic development of sophisticated central nervous systems.

The appraisal mechanism suggested here may also help to understand the ontogenetic development of the emotions which according to most scholars in this area is marked by an increasing differentiation of emotional states, a process which seems linked to a simultaneous advances in cognitive and self development (Campos & Barrett, 1984; Emde, 1984a,b; Lewis & Michalson, 1983; Sroufe, 1979). In terms of the model presented in Table 3, the neonate is thought to function at the sensory-motor level at birth, accounting for the rudimentary emotions seen in the first weeks. Due to maturation and learning the infant consecutively acquires the competence to process information on the schematic and conceptual levels. 2

It can thus be assumed that a lower level continues to operate once the next higher one has been attained. It is highly probable that on each of the levels the SECs are acquired in the same sequence in which they are hypothesized to occur in actual emotion elicitation. The author has argued that the SEC sequence predicted for the microgenetic appraisal should parallel the sequence of ontogenetic and phylogenetic acquisition of the SECs. There is some evidence that the first appearance of specific emotions in the infant (based on the existence of appropriate facial expressions as reported in the literature) follows the predicted sequence of SEC acquisition (Scherer, 1984a).

The theoretical analysis of the ontogeny of disgust which has recently been suggested by Rozin & Fallon (1987) is nicely suited to illustrate the multilevel sequence perspective proposed here. These authors argue that while neonates may have an innate capacity for distaste reactions they lack the cognitive equipment to experience disgust defined as revulsion at the prospect of oral incorporation of contaminating offensive objects. The developmental sequence they outline could be reconceptualized in terms of the present theoretical approach as follows: The innate distaste response to certain tastes (especially bitter, e.g. Chiva, 1985; Steiner, 1979) is due to intrinsic unpleasantness appraisal at the sensory-motor level. Apparently, innate sensory-motor links exist only between gustatory and olfactory stimulation and motor expressive and expulsion responses since children up to two years tend to put almost anything into their mouth (Rozin, Hammer, Oster, Horowitz, & Marmora, 1986), indicating that visual or tactual stimulation are not yet linked to distaste-related avoidance responses. In the period between 2 and 5 years children seem to learn what is culturally acceptable to eat and will refuse offensive food on the grounds of distaste and danger for health (Rozin & Fallon, 1987, p.34). Apparently, processing occurs at the schematic level in this period during which a large number of schemata are acquired. These schemata may concern several checks, e.g. relevant to intrinsic pleasantness (taste), goal/need significance (concern about maintaining and improving well-being by eating hearty, healthy fare and avoiding potentially dangerous food), coping potential (food or drink one is able to "stand" or digest), and internal/external standards (what is forbidden even though it may taste very good, e.g. liqueur).

According to Rozin & Fallon, it is only after 7 years of age that children acquire the capacity for true disgust reactions, since it is only then that they have acquired the cognitive sophistication for the concept of contamination. In order for this concept to emerge the child must be able to clearly distinguish between self and the outside world, and to understand the rudiments of food chemistry and of food ingestion and waste expulsion. In addition to the notion of contamination, Rozin & Fallon require a further criterion for disgust - ideational rejection, i.e. explicit reference to a substance's nature as the basis for its rejection. Again, it is only after seven years of age that children produce this response. Clearly, both contamination notions and ideational rejection require processing on the highest and last acquired, the conceptual level. Again, several checks may be involved: novelty (the probability of contamination or cause-effect relationships for expectation), intrinsic pleasantness (derived positive or negative evaluations), goal/need significance (related to conscious goals of eating "pure" food), coping potential (knowledge of how to deal with potential effects of contamination), or standards (moral evaluation of certain substances, e.g. alcohol).

Rozin & Fallon argue that disgust is not just a variant of innate distaste, although it may share some features such as facial expression, rather, they consider it as qualitatively different system which requires an interaction of the subject with the object or context. This is also very much in line with the present theoretical proposal: the emotion seen as resulting from the appraisal process is determined by the specific outcomes of the SECs and the levels of processing which have been involved, both of which depend on specific features of the organism and of the situation appraised.

While adults can be expected to have the competence to process information on all levels and using all SECs (although there may be differences in terms of intellectual capacity, cultural meaning structures, and richness of learning experience) it is possible that higher levels are only used for processing of stimulus input if the lower levels are not able to resolve the problem. Thus, even for adults one expects rudimentary emotions (such as distaste), processed only on the lower levels of the appraisal mechanism, in cases where adaptation is possible with relatively automatic responding.

One may question the need for complex appraisal mechanisms such as decried here, given that emotions can be induced by drugs or by brain stimulation (Gray, 1982; Panksepp, 1982; Ruch, 1979; Tucker, 1981, Valenstein, 1973). However, since the sensory-motor level and parts of the schematic level are expected to rely on brain stem and limbic system structures one can easily account for drug and brain stimulation effects by assuming that the structures that normally operate on the basis of stimulus input are directly activated by the manipulation used. Furthermore, some of the effects could be due to an activation of central control points for integrated response patterns (e.g. ergotropic arousal; see Pribram, 1984) which, under normal circumstances, might be activated by different appraisal results.

Before turning to the detailed SEC description, it seems useful to raise two points in relation to the nature of the events or stimuli which trigger emotion-relevant appraisal.

First, it is important to stress that the appraisal process is always subjective and depends exclusively on the appraising individual's perception of and inference about the characteristics of an event. While under normal circumstances and for "reality-testing" individuals, this subjective perception will be closely related to the objective event characteristics, the two can diverge rather drastically in some cases. Furthermore, events become objects of appraisal only in those cases where they "stimulate" the organism, i.e. when the individual perceives and processes them. This is why the term "stimulus event" is used to refer to the object of appraisal (although "stimulus" or "event" are often used as a shorthand in this paper). As mentioned before, both external events and internal events (i.e. a thought, memory recall, or self-perceived autonomic reactions) can evoke appraisal processes.

Second, when individuals evaluate events that happened in the past or that are in the process of happening, they often base the evaluation on experienced outcomes. This is not the case when individuals evaluate events (and associated outcomes) that are expected to happen in the future. In these cases such evaluations are provoked by signal events, i.e. small scale changes in states of affairs foreboding major events that will yield important outcomes for the organism. For example, the raised fist of an opponent serves as a signal of an impending act of aggression leading to an event which may change the state of one's nose and yield the outcome of pain.

In many cases emotions are the result of evaluations of such signal events, a fact that has been particularly emphasized in learning theories of emotion (see Strongman, 1978, for a review). One can argue that it is one of the functions of emotion to motivate organisms to prevent the occurrence of signaled events with negative outcomes. It must be stressed that what is important for the evaluation is the perceived or expected outcome not the event itself. Similarly, in terms of the potential to cope with a future event it is important to distinguish between the possibility to prevent the event or change its nature (i.e. the type of result) and the organism's attempts to change the consequences or outcomes of a given event.

Description of the stimulus evaluation checks

The individual SECs will now be described in detail. In each case the function of the check in terms of providing information that is essential for an adaptive response will be discussed first. This is followed by a description of the criteria checked and the possible results of the check. In addition, verbal labels commonly used to describe the state of an individual following the specific result of a check are suggested. As shown in Table 2, several subchecks are postulated for the later SECs. It will become apparent in the discussion below that while it is possible to conceptually separate the criteria represented by the subchecks, the functional interdependence between them justifies subsuming them under a more global mechanism. In describing the SECs an attempt will be made to show how the respective checks could be thought to function on each of the three levels of processing proposed above.

The SECs as postulated in the sequence theory of emotional differentiation are not considered to be binary yes/no or present/absent comparators. Their operation and result is as differentiated and complex as the information processing of the respective organism. In many cases this implies a continuous or graded appraisal on a scalar criterion and/or a multidimensional evaluation. However, in the following description of the SECs, the check results are frequently discussed in terms of the polar opposites of the respective dimension in order to simplify the presentation.

Novelty check. Organisms need to constantly scan external and internal stimulus input to check whether a novel stimulus requires deployment of attention or whether the status quo can be maintained and ongoing activity pursued. At the most primitive level of sensory-motor processing, any sudden and intense stimulus is likely to be registered as novel and deserving attention. The literature on attention (Bargh, 1984; Parasuraman, 1983) and on the orientation reflex (Graham, 1979; Grossman, 1967; Kimmel, van Olst, & Orlebeke, 1979; Sidle, 1983) suggests a large number of factors (both concerning the nature of the stimulus and the prior state of the evaluating organism) that are relevant for a novelty check on this level. Beyond this, the criteria for a novelty check may vary greatly for different species, different individuals, different situations and may depend on motivational state, prior experience with a stimulus (e.g. habituation), or expectation.

For example, whereas the amoebae might only be able to detect whether the temperature of the water is changing or not, humans check novelty on a number of dimensions. On the schematic level of processing, one would assume schema matching to take place by yielding an appraisal of familiarity. On the conceptual level, the evaluation is likely to be based on complex estimates (based on an observation of regularity in the world) of the probability and predictability of the occurrence of a stimulus and particularly on whether it was expected to occur or not. Also, not only the occurrence of an event is evaluated but also its consequences. Obviously, anything improbable or unpredicted requires the organism's attention. It should be noted that in the present context the use of the term expectation is limited exclusively to the perceived probability of a stimulus event's occurrence. This must be distinguished from expectations concerning one's anticipated position in a goal-plan-sequence (see goal/need significance check below) where further, motivational factors, such as "entitlement" are likely to play a role.

The novelty check is directly concerned with "predictability" of stimuli or outcomes as used in the extensive literature on control of stimulation (see Miller, 1981; Mineka & Henderson, 1985) since it operates on the expectedness of stimulation which would seem to be largely determined by predictability.

What are the consequences of the novelty check result? Unless a novel or unexpected stimulus is detected, the organism is likely to continue with its ongoing activity. If a novel stimulus is discovered, changes in other subsystems of the organism will take place - in the monitor subsystem (attention deployment), the support system (increasing alertness), and the action system (supporting the gathering of further information by the sensorium). The effects of the result of the individual SECs on the other subsystems (and components of emotion) will be discussed in more detail in subsequent sections.

Can the state changes resulting from the result of the first SEC be called an "emotion"? Appropriate labels for such states following the discovery of a novel stimulus requiring the organism's attention might be "attentive" or "alert". These terms are often included in lists of emotion (see Averill, 1975; Plutchik, 1980). Unfortunately, this implies that almost any reflex reaction must be considered an emotion. Leventhal & Scherer (1987) have suggested reserving the term "emotion" for those cases in which more than one processing level are involved, so as to exclude automatic regulation processes of the organism. Since reflex reactions to sudden intense stimulation can be processed on the sensory-motor level without participation of higher processing levels, the startle would not be considered an emotion under this definition. Ekman, Friesen, & Simons (1985) come to a similar conclusion after demonstrating the reflex characteristics of the startle using micro-coding of facial muscle action.

If a highly improbable event occurs or the outcome of an event is very different from what had been anticipated the organism is usually assumed to be "surprised" or "astonished". These states are commonly assumed to be emotions and since higher processing levels are likely to be involved, one can argue that these particular emotional states are produced solely by the result of the first SEC. Clore and Ortony (1984) have argued that surprise is a cognitive rather than an emotional state because it does not involve hedonic evaluation or happiness. However, it seems problematic to assume a central role of "happiness" for all emotions. Rather, it seems that any condition considered relevant to the organism's needs or goals can elicit an emotion. Since the ability to predict environmental events can be considered an important need for any organism, the violation of expectation can produce an emotional state, facilitating adaptation. In line with the definition proposed above, the term emotion is reserved for those surprise states which involve changes of all subsystems, excluding those states in which only the information processing subsystems is involved (which should be considered as purely cognitive states). In most cases, however, surprise is further differentiated almost immediately by the result of the following SECs. Indeed, surprise is often only the precursor of another emotion, such as joy, fear, or anger, depending on the further evaluation of the significance of an event. Emotional states are expected to be different in quality when preceded by surprise than when preceded by an expected eliciting event.

Intrinsic pleasantness check. While the novelty check alerts the organism to novel stimuli and sensitizes the sensorium to gather appropriate information, the result of the intrinsic pleasantness check determines the fundamental reaction or response of the organism - liking or pleasurable feelings encouraging approach versus dislike or aversion leading to withdrawal or avoidance. The evaluation of whether a stimulus event is likely to result in pleasure or pain is so basic to many emotional responses, that affective feeling is often equated with the positive or negative reaction toward a stimulus. In the component process model of emotion advocated here, the intrinsic pleasantness evaluation is but one step, albeit an important one, in the sequence of SECs leading to differentiated emotional responses.

Even though the concept of pleasure is as old as the philosophical inquiry into human nature, and even though concepts of pleasurable rewards and reinforcement are the cornerstones of many influential psychological theories, we are still far from understanding which features of stimuli produce liking, pleasure, or preference on the one hand or dislike, aversion or distress on the other hand. Consequently, it is difficult to specify the criteria that are likely to underlie the intrinsic pleasantness check.

One of the earliest efforts to theoretically specify the nature of hedonic tone was Wundt's (1874/1902) linking pleasantness and unpleasantness as aspects of conscious feeling states to different stimulus intensities. Berlyne (1960) has formalized this assumption as an inverted U-shaped curve with hedonic tone becoming more positive with the increase of stimulus intensity up to a maximum and then becoming negative as intensity increases further. From a comparative perspective Schneirla (1959) made similar observations on approach-withdrawal processes in animal behavior, showing that low stimulus intensities tend to elicit and maintain approach responses, whereas high stimulus intensities tend to produce adjustment responses and withdrawal. In a similar vein, Tomkins (1962, 1963, 1984) hypothesized that the differential elicitation of positive or negative discrete emotions depends on the "density of neural firing" and argues that positive emotions are characterized by a decrease of the gradient of stimulation. While there has been some empirical support for these theoretical notions, many studies have shown that a number of other stimulus characteristics, such as complexity, for example, need to be taken into account (see Berlyne & Madsen, 1973, for an overview of different perspectives). Frequency of occurrence also seems to affect intrinsic pleasantness evaluation as shown by the effects of mere repeated exposure (Zajonc, 1980) which may suggest an interaction between the novelty and the intrinsic pleasantness check outcomes.

In addition to general characteristics of stimuli such as intensity or complexity, it is rather likely that particular kinds of stimuli are evaluated as intrinsically pleasant or unpleasant by innate detection mechanisms. Comparative and developmental work suggests that this may be true for a number of different stimuli. For example, it has been shown that many animals, as well as infants and humans in many cultures have an apparently hard-wired preference for sweet and aversion for bitter tastes (Chiva, 1985; Pfaffman, 1960, 1978; Rozin, 1976; Steiner, 1979). Similar results have been found for different kinds of odors (Engen, Lipsitt, & Kaye, 1963). Facial features and expressions also seem to be intrinsically evaluated (Vinter, Lanares, & Mounoud, 1985), possibly serving as innate releasing mechanisms for approach or avoidance responses (Eibl-Eibesfeldt, 1979; Hinde, 1974). While some of these evaluation patterns might well be universal and even phylogenetically continuous, others are likely to be species-specific. All of the foregoing examples share the characteristic of being very potent intrinsic elicitors, i.e. the criteria utilized in the organism's intrinsic pleasantness check are probably innate rather than acquired.

The intrinsic pleasantness appraisals described so far are likely to occur almost exclusively on the sensory-motor processing level. However, humans and many animals have differential preferences for objects that are unlikely to be based on innate evaluation processes. As the huge literature on learning and conditioning shows, nothing seems to be easier than to acquire a like or a dislike for various things even though they may have been never encountered before (through generalization, for example). Both the schematic level of processing (e.g. conditioning) and the conceptual level (e.g. judgment of esthetic pleasantness or anticipated or derived pleasantness) are likely to be involved. The intrinsic pleasantness check must include, then, the evaluation of input in terms of acquired preferences or aversions - a process, which due to different learning histories, may produce different results for each individual organism.

It is important to note that the pleasantness or unpleasantness detected by the intrinsic pleasantness check <u>is a characteristic of the stimulus</u> and even though the preference may have been acquired, it is independent of the <u>momentary</u> state of the organism. In contrast, the positive evaluation of stimuli that help us to reach goals or satisfy needs, depend on the relationship between significance of the stimulus and the organism's motivational state (see below).

The result of this check would consist of a value on a pleasant-neutral-unpleasant continuum. This result will serve as input to the next SEC which examines the significance or adaptational value of the stimulus event for the organism. Are there emotion labels in our language that refer to an organism's state after the result of this check? It would seem that "being pleased", "rapture" and "distaste" are good candidates for this situation. Distaste in particular seems to be often used to describe a reaction to - often intrinsically - unpleasant stimuli such as spoiled food or rotten smells. The expression of distaste may serve as a warning signal for conspecifics.

The goal/need significance check. This check is central to relevance evaluation since it determines to what extent a stimulus or situation furthers or endangers an organism's survival and adaptation to a given environment, as well as the satisfaction of its needs, and the attainment of its goals. While the phenomena of motivation and goal-directed behavior are central to behavioral science, the present state of theory makes it rather difficult to specify more concretely which motives, needs, or goals are involved. Even the terminology is most confusing: there is no consensus on the differential usage of drives, needs, instincts, motives, goals, etc. The use of the term "goal" might imply that there need to be conscious goal/plan structures as criteria for this check. This is not intended. For the purposes of defining this check, "goal" is used to stand for any desirable state the organism is motivated to attain, without consideration of the source of this motivation or the consciousness or intentionality associated with it. Frijda (1986) uses the term "concern" to refer to this very general motivational concept.

The criterion for the goal/need significance check might be best described in terms of systems theory: There are a number of different set levels (Sollwerte) that must be attained (different goals/needs) to reach equilibrium and the system evaluates inputs in terms of their contribution to or deflection from the path toward equilibrium. (It should be noted that the term equilibrium is used in a dynamic sense as defined above and does not imply that the organism strives for immobility.) The response of the system depends on the number of goals/needs affected by an input stimulus and the magnitude of its effect. For the purpose of discussing the goal/need significance check, it is assumed, in line with a long tradition of theorizing in psychology, that organisms have hierarchies of goals/needs (from most important to least important) that they "try" to reach (whether they know it or not, whether motivated by their own free will and decision or by "ultimative" factors related to natural selection).

It is in this sense of goal and motivation to reach a goal that the goal of survival (which is obviously very high in the hierarchy), the goal of maintaining positive social relationships with conspecifics, the goal of enjoying pleasurable experiences, or even the goal of crossing the street to buy a newspaper, will be referred to in this paper. It would be impossible to check the conduciveness of an event for all possible goals/needs, even in simple organisms. Consequently, one must assume that the goal/need significance check is based on those goals/needs that are high in priority during the momentary system state. This notion seems well established in the literature on motive hierarchies and goal-directed behavior. Most likely, some of the central goals/needs such as survival and bodily integrity have a stable position near the top of the hierarchy and are perhaps always involved in goal/need significance checks.

Five subchecks of the goal/need significance check are postulated. The first one concerns the relevance of a stimulus or situation for the momentary hierarchy of concerns (cf. the discussion on the "significance" of stimuli eliciting the orienting response; Bernstein, 1979, 1981; Öhman, 1987). A stimulus is relevant for an individual if it results in outcomes that affect major goals/needs. Relevance is likely to vary continuously from low to high, depending on the number of goals/needs affected and/or their relative priority in the hierarchy. For example, an event is much more relevant if it threatens one's livelihood or even one's survival than if it just endangers one's need for rest.

It is suggested that the relevance subcheck determines which concerns are affected in particular. While it seems to be the case that any interruption of a goal directed act or the thwarting of a need will result in frustration, the emotional state elicited may be determined by the nature of the motive concerned.

There is some evidence for this assumption from a recent questionnaire study on emotional experience in several European countries (Scherer, Wallbott, & Summerfield, 1986). In trying to summarize the findings on the emotion-eliciting situations, Scherer (1986b) distinguished three major types of motives or concerns which seemed to have been affected by the eliciting situations: person concerns (survival, bodily integrity, fulfillment of basic needs, self-esteem), relationship concerns (establishment, continued existence and intactness of relationships, cohesiveness within social groups), and social order concerns (sense of orderliness, predictability in the social environment including phenomena such as fairness and appropriateness). The findings showed that the different emotions were not evenly distributed across these three classes of basic concerns. Person concerns, particularly bodily intactness and welfare (e.g. avoidance of injury or death and satisfaction of needs) as well as self-esteem (as in achievement situations) produce mainly joy and fear, depending on whether the goals concerned have been attained or are endangered. Relationship needs lead to joy or sadness experiences, depending on how well things go in the relationship or group. Social order concerns are often at the root of anger emotions, particularly in cases in which the social order is disrupted by inappropriate, norm-violating, or unjust behavior (see Kulik & Brown, 1979, for an experimental demonstration). These patterns are seen as indicating that at least the emotion labels in our language, if not the underlying emotional experiences, are to some extent linked to specific central concerns of the individual (Scherer, 1986b, p. 176).

These findings underline Tomkins' (1962/63) notion that affects are amplifiers of the motivational system. However, they do not support the assumption that any affect can amplify any motive or drive. At least in terms of modal occurrence, there may well be a strong linkage between specific needs, goals, or concerns and specific emotional states. In any case, the strong link between motivational state and emotional responding underlines the general importance of self-involvement as a major requirement for emotion elicitation (see Buck, 1985; Frijda, 1986).

The second subcheck concerns the probability of the concern relevant outcome. Since it is not the event itself but the outcomes for the individual that determine the evaluation result, the likelihood or certainty with which certain effects are to be expected needs to be assessed. This is of particular importance in the case of signal events where both the probability of the signaled event occurring and its consequences are in doubt. But even in those cases in which an event has already happened, the actual consequences for the individual in terms of the likely outcomes need to be determined via probability estimates. For example, if a student fails an exam, some of the potential outcomes, e.g. the reaction of the parents, can only be assessed in a probabilistic fashion. Both of these subchecks are closely linked to the issue of relevance: the more important the concern affected and the more certain the outcomes, the more relevant is the event for an individual.

The third subcheck determines whether the situation created by the event - the outcome - is consistent or discrepant with the organism's expectation concerning that point in time or position in the action sequence leading up to a goal. For example, if one sends an important letter to the bank in town one expects it to arrive within two days. If it still has not arrived after five days, this outcome of the action is discrepant from expectation. Again, an outcome can be more or less discrepant from or consistent with an expected state of affairs, allowing this check to operate on a continuum rather than a binary choice, particularly since results usually have many features, some of which can be discrepant, others consistent. Thus the degree of discrepancy or consistency could be determined by the number of features or elements that fit the original expectation.

It might be asked in what way the expectations checked here differ from those in the novelty check. Expectation itself is not part of the mechanism of a particular check. Rather, it is a general cognitive (or in rudimentary form even subcognitive) mechanism which serves several checks. The difference in the expectation checking of the novelty and goal discrepancy checks respectively are related to the content of the expectations. In the novelty check the set point (Sollwert) is the status quo and any change produces attention and regulation attempts. Only short term anticipation is used. Furthermore, the expectations concern the state of the world without reference to the organism's needs or goals. In the discrepancy check, on the other hand, the expectations are centrally concerned with the state of things in a specific goal/plan-sequence related to a motive hierarchy in the individual. Also, successive set points (Sollwerte) always constitute changes from previous points. These anticipations are often built up over a very long period of time.

The fourth subcheck consists of the evaluation of the conduciveness of a stimulus event to attain one or several of the current goals/needs. Results of acts or events can constitute the attainment of goals/needs, or progress towards such attainment, or facilitation of further goal-directed action. The more directly outcomes of events facilitate or help goal attainment and the closer they propel the organism toward reaching a goal, the higher the conduciveness of an event. Results of events can also be obstructive for goal attainment, by putting goal or need satisfaction out of reach, delaying their attainment, or requiring additional effort (see Srull & Wyer, 1986, for an interesting analysis). This is the classic case of "frustration", the blocking of a goal-directed behavior sequence. Again, the obstruction can be more or less pronounced, depending on how much goal attainment is hampered. Conduciveness is orthogonal to expectation -- we can encounter highly conducive events that are very discrepant from pessimistic expectations or very obstructive events that are consistent with our worst premonitions (see Table 4 in Scherer, in press).

While the intrinsic pleasantness check provides the organism with guidance on whether or not a stimulus should be approached or avoided (which may be more or less inconsequential in cases where the major behavioral response is to turn the sensorium toward or away from the stimulus), the goal/need significance check provides the organism with information on whether it needs to act on a stimulus or not. The result of the check determines whether an adaptational response or adjustment - external or internal - is needed.

How soon action is needed is determined by the fifth, the urgency subcheck. Action is particularly urgent when high priority goals/needs are endangered, and the organism has to resort to fight or flight, and/or when it is likely that delaying a response will make matters worse. Urgency is also evaluated on a continuous scale: the more important the goals/needs and the greater the time pressure, the more urgent immediate action becomes. While any event evaluated as requiring an urgent response must be considered relevant, the reverse is not true. Urgency depends not only on the significance of an event for an organism's goal/need but also on temporal contingencies.

In view of the complexity of this series of subchecks and given the lack of comprehensive knowledge concerning the neurophysiological substrata of motivational processes, it is very difficult to speculate about the involvement of the three levels of processing proposed above. It would seem likely that basic physiological needs can be dealt with on the sensory-motor level, perhaps involving innate feature detectors for relevance and conduciveness (though it is not clear whether discrepancy from expectation can be processed on this level). Even basic needs can require the intervention of the higher processing level, of course, particularly when deficiency states cannot be regulated on the lowest level. The schematic level would seem adequate for many relatively low level acquired needs and motives, and here schemata are likely to exist for the appraisal of relevance, expectation, conduciveness, and urgency, given the schema-building function of past experience. The conceptual level, finally, is specialized in dealing with conscious goals and plans, and high level cognitive processing is likely to be involved in the performance of the subchecks.

The labels used to refer to states following the result of this check might be the following: "concern" for high relevance, "disinterest" for low relevance; "consternation" for discrepancy, "acknowledgement" for consistency; "frustration" or "discontentment" for blocking or hindrances, "satisfaction" or "gratification" for conduciveness; and "urge" or "eagerness" for urgency. Given the importance of the goal/need significance check to instigate adaptational behavior, the effects of the result of this check on the other components of emotion (to be discussed in the next section) are particularly strong.

While a result of a goal/need significance check may generate positive feelings (when a goal has been reached, for example) it is necessary to distinguish clearly between this check and the intrinsic pleasantness check, which may also generate "positive" feelings (for example, after a pleasant stimulus has been encountered). The difference is quite obvious in cases where an inherently pleasant stimulus blocks goal achievement in a particular situation and thus generates negative feelings (like the sitcom stereotype of the sexy girlfriend turning up at a very inopportune moment or in the case of having too much of a good thing; see Scherer, in press, for a more detailed analysis). As mentioned above, intrinsic pleasantness refers to hedonic tone of a stimulus whereas the positive evaluation of a conducive event is based on a comparison with the current goal state of the organism.

Before moving on to the next SEC, in order to underline the importance of the goal/need significance check in the evaluation process, it is useful to recall the important adaptational function of emotion: to initiate and prepare appropriate responses to environmental stimuli of major significance for the survival and well-being of the organism. Contrary to the automatism of a reflex reaction, the emotion provides a latency time for re-evaluation and selection of the most promising response. Since the actual behavioral response is not preprogrammed and is thus not automatically triggered there is the danger that the organism will not respond at all, for example, because it cannot decide on the best response alternative or because of intervening events. The safeguard in the emotion system against this happening is that the evaluation via the SEC sequence occurs not only once but is repeated continuously as long as the stimulus being evaluated is present, physically or in active mental representation. Thus a negative result of the goal/need significance check will continuously provide a warning signal until the result of the check changes. This can happen by acting on the stimulus (i.e. removing an obstacle by attacking and subduing an opponent) and thus getting closer to the original goal, or through internal adjustments like changing goals/needs or the priority of goals (the literature on reactions to frustration is instructive here, see Cofer & Appley, 1964). As long as this is not the case, a stimulus event dominates an organism by affecting its emotional response system.

<u>The coping ability check</u>. The ability to successfully cope with a stimulus event can be defined as the ability to free the emotion system from being controlled by this particular event. It should be noted that this does <u>not</u> imply that the organism is able to necessarily reach its goals. As shown above, this is only one way to change the result of the goal/need significance check. As its frequent occurrence in many species shows, aggression is often the first coping strategy that organisms resort to. It is one of the functions of the coping ability check to determine the appropriate form of the organism's response to an event.

In order to achieve this task, a number of subchecks are necessary. The first of these concerns the <u>causation</u> of the event. The organism will first attempt to discern the agent and the cause of the event (in the case of an animate agent this includes an inference relative to the motive involved). This information is generally obtained with the help of attribution processes which may be rather complex and time-consuming, particular if the causation is not obvious or happened long before the observation of the outcome (see Weiner, 1985, for some of the attribution mechanisms involved). The result of this subcheck provides the basis for the next subcheck, <u>control</u>: the assessment of how well an event or its outcomes can be influenced or controlled by natural agents. For example, while the behavior of a friend or the direction of an automobile are generally controllable, the weather or the incidence of a terminal illness are usually not. It is important to distinguish control from predictability as discussed above (although control, in particular as far as offset of a stimulus is concerned, implies predictability; see Mineka, & Henderson, 1985, p. 508-509, for a detailed discussion of this point).

If control is possible, coping potential depends on the power of the organism to exert control or to recruit others to help. This constitutes the power subcheck: the organism evaluates the resources at its disposal to change contingencies and outcomes according to its interests. The sources of power can be manifold -- physical strength, money, knowledge, or social attractiveness, among others (see French & Raven, 1959). In the case of an obstructive event brought about by a conspecific aggressor or a predator, the comparison between the organism's estimate of its own power and the agent's perceived power is likely to decide between anger or fear and thus between fight or flight. In many aggressive encounters in animals there is a vacillation between fight and flight behavior tendencies. This may reflect the constantly changing outcomes of these power comparisons, as affected for example, by the distance from the adversary and the reactions of other group members.

The independence of the control and power subchecks needs to be strongly emphasized, since these two criteria are not always clearly distinguished in the literature, where "controllability" often seems to imply both aspects (see discussions in Garber & Seligman, 1980; Miller, 1981; Öhman, 1987). Control here refers exclusively to the likelihood that an event can be prevented or brought about or its consequences changed by a natural agent known to the organism. Power, on the other hand, refers to the likelihood that the organism is actually able either by its own means or with the help of others to influence a potentially controllable event. A similar distinction has been suggested by Bandura (1977) in contrasting outcome expectation (contingency between response and outcome) and efficacy expectation (assumption that one's own response can produce the desired outcome). The important work by Bandura and his associates (1977, 1982; Bandura, Reese, & Adams, 1982) on self-efficacy illustrates how the individual's appraisal of his or her power can be empirically measured and manipulated.

The final subcheck is an adjustment evaluation, relevant to the organism's potential to adapt to changing conditions in the environment. This subcheck is particularly important if the control and power subchecks yield the conclusion that it is not within the possibilities of the organism to change the outcomes of an event. Here, the possibility to change goals or reduce their priority and the cost of doing this is established.

The total result of this SEC is to initiate adaptive responses in terms of internal or external coping strategies. The perceived ability, as a result of the subchecks, to free the emotion system of the organism from control by a salient stimulus event (for example, by fight, flight, or goal/need restructuring) is the outcome that determines the effects on the other components of the emotion (see below). It seems quite obvious that the control, power, and adjustment estimates will also vary on a continuous scale. As far as the units of this scale are concerned, one might think of probabilities of success of influence or adjustment attempts.

As for the preceding check, the complexity of the sequence of subchecks renders it rather difficult to dices the role of the different processing levels. It is possible that on the primitive level of sensory-motor processing only a very general coping or power check is performed, based on global representations of available energy and physical strength. The differentiation into the control and power subchecks may be reserved for the higher processing levels. Event contingency schemata and body or self schemata operate on the schematic level. On the conceptual level, complex inferences concerning probability of control and problem solving ability are involved.

In terms of labels describing the states following various results of this check, "hope" would seem to be the appropriate description if control is possible and "confidence" or "assurance" if power is considered adequate. Similarly, "hopelessness" for lack of control and "helplessness" for lack of power. One might think of "resignation" if adjustment is possible, and "despair" if it is not.

The norm/self compatibility check. The terms "norm" and "self" may be interpreted to mean that this check applies to human organisms only. This is not intended, however; the terms were chosen merely for lack of less anthropomorphic ones that would be equally cogent. This last SEC is rather special, though, in that it is by definition only relevant in socially organized species and that it pertains only to events that consist of a behavior or action of the evaluating organism or of conspecifics. The underlying idea is that in socially living species it is not unimportant for the reaction of an organism to take into account how the majority of the other group members evaluate an action. Social organisation in groups depends on shared rules (norms) concerning status hierarchies, prerogatives, and acceptable and unacceptable behaviors. The existence of such norms depends on appropriate emotional reactions of group members to behavior violating norms as well as to conforming behavior. The most severe sanction a group can use on a norm violator short of actual aggression, is the display of emotional aversion and the relegation to the status of an outsider or a reject, depriving the individual of the positive emotional atmosphere of group contact. Therefore, evaluating the significance of a particular action in terms of its social consequences is a necessary step before finalizing the result of the evaluation process and deciding on appropriate behavioral responses.

It is suggested that the norm/self compatibility check consists of two subchecks. One is an external standards check which evaluates to what extent an action is compatible with the perceived norms or demands of a salient reference group in terms of both desirable and obligatory conduct (discrepancy resulting, for example, in states one could label "righteous rejection", in case the behavior of another person is evaluated, or in "shame" if it concerns one's own behavior). The second subcheck evaluates the extent to which an action falls short of or exceeds internal standards such as one's personal self ideal (desirable attributes) or internalized moral code (obligatory conduct). These are often at variance with cultural or group norms, particularly in the case of conflicting role demands or incompatibility between the norms or demands of several reference groups or persons. Discrepancy with the internal standards might lead to states often referred to as "contempt" in the case of behavior of others and as "guilt feelings", in the case of one's own behavior. Exceeding internal or external standards may produce "pride". As in the case of the preceding SECs, the result is a value on a continuous dimension, indicating the degree of consistency of the action that is evaluated with external or internal standards.

As far as processing levels are concerned, it is very difficult to envisage even very rudimentary operations of this check on the sensory-motor level. On the schematic level we would expect self schemata and social group schemata as a template for comparison. The conceptual level seems most appropriate for this check. Here propositional structures for both self ideal and norm representations subserve moral evaluation.

The context of evaluation

The description of the SECs has been very abstract in order to show the structural invariance of the nature of the individual evaluation steps independent of the respective social and situational context, or the type of event concerned. Of course, the evaluation sequences normally take place in a specific context and it is most likely that context factors affect the result of the evaluation process.

Most importantly, the state of the evaluating organism will strongly affect the process of evaluation since many of the criteria used depend on the organism's momentary condition. For example, independently of the event, the salience and importance of particular motives or goals will affect the goal/need significance check in a very characteristic way - not just in terms of criteria for the goal/need significance check but also in affecting the process of appraisal itself. For example, the desire to reach a certain achievement goal may change the evaluation of one's own competence or the probability of certain events (e.g. wishful thinking and other effects of motivation on perception).

Just as the dominant motives change over situations, so do the criteria used for the coping potential check, particularly the assessment of power, which depends at least partly on situational factors, such as the individual's well-being or alertness or the ease with which help can be obtained. Thus, the very same event with similar consequences may give rise to rather different emotional states depending on the subjective evaluation of power available in the respective context.

Similarly, the norms or standards used for comparison in the norm/self compatibility check are dependent on the situational context. An adolescent's evaluation of a behavior on the basis of his or her peer group's norms and standards will be rather different from that involving the standards enforced by authority figures.

A factor of major importance which cannot be adequately dealt with in the present context, is the existence of individual differences in evaluation. Clark (1984) rightly underlines the major role of expectancies, self-consciousness, personality, learning history, and momentary affect state in influencing people's information processing about affect eliciting stimuli. In terms of the model proposed above, both the type of processing (for example, selective perception) and the criteria used for evaluation are seen to depend on the particular individual and his or her actual state. To cite but one well-known example: depressive persons seem to use a more realistic, yet discouraging, strategy for contingency evaluation (Alloy & Abramson, 1979).

Cultural and social frames, the nature of the situation, and in particular the type of social relationships within the situation, will all influence the evaluation. The importance of social and cultural factors has been strongly asserted in a number of recent contributions by sociologists and anthropologists (e.g. Gordon, 1981; Hochschild, 1983; Kemper, 1978; Levy, 1984; Lutz & White, 1986). There seem to be three kinds of socio-cultural influences. One concerns the type of emotion that is actually elicited. It is frequently noted that cultures and social groups have feeling and expression rules - mandating which emotions are to be or are not to be felt and/or expressed in certain situations or under certain conditions (a point which was cogently made by Aristotle in his Nicomachean Ethics, 1941, p.996). One most often thinks of the control or repression of certain emotions or at least of their expressive reactions (mentioned explicitly by Wundt, 1905, p. 285; later termed display rules by Ekman & Friesen, 1969). However, in some cases social norms may demand that certain emotions be not only expressed but actually felt (Hochschild, 1983). The latter case is most important for the appraisal mechanism suggested here since it implies that a desired emotional end state may influence the checking process.

The second kind of socio-cultural factor is directly linked with the evaluation criteria - it concerns the fact that many of the criteria mentioned above are not independent of the respective culture or social group. For example, it is most likely that different concerns may have different priorities in particular cultures, depending on subsistence level and moral or religious beliefs, for example (see Rokeach, 1973). Furthermore, cultures may differ in terms of modal beliefs concerning coping potential, in collective cultures, for example (see Hofstede, 1980; Hofstede & Bond, 1984), there should be a much higher reliance on help from others (see Gudykunst & Ting-Toomey, in press).

The third type of socio-cultural influence consists of the folk theories of emotion current in a culture. Averill (1980b) has suggested viewing emotions in general as social constructions. While this would seem to go somewhat too far in the direction of socio-cultural relativism, it is certainly possible that the social representations of emotions and their functions may affect the appraisal process and the response patterning (for example, through specific socio-cultural schemata on the schematic level of processing). The actual content of many of the abstractly described checking criteria may thus be determined by socio-cultural factors.

Thus, while the results of the SECs determine the nature of the resulting emotional state in a broad sense, many context factors, particularly the content of specific SEC criteria, also differentiate the emotion process.

Sequential vs. parallel processing

The assumption of sequential processing of the stimulus evaluation checks, and, in particular, the notion of a fixed order of the SECs, is frequently challenged. It is pointed out that the onset of an emotional reaction can occur very abruptly indeed, making the assumption of parallel processing more likely (if indeed a number of different checks are involved). The apparent speed of an emotional reaction to an event does not preclude a sequential model, however, given the rate with which these evaluations can occur, particularly when lower brain structures are involved. There are several reasons why a sequential processing model seems required to account for the process of emotion generation.

Firstly, there are purely logical grounds: In terms of systems economy it seems useful to engage in information processing only upon detection of a novel stimulus which is considered relevant for the organism and consequently requires attention. Similarly, extensive processing of available behavioral reactions are useful only if the event actually concerns a major goal or need and when a discrepancy with an expected state is detected. Furthermore, the nature of the discrepancy and its cause need to be determined before coping potential can be assessed since the latter is always relative to a specific demand. It seems reasonable, then, to argue that the results of the earlier SECs need to be processed before later SECs can operate successfully.

Secondly, considering the relationship to phylogenetic and ontogenetic development mentioned above, it is tempting to argue that the microgenetic unfolding of emotion-antecedent appraisal processes parallel both phylogenetic and ontogenetic development in the differentiation of emotional states. Since the lower SECs, particularly the novelty and the intrinsic pleasantness check seem to be present in most animals as well as newborn humans, one could argue that these very low-level processing mechanisms take precedence as part of our hard-wired detection capacities. More complex evaluation mechanisms are successively developed at more advanced levels of phylogenetic and ontogenetic development, with natural selection operating in the direction of more sophisticated information processing ability in phylogenesis and with maturation and learning increasing the individual's cognitive capacity in ontogenesis (see Scherer, 1984a, pp. 313-314).

The assumption of sequential processing raises interesting issues concerning the possibilities of short-circuiting the checking process or of bypassing or skipping certain checks. While this is unlikely to happen in the first evaluation cycle for a new event, it might happen in the subsequent (re-evaluation) cycles (the radar antenna analogy). One could argue that the elimination of irrelevant checks would speed up processing and cut down on it's cost. Yet, one could envisage optimizing mechanisms which do not require such bypassing operations. For example, it is possible that the process runs through all of the checks but that if a prior check result is stored and no changes have taken place, the status quo is accepted without further, specific processing (which should also increase speed). The advantage of this model compared to one based on conditional skipping or bypassing is that no complex decision procedures concerning information needs or conditional branching are required.

It must be strongly emphasized that the sequence hypothesis does not make any assumptions about the micro-architecture of the processing system. It is entirely feasible that massively distributed parallel processors, as they have been emphasized in recent work in cognitive psychology and artificial intelligence (McClelland & Rumelhart, 1985; Minsky, 1986) are at the root of the evaluation process. However, this does not preclude, that on a macro level the result of a prior processing step must be in before the consecutive step can produce a conclusive result (although it may start processing before the result of the prior check is in). Obviously, an entirely parallel system would quickly reach capacity limits for complex problems and it seems necessary to consider the operation of sequential control processes.

The arguments advanced above are theoretical rather than empirical. Obviously, one needs to buttress the postulate of a sequential processing system with empirical evidence. Unfortunately, pre-cognitive and cognitive processes such as those postulated here are not amenable to direct observation or measurement at our present stage of knowledge of brain physiology. Thus, indirect means of empirically demonstrating a sequence of evaluation have to be used. One possibility is to observe the effects of the SEC results on systematic changes in the states of the other emotion components, such as the support, action, or monitor subsystems. In the following section of the paper some detailed predictions for empirical investigations will be developed.

The componential patterning theory

It will be shown below that the assumption that emotional differentiation can be predicted on the basis of a number of features, dimensions, or criteria of appraisal corresponds to a number of recent theoretical statements in the field. However, the component process model departs radically from other theories as far as the differentiation of autonomic patterns and motor expression is concerned. Like discrete emotion theorists (Izard, 1971, 1977; Tomkins, 1962, 1963), the view that emotions are differentiated only on the cognitive level with undifferentiated arousal providing activation is rejected. However, while discrete emotion theorists assume that there are a limited number of basic emotions characterized by a specific set of autonomic and expressive patterns, it is assumed that it is the result of each SEC, rather than an innate emotion program, that produces a characteristic change in the state of the other organismic subsystems. The differentiation between emotion processes, then, is thought to be produced by the net effect of all subsystem changes brought about by the series of results in the SEC sequence.

Based on these assumptions a componential patterning theory which attempts to predict specific changes on the basis of alternative SEC results is proposed. It may be useful to discuss the basic notion of componential patterning in more detail at this point, before proceeding to more detailed predictions.

Description of major theoretical assumptions

The central assumption of the componential patterning theory is that the different organismic subsystems are highly interdependent and that changes in one subsystem will tend to elicit related changes in other subsystems. This process is not unidirectional. The postulates of general systems theory and neurophysiological evidence point to complex feedback and feedforward mechanisms between these subsystems. To take a simple example, an increase of CNS activation is likely to affect the muscle system by increasing tone which, in turn, will feed back to the CNS and affect activation (Gellhorn, 1964). Yet, in many cases the origin of a chain of change patterns are identifiable and can be traced to a specific subsystem. In the case of emotion, it is a reasonable assumption that the origin of a chain of changes is the information processing subsystem, and that the changes are produced by the evaluation of a specific event. Given the complexity of the interrelationships between the organismic subsystems, only the very first step of the sequence of reverberating changes - the effect that specific evaluation check results (in the information processing subsystem) on other subsystem states will be discussed here.

The basic tenet of the theory is that, as the sequence of SECs unfolds, the result of each consecutive check will differentially and cumulatively affect the state of all other subsystems. There are two parts to the argument: 1. the outcome of each SEC changes the state of all other subsystems, and 2. the changes produced by the result of a preceding SEC are modified by that of a consequent SEC. Let us take an example: The detection of a novel, unexpected stimulus by the novelty check will produce an orientation response in the support system (e.g. heart rate decrease, skin conductance increase), postural changes in the action system (to focus the sensory reception areas toward the novel stimulus), a change in goal priority assignment in the executive subsystem (to deal with a potential emergency), and alertness and attention changes in the monitor subsystem. When, milliseconds later, the next check, the hedonic valence check, operates and determines unpleasantness of the novel stimulus, this result will again affect the state of all other subsystems and thus modify the changes that were produced before by the novelty check. For example, an unpleasant evaluation might produce the following changes: 1) a defense response in the support system (heart rate increase, etc.), 2) an avoidance tendency in the executive subsystem, 3) motor behavior to turn the body away from the unpleasant stimulation (and to thus reduce intake of stimulation in the action system, and 4) a negative subjective feeling in the monitor system. Similarly, all of the following checks will change the states of all other subsystems and thus further modify the preceding changes.

It is important to note that each SEC result modifies the preceding changes with the effect that the patterning of the component states is specific to the unique evaluation "history" of the respective stimulus. For example, an unpleasant odor that was expected will yield a different componential patterning than the unexpected one described in the example above since the changes produced by the preceding step are different. Thus, in addition to specifying particular change patterns for the results of the SECs, the component patterning theory emphasizes the unique patterning of the emotion component states due to the particular sequence of modifications following the SEC results. In other words, the SECs and the effects of their results on the other subsystems are not independent of each other, rather, each preceding SEC result and the change produced by it "sets the scene" for the effects of the following SEC's result. Looking at it in another way, specific "patterns" of component states (such as those that seem to characterize discrete emotions like anger or fear) can only occur if there is a series of specific SEC results where each SEC adds a particular modification.

It may be helpful to compare this hypothesis to Smelser's (1963) theory of collective behavior. Smelser argued that particular kinds of collective behavior such as a panic or a riot depend on a sequence of events in which each subsequent event mediates or modifies the meaning of a preceding event. For example, a traffic accident in which a member of a minority group is killed by a member of an ethnic majority takes on a totally different significance after a right wing group issues threats toward the minority group. Smelser uses a "value added" notion, borrowed from industrial production and taxation, to show that each consequent event which is linked to a preceding event, adds to and modifies the meaning of the initial eliciting stimulus. Certain outcomes, such as a riot, will only occur if the eliciting event has been appropriately modified in significance by subsequent incidents. Similarly, it is postulated that particular emotions characterized by typical patterns of states in the various organismic subsystems, will only occur after a "value added" process in which each SEC result appropriately modifies the preceding changes.

What are the psychological mechanisms in this sequential "value added" process? As described above, in the information processing subsystem the operation as well as the result of each SEC depends on the result of the preceding SEC and each additional SEC result modifies and further differentiates the overall evaluative stance of the individual in relation to the event appraised. In the other subsystems, the changes occurring in any subsystem are dependent on the nature of the state and the preceding changes in other subsystems (which in turn have been produced by prior SECs). Consequently, the final state is the result of a complex sequential interaction.

Table 4 about here

Patterning of the executive, support, and action systems

In this section, a set of predictions for the effects of specific SEC results on the executive, support and action systems will be described. These predictions follow directly from the functional approach adopted in cpt, both in terms of the general functions of emotion as described at the beginning of the paper and in terms of the specific functions of each SEC as discussed in the last section. An overview of these function premises used in developing the predictions is provided in Table 4. This table shows which motivational and behavioral tendencies are expected to be activated in the executive subsystem in order to serve the specific requirements for the adaptive response demanded by a particular SEC result. For socially living species adaptive responses are required not only in terms of the internal regulation of the organism and motor action for instrumental purposes but also with respect to interaction and communication with conspecifics. Consequently, in Table 4 the executive subsystem changes are described both on the organismic and the socio-communicative levels. (It should be noted that here and in later tables categorical alternatives for the SEC results are used for simplicity of exposition -- as mentioned above, the SEC results are assumed to be continuous, producing graded changes in the subsystem states concerned.)

On the basis of these premises detailed predictions of changes in the support and action subsystems can be developed. While the discussion so far has remained on a very general, functional level which is not amenable to empirical testing, the following predictions concern objectively measurable response domains which are seen as major indicators of the operation of these two functionally defined subsystems. For the support subsystem, endocrine secretion and autonomic responses can be considered to be most representative. For the action subsystem hypotheses concerning changes in voice production, facial expression, and body movement are presented. These predictions are based on functional considerations of intraorganismic and behavioral adaptation described in the relevant literature as subserving the adaptive needs listed in Table 4.

Table 5 about here

In Table 5 hypotheses concerning detailed response patterns for the CNS, the ANS, and the SNS are listed for the major results of the SECs. For the sake of brevity not all of the subchecks are listed, and in some cases only major combinations of subcheck results are used. The predictions have been arrived at in the following manner:

Physiological variables. For the first two SECs the literature on the orienting and defense responses (Ref) has been used extensively. For the remaining SECs the functional considerations proposed in the literature on endocrine responses and autonomic-somatic integration have been used as the basis for the predictions. With respect to endocrine secretions, the notion of two major axes of neuroendocrine responses to functional needs of the organism, the hypothalamo-adreno-medullar and the pituito-adreno-cortical axes, has been adopted (Henry & Stephens, 1977, Mason, 1968, Frankenhaeuser, 1970). The predictions on autonomic and somatic system responses have been based on the ergotropic-trophotropic tuning model which has been proposed by Gellhorn (1970, based on Hess, 1954). These major dimensions, including the sympathetic-parasympathetic distinction implicit in Gellhorn's model, have been used to derive the detailed hypotheses on individual variables from the general treatment of the nervous system in standard physiological textbooks (sources used: Gellhorn, 1970; Grossman, 1967; Schmidt & Thews, 1980)

Motor expression variables. Predictions for the action system, particularly facial expression and vocal production, are much more difficult since several classes of determinants are involved: 1) the effects of the general physiological changes discussed above, 2) the preparation of specific instrumental motor actions, and 3) the production of socio-communicative signals. The first two determinants can be subsumed under what the author has called "push effects", i.e. internal changes which affect the expressive motor system from within whereas social signals are often due to "pull effects", i.e. particular visual or auditory signal configurations which need to be produced in order to communicate (Scherer, 1985; Scherer & Kappas, in press). The first class of determinants needs to be further subdivided into three major instrumental functions of the facial organs (lips, nose, ears) and the vocal tract (mouth, pharynx, larynx): 1) passing matter to and from internal organs (light, air, liquids, solids), e.g. in the service of respiration, metabolism, glandular secretion, 2) positioning sensory organs for optimal reception of stimulation (e.g. raising eyebrows, flaring nares), and 3) direct action on objects and other organisms (biting, licking, kissing). Given the multi-determination of the muscles in the oropharyngeal and orofacial systems, and the fact that different demands upon the system may be more or less prevalent in a particular situations, the predictions made can only be very rough approximations. An attempt has been made to take all of these determinants into account in formulating the predictions in Table 5.

The major sources of literature used to derive the predictions for facial expression were the following: Andrew, 1972; Darwin, 1872/1965; Ekman & Friesen, 1975, 1978; Frijda, 1986; Lersch, 1932/1971; Leonhardt, 1949; Redican, 1982; van Hooff, 1972. This references will not be consistently cited below in order to avoid repetition.

Ekman & Friesen's (1978) FACS system has been used to describe the expected facial patterns. The reason is that this is the most molecular system in terms of coding the muscular action units used in emotional expression. It can be used independently of prior assumptions concerning specific emotional expressions (as is the case for Izard's MAX, see Ekman, 1982), allowing to develop functional hypotheses on the effect of individual SEC outcomes on facial action units. In addition, the system has been shown to be highly reliable and valid (see Ekman, 1982) and is widely used in the behavioral sciences.

The predictions on vocal expression are expressed both in terms of the phonatory and articulatory changes (on the physiological level) and in terms of the acoustic characteristics of the resulting sound wave (in parentheses), which is the modality for empirical measurement. It should be noted that the translation from phonatory-articulatory to acoustic variables is based on the assumptions in the relevant literature, not all of which have been empirically tested. The major sources used for the development of the vocal predictions are the following: Jürgens, 1979; Laver, 1980; Morton, 1977; Tembrock, 1975; Trojan, 1975). A detailed discussion of the issues and a justification of the hypotheses can be found in Scherer (1985, 1986a).

There is very little literature on body movement in the service of emotion-related adaptive action, in spite of early concerns with this behavioral domain (e.g. Engel, 17xx). The only exception is the ethological literature, where, following Darwin's example, there has been continuing interest in body posture and body movement (Eibl-Eibesfeldt, 1979; Morris, 1977). Consequently, many of the predictions are based on this literature as well as on common sense considerations. The latter is sometimes scorned by psychologists who believe that anything obvious is trivial and of no scientific interest. It might be useful, however, to remind oneself that much that is obvious may also be true and that the fact that a particular phenomenon or mechanism is available to lay psychology does not automatically disqualify it from scientific consideration. Conversely, many "nontrivial" findings reported in the literature seem to be also nonreplicable.

It should be noted, that the entries in Table 5 are not always independent of each other. In some cases, particularly within a response domain, the dependent operationalization of a particular change has been noted in parentheses. In other cases, changes in one domain are due to prior changes listed in another domain, e.g. acoustic changes may be the result of mucuous secretion changes in the vocal tract. Because of the large number and interdependency of these relationships, they have not been generally included.

The following discussion is aimed at illustrating the way in which the hypotheses in Table 5 were derived from the assumptions in Table 4 and to expand on some of the predictions. Although the existing empirical evidence cited cannot be considered a systematic test of the predictions, since the latter are partially based on that literature, the data and observations referred to strengthen the case made here.

The result of novelty detection should be a focussing of the organism's attention to the novel stimulus and alerting the social environment to the event. Priority is on the gathering and processing of information at the expense of ongoing activities which are interrupted. The CNS and ANS components of this reaction are generally referred to as orienting reflex or response (OR), usually described as involving EEG alpha blocking, onset of a P300 component in evoked cortical potentials, heart rate deceleration, vasomotor changes, skin conductance responses, pupillary dilatation (Graham & Clifton, 1966, Siddle, 1983), and a brief inhibition of respiration followed by deep inhalation (see Grossman, 1967, p. 623f), which may produce an ingressive vocalization.

In the action system, ongoing locomotion, gesturing, and instrumental action are interrupted, and all sensory organs are directed towards the novel stimulus by straightening the posture, raising and turning the head, raising eyelids and eyebrows, frowning, and opening mouth and nostrils. Many of these movements also optimize the processing of visual, auditory, and olfactory stimulation, for example, the presumed increase in visual acuity through frowning (see Redican, 1982, pp. 220-222, for a detailed discussion). Many of these motor movements are also highly visible, and may be enhanced for communicative purposes in order to alert conspecifics. Vocalizations may also be added to this effect.

No changes would be expected for a situation in which the status quo is maintained.

If a stimulus is evaluated as intrinsically pleasant, and thus desirable, intensive stimulus processing, instrumental and locomotor approach behavior, as well as incorporation attempts will follow. On the socio-communicative level, the expressive aspects of the response serve to "recommend" the stimulus event to others (unless the desirable commodity is very scarce and the individual attempts to dissimulate its discovery). For the ANS one expects autonomic sensitization of the exteroceptor sensory organs and salivation, all serving to maximize taste and smell sensations (cf. Chiva, 1985; Pfaffman, 1978; Peiper, 1963; Piderit, 1867; Rozin, 1975; Steiner, 1974). In addition, heart rate deceleration and pupillary dilatation may accompany intensive stimulus processing.

Motor effectors are expected to turn the sensory organs toward the stimulus and to widen the bodily orifices (gaze directed toward stimulus, opening eyes, mouth, and nostrils) to let in as much stimulation as possible. Similarly, a widening of the vocal tract (faucal and phyryngeal expansion, relaxation of tract walls) is likely to occur, producing a "wide", sensuous-sounding voice (increase in low frequency energy, F1 falling with slight broadening of its bandwidth, velopharyngeal nasality). Further oro-facial changes accompanying a pleasantness evaluation, like zygomaticus action (pulling the lip corners upwards) and smacking may be orgininally due to gustatory processing (Lersch, 1932, p. 116). This action shortens the vocal tract and thus raises the resonances of the voice sound. Body movement is expected to consist of approach locomotion, expanding posture (opening towards the stimulation), and incorporation-related hand and arm movements (centripetal).

Conversely, unpleasantness evaluations should lead to defense reactions, in order to avoid processing of unpleasant stimulation or to reject or expel noxious matter. The expressive side of the response serves to warn conspecifics of disagreeable stimuli, and to "decommend" exposure or incorporation. On the level of the ANS, a defense reflex or response (DR) to intrinsically unpleasant stimulation is hypothesized. This reaction often immediately follows an orienting response and is thus difficult to distinguish from it. However, research using fine-grained analysis methods and high temporal resolution showed that the defense response is characterized by heart rate acceleration, pupillary constriction, and increased skin conductance level (Graham, 1979), constituting a mixed arousal and avoidance response. In addition, a desensitization of the exteroceptor sensory organs, including decrease in salivation, is to be expexted.

Motor responses consist in turning the exteroceptor organs away from the stimulus and oro-facial actions serve to close or narrow the orifices, e.g. gaze aversion, eye closing, brow lowering, nose wrinkling, nostril compression, mouth closing with lip press or open mouth with tongue protrusion to expel noxious matter. Vocally, a "narrow", squeezed-sounding voice (high frequency energy, raised F1 with narrow bandwidth, laryngopharyngeal nasality) will result because of the constriction of parts of the vocal tract (fauces, pharynx, vocal tract wall tensing). Lip corner depression and retraction will shorten the vocal tract and lead to a raise in the resonances. In terms of body movement, instrumental and locomotor distancing or avoidance responses are expected.

The organism needs to get activated for appropriate action if there are obstacles to reaching a goal or satisfying a need, and to announce the forthcoming burst of activity to others. This is the function of the response to the result of the goal/need significance check. In his classic contribution, Cannon (1929) emphasized the role of the sympathetic branch of the ANS for "emergency" responses in the case of a threat to the organism. The approach suggested by Gellhorn (1964, 1970) attempts a functional description of the organismic arousal states, for ANS and SNS combined, in terms of a balance between an ergotropic (mostly sympathetic ANS activation) and a trophotropic (mostly parasympathetic ANS involvement) system (see also Wenger & Cullen, 1972). This theoretical approach seems to be particularly well suited for the analysis of ANS response as well as SNS related motor expression as a consequence of SEC results. In line with the general definition of the two systems, the ergotropic system is seen as serving an energizing, action preparatory function, whereas the trophotropic system subserves rest and recovery functions.

A discrepancy between desired state and actual state is expected to produce ergotropic dominance, particularly if a highly relevant and salient need or goal is involved. In terms of endocrinology and neurophysiology there is now massive evidence that situations deviating from expectations and demanding effort from the organism result in corticosteroid and catecholamine (particularly adrenaline) discharges (Frankenh{user, 1975; Mason, 1968). One also finds considerable evidence for the sympathetic ANS response expected: increase in depth and rate of respiration, (Frijda, 1986, p. 132-133; Rehwoldt, 1911; Skaggs, 1930), increased heart rate and heart stroke volume (Obrist, 1981), vasoconstriction in skin, gastrointestinal tract, and sexual organs, vasodilation in heart and striped musculature, bronchial dilatation, increase of glucose and free fatty acids in the blood, increase in skin conductance (Epstein, 1973), decrease in glandular secretion and gastro-intestinal motility (Wolf & Welsh, 1972), dilatation of the pupils (Janisse, 1977) -- to name only a few summary references (see also the review by Frijda, 1986).

For the action system the need for adaptive action implies increased tonic innervation of the musculature as well as phasic task-dependent innervations. In facial expression, a frown (corrugator activity) is frequently associated with this condition. The frown is generally seen as a sign of "something difficult or displeasing encountered in a train of thought or action" (Darwin, 1872/1965, p. 222; see also Ekman & Friesen, 1975; Redican, 1982). In addition, a general tightening of the facial musculature (in particular lids and lips) is expected. The voice will tense up due to the increased muscle tone (Laver, 1980), tending towards sharpness (F0 and amplitude increase, more energy in upper frequencies).

A match between desired and actual state (consistency, e.g. reaching a goal) should lead to relaxation and to replenishing of the resources the organism expended in the pursuit of the goal, characterized by comfort and rest behavior. In the ANS, a shift to the trophotropic side of the ergotropic-trophotropic balance (trophotropic "tuning") and a balanced tone in the striated musculature, should result. One would expect, then, an increase in parasympathetic activity: decrease in respiration rate, slight HR decrease, vasodilatation of sexual organs, increase in glandular secretion, bronchial construction, increase in gastro-intestinal motility, relaxation of sphincters. Unfortunately, comfort states and positive emotions are rarely investigated (Averill, 1980a; Stern, Farr, & Ray, 1975); except for sexual excitement and response to humour (see Frijda, 1986) which do not correspond to the results of the goal conduciveness SEC. Yet, there is evidence for parasympathetic dominance during pleasurable relaxation (Brown, 1971; Nowlis & Kamiya, 1970). Frijda (1986) reviews further evidence for parasympathetic dominance in rest and recovery states.

Expressive behavior is likely to be restricted, with facial and vocal musculature relaxed (low F0, low-to-moderate amplitude, balanced resonance).

For positive or negative outcomes of the conduciveness check elements of the pleasantness resp. unpleasantness responses are expected, particularly with respect to motor expression. This hypothesis is based on the assumption that the pleasure and displeasure reactions of the biologically based pleasantness check, and the associated approach or avoidance behaviors, generalize to positive or negative goal conduciveness evaluations. It is possible that pull effects play a major role in this transfer.

If the result of the control subcheck of coping potential check is negative, the individual has to adjust to the changed situation (and indicate by withdrawal that others should not disturb this - often painful - process). It is useless to activate all energy resources for an "emergency" response if the chances for succeeding are very slim. Thus, trophotropic dominance and general hypotension of the musculature is predicted if the control subcheck of the coping potential SEC yields the information that the organism is unable to control or avoid a negative event and its consequences. A number of animal experiments suggest that while corticosteroid level (increased by the discrepancy from desirable goal states, see above) remains high, catecholamine secretion decreases for animals faced with uncontrollable contingencies (Coover, Ursin, & Levine, 1973; Corley, Mauck, & Shiel, 1975; Russo, Kapp, Holmquist, & Musty, 1976; Seligman, 1975; Weiss, 1972; Weiss, Glazer, Pohorecky, Brick, & Millec, 1976). Similar results emerge for animals with subordinate positions in dominance hierarchies (Henry & Stephens, 1977; von Holst, Fuchs, & Stöhr, 1983). In the case of humans, hopelessness and helplessness (see Seligman, 1975) seem to be the appropriate illustration for habitual results of negative control appraisals. While the data are scarce, it seems likely that similar neuroendocrinological patterns can be found in depressed patients. (This does not mean that all depressives are characterized by trophotropic dominance. As will be suggested in the concluding section, "depression" is too broad a category and may need to be refined according to the specific pattern of "pathological" appraisal). For the ANS, trophotropic dominance implies extreme parasympathetic activity: decrease in respiration rate and depth, HR decrease, increase in glandular secretion, particularly tear glands, bronchial constriction.

In terms of body movement, slumping posture (Riskind, 1984), slow movement, for the face, a flaccid muscle tone (jaw dropping, lids drooping, eyes closed) can be predicted. The voice can be described as "lax", due to hypotonus of the vocal musculature, sounding dull or gloomy (due to low F0, restricted F0 range and lack of higher harmonics).

If control can be exerted and if the power subcheck results in the evaluation that there is enough power to threaten and, if necessary, fight an adversary, goal and dominance assertion will occur. In this case, an increase of the noradrenaline component in catecholamine secretion and a decrease in corticosteroid secretion is to be expected (cf. Ax, 1953). Rather than a further increase in ergotropic arousal with its consequent sympathetic pattern (after the initial ergotropic shift following the discrepancy result of the goal significance check) a case can be made for expecting a change in the direction of ergotropic-trophotropic balance. This argument is based on ethological considerations concerning the best strategy of a confident fighter (which seems to be relaxation; see Zahavi, 1982, and Scherer, 1985a, p. 213, for a more detailed discussion of this important point). While there is little empirical evidence so far, it is interesting to note that Levenson, Jaffe, & Mc Fall (1980) found heightened responsivity to stress ("overarousal") in low-assertive, non-confident subjects.

For the ANS, this should imply (particularly, in relation to a prior ergotropic shift due to discrepancy evaluation): increase in depth of respiration, slight HR decrease, increase in diastolic and systolic blood pressure, slight increase in gastric motlitiy, pupillary constriction. Of particular interest is a thermogenetic effect of the noradrenaline secretion (increase of free fatty acids in the blood; see also Van Toller, 1979). This may be one of the reasons for anger, which is expected to be based on a positive outcome of the power subcheck, feeling "hot" (Ekman, Levenson, & Friesen, 1983; Scherer, Summerfield, & Wallbott, 1983; Scherer, Summerfield, & Wallbott, 1986; see below). Furthermore, peripheral vasodilation in the upper torso due to the redirection of blood flow to the head and chest regions to support threat displays and fighting responses (cf. Baccelli, Albertini, Del Bo, Mancia, & Zanchetti, 1981) can be expected.

In line with Darwin's argument that expression makes use of rudimentary adaptive behavior patterns, it is predicted that the facial musculature tends to show preparatory biting patterns (lips tight and parted, bared teeth) and tensing of the muscles in the neck and around the mouth as well as the "stare" in the eye region (eyes widened, eyebrows contracted). An alternative pattern, possibly produced by pull effects in terms of controlling an overly aggressive facial expression, consists of averted gaze with tight lids and narrowed eyes and a tight lip press. In terms of vocal behavior, we would expect a "power-ful" voice, produced by chest-register phonation (low F0, high amplitude, strong energy in the entire frequency range), sounding loud, strong, and deep. Posture is likely to be erect (Weisfeld & Beresford, 1982). Furthermore, one may expect agonistic hand/arm movements, forward body lean, and approach locomotion, all with threat or aggression intention.

In the case where events or outcomes are in principle controllable, but where the organism disposes of insufficient power to ward off danger, protective responses are indicated, with flight or subordination as the only behavioral alternative. Ergotropic dominance should increase still further (to provide the organism with sufficient energy for a true emergency reaction). Here one would expect an increase in the adrenaline component in catecholamine secretion (probably with the corticosteroid level remaining very high) and high sympathetic arousal. Earlier work (Ax, 1953; Funkenstein, 1955) indeed suggested increased adrenaline secretion in fear (control possible but low power). While these findings are still controversial and await replication (see discussion in Kemper, 1978; \hman, 1987; Stemmler, 1984; see below), the effect of adrenaline would clearly be functional in low power emergency situations in which flight or desperate fight might be required. It produces a strong increase in the arterial blood pressure of the muscles and the cardiovascular system and mobilizes glycogen. Thus, blood flow is likely to be redirected to the muscles of the peripheral organs (for running or protecting). The hypertension of this musculature may be the reason for the trembling that is sometimes seen in this condition. Another adrenaline effect is peripheral vasoconstriction which reduces the amount of bleeding in the case of injury (Van Toller, 1979, p. 36). Peripheral vasoconstriction in turn results in a drop of skin temperature (feeling cold), a prediction which, for fear, seems supported by physiological data (Ekman et al., 1983) and a very consistent set of self report data (Scherer et al., 1986; Wallbott & Scherer, 1986). Finally, respiratory rate may increase and become irregular (see Moses, 1954; Skaggs, 1930). In general, one would expect the general sympathetic arousal pattern (Cannon's classic emergency response) -- increased heart rate and heart stroke volume, increase in systolic and decrease in diastolic blood pressure, vasoconstriction in skin, sexual organs, and gastro-intestinal tract, sphincter constriction, tracheo-bronchial relaxation, elevated skin conductance level, decrease in glandular secretion, particularly salivation, pupillary dilatation.

For the action system, one obviously expect postures and action tendencies directed toward defense and flight, and the expression of submission or subordination. Facial expression is often characterized by a wide open mouth and flared nostrils (which may ease rapid respiration), brow and lid rising, giving the appearance of bulging eyes (due to consistent staring at the source of danger?). In addition, tight lips with mouth corner retraction may represent a phylogenetically old subordination gesture (bared-teeth or grinning display; see van Hooff, 1972; Redican, 1982). The voice, due to the hypertense vocal musculature, is produced with head or even falsetto phonation (raised F0, widely spaced harmonics with relatively low energy), which makes it sound thin, high-pitched, and shrill.

Our present state of knowledge is not sufficiently advanced to allow very detailed predictions for the patterning produced by the norm/self compatibility check. As in the case of the conduciveness subcheck, we can expect a generalization of response patterns from "lower" checks which seem to be implicated. In the case of surpassing standards, one can expect elements of an ergotropic response (because of the discrepancy with expectation) and of a pleasantness (because of the conduciveness to the desirable state of excelling in social comparison) and a high control/high power response (because of the mastery experience involved). If the behavior falls short of the standards upheld by the self or the social group, one would again expect an ergotropic response because of the discrepancy with expectation and an unpleasantness as well as a low power response (because of anticipated sanctions by powerful others). Given potential sanctioning or censuring from others, as well as increased self-awareness from direct exposure to other individuals' attention, one expects avoidance behavior and the reduction of communicative activity.

So far, the differentiation of the monitor subsystem as a consequence of SEC patterning has not been mentioned. Since the monitor system, and the emotion component of subjective feeling, are supposed to reflect the changes in all other subsystems, we lack a terminology to describe the exceedingly complex configurations of monitor subsystem states which are to be expected. As far as the conscious reporting of feeling states via verbal labels is concerned, the issue will be dealt with in a special section below.

Further empirical research

The model presented here suggests an intermediate step in the study of the differentiation of emotional states in the neurophysiological and expressive domains. If the assumption is correct that the states referred to by current verbal emotion labels (see below) are the composite effect of many possible patterns of SEC results (with the corresponding diversity of response system patterning), one would be ill advised to start with the investigation of these complex states before better understanding the building blocks. In other words, it may be necessary to first investigate the neurophysiological and expressive responses to the "simple" SEC results, such as novelty, reaching or missing a goal, feeling powerful or helpless in front of a challenge, before venturing on to anger, fear, or happiness (which, according to this model, are claimed to be derived from these component results through sequential modification of different subsystem states).

Interestingly, in two recent reviews of the literature on the psychophysiological differentiation of emotional states a similar conclusion is reached. Frijda, after reviewing in depth a large number of studies dealing with the physiology of emotion, and finding, as many other authors before, that stable replicated findings of differentiated physiological patterning are few and far between, concludes: "... it become apparent that physiological response patterns correspond to the functional requirements of dealing with the environment rather than to different emotions. ... In other words, physiological response can be expected to show directional fractionation systematically related to stimulus and action requirement variables. To the extent that such variables are correlated with given emotions, physiological response is correlated to those emotions; but many of these variables may be expected to cut across emotion classifications." (1986, p. 165).

Stemmler (1984), after a comprehensive review of studies on physiological differences between fear and anger, and a critical interpretation of the data in a major experiment of his own, reaches the conclusion that the notion of emotio-specific physiological response profiles should be replaced by the notion of a "physiological map" which reflects the complete person-environment interaction at any one time. While emotions are part of this interaction (and may be particularly related to an intensity dimension) they can, according to Stemmler, only be understood on a physiological level, if the more general context is taken into account.

Componential patterning theory suggests a grid which allows to plot person-environment interactions on "maps" for several different response modalities, not just physiology. In addition, an attempt is made to explain the effects of the demands of these interactions on the response level in functional terms. This approach allows a principled derivation of hypotheses reflecting the demands of person-environment interaction or internal regulation in terms of the adaptive responses of the organism. Clearly, systematic empirical tests of the predictions made require a direct manipulation of the outcome of a particular SEC rather than the induction of a specific emotion. It would seem that such a research program may be more feasible than direct investigation of discrete emotional states. As shown above, there are already quite a number of studies in the literature which have manipulated variables such as novelty, control, power, and the like. It is expected that further studies of this kind will soon allow to submit the predictions made to a rigorous empirical test.

The concept of modal emotions and verbal labeling

In discussing the differentiation of emotional states the standard emotion words that generally characterize discussions of affect and emotion - anger, fear, joy, sadness, disgust and the like, have been very rarely used. In part, this is motivated by an attempt to avoid reification of these concepts and to set the present theoretical approach apart from discrete emotion theories. Contrary to those theorists, the component process model does not share the assumption of a limited number of innate, hard-wired affect programs, which mix or blend with each other in order to produce the enormous variety of different emotional states (see detailed comparison below). Rather, the emotion process is considered as a continuously fluctuating pattern of change in several organismic subsystems. In addition, it is considered advisable to empirically study the response patterning produced by individual SECs before looking at more complicated sequences of SEC results.

However, there is no denying that there are some major patterns of adaptation in the life of animate organisms which reflect frequently recurring patterns of environmental evaluation results. All organisms, at all stages of ontogenetic development, encounter blocks to need satisfaction or goal achievement at least some of the time. Thus, frustration in a very general sense is universal and ubiquitous. Equally universal are the two major reaction patterns fight and flight. Consequently, it is not surprising that the emotional states which often elicit these behaviors, anger and fear respectively, seem universal and present in many species. In terms of the model proposed here, it is highly likely that, if one were to compile a frequency distribution of SEC patterns, some combinations of SEC results would be found to be very frequently encountered by many types of organisms, giving rise to specific, reccurring patterns of state changes. It has been suggested (Scherer, 1984b) to use the term modal emotions for the states resulting from these predominant SEC outcomes due to general conditions of life, constraints of social organization, and similarity of innate equipment.

Given the prominence and the frequency of occurence of these episodes of highly similar emotional experiences, it is not surprising that they have been labelled with a short verbal expression, mostly a single word, in most languages of the world. This would be predicted from a principle of economical verbal coding of objects of communication (see Clark & Clark, 1977, pp. 552-557; Whorf, 1956; Zipf, 1949). It seems appropriate, then, to talk about fundamental or basic emotions in the sense of modal emotional states (as characterized by a specific sequence of SEC results and the appropriate subsystem patterning) which are highly likely to be verbally labeled. However, this does not necessarily indicate the existence of rigid innate affect programs or even of discrete response states since a modal emotion could consist of a fuzzy set of similar but not identical component patterns (see Fehr & Russell, 1984; Shaver, Schwartz, Kirson, & O'Connor, 1987, p. 1063; for a review of similar suggestions in the literature). Discreteness is -- at least in part -- bestowed by linguistic categorization and the cultural prototypes these categories reflect (see Shaver, et al., 1987). Linguistic categories conceptually order the world for us in many domains and they do so for emotion. Among the many advantages of this categorial organization are cognitive economy and communicability of the underlying referents.

Verbal emotion labels are only one type of representation of the emotion process. It can be argued that they represent the reflexive part of the monitor subsystem described above. Whereas the monitor subsystem as a whole reflects the changes in the states of all other subsystems, there is, at least in humans, a conscious part. This is the component of the emotion process available for reflexion and for verbal description. The conscious part of the monitor system may reflect many aspects of the other emotion components -- the evaluation of the situation, the neurophysiological changes, expression, and action tendencies -- and so do many emotion words, particularly those considered to stand for "fundamental" emotions.

However, it is important to keep in mind that the activity of labelling is independent of the emotion process, and of emotional experience as a whole. It is to some degree arbitrary which aspects of the emotion process are selected and labelled by a word in the language, depending on the communication intentions of the language users. Thus, there are some words that mainly select out the physiological reaction component, such as "aroused" or "tired". Some are quite cognitive, like "bewildered" or "curious". Others focus on rather specific socio-motivational antecedents like "jealous". Still others emphasize the action tendency aspect like "hostile". As mentioned above, the special importance of the "basic emotion words" may reside in the fact that they refer to a more global set of changes in many of the subsystems of our emotion construct (see Scherer, 1984b).

It is important to note that the existence of a specific emotion label in one, or even several languages, does not yet establish the existence of a corresponding, frequently occurring pattern of SEC results with respective componential response patterning, i.e. a modal emotion. This would seem to be a matter for empirical investigation. Consequently, a verbal emotion label cannot be used as an explanans (as it often is in the psychology of emotion). Rather, it is an explanandum. Emotion labels may in part be based on typical reactions of the social environment which may be quite similar for rather different emotions (cf. the constructionist view held by Averill, 1980b). Consequently, empirical investigation is required to determine how patterns of event appraisal and the nature of the subsequent subsystem responses result in the use of a particular emotion word or expression by the experiencing subject (reflective activity within the monitor subsystem)?

In the following section, a series of hypotheses on the nature of combinations of SEC results that will elicit the use of a set of major emotion labels (as found in many languages) is suggested. Furthermore, even though as noted above, the existence of a label does not prove the presence of a modal emotion, the existence of a standard set of similar verbal labels in many languages of the world will be used as a working hypothesis to predict vocal, facial, and autonomic patterning of a number of hypothetical modal emotions which might be referenced by these labels.

Table 6 about here

SEC predictions of emotion label use

Since the component process model assumes that emotional differentiation is produced by the results of the SEC sequence, it follows that the latter should also be the key to understanding the use of emotion labels. Table 6 shows the predicted profiles of the antecedent SEC result patterns expected to underly the use of selected emotion words. The predictions made were based on a theoretical analysis in the first version of this table (Scherer, 1981), they have been continuously refined on the basis of the author's own research and the relevant literature that appeared in recent years (see below).

For each of the SECs, a graded scale of result alternatives is assumed and both the polarity and the grading are used for the predictions. The term "open" indicates that many different results of a particular check are compatible with the use of a certain term or that the check may be irrelevant for the term concerned.

The grading (or intensity) aspect is particularly important for the attempt to differentiate between emotions that are closely related in the basic structure of the antecedent situation, but which may be quite different qualitatively because of grading differences in the SEC results. This is true, for example, for the distinction between hot and cold anger, or between worry and fear. The failure to distinguish between such related states may be the reason for the difficulty of replicating results in research on emotional responses since different investigators may have used similar sounding labels for qualitatively rather different emotional states.

Empirical tests of predictions on emotion label use

As in the case of the bodily subsystem responses, the predictions ventured in Table 6 are difficult to test empirically since the results of an SEC sequence can only be obtained by self-report of the experiencing subject. Obviously, any checking that occurs below the cortical level, outside of awareness, is not retrievable in this fashion. Yet, there exist some indirect ways of investigating the hypothesized relationships between SEC results and verbal labels. In this section the most promising paradigms for this type of research and the evidence to date will be reviewed briefly (a more extensive discussion can be found in Scherer, in press).

Similarity analysis of emotion labels. One possibility is to study the degree of fit between emotion word taxonomies based on similarity analyses of emotion labels and hypothesized SEC results. It seems useful to employ empirically obtained taxonomies rather than theoretically derived ones in order to avoid circular reasoning. The aim is to assess to which degree the conceptual distinctions in the semantic field of the emotion lexicon, i.e. the factors, dimensions, or tree structures found in similarity rating studies of emotion terms reflect the antecedent appraisal criteria. While there are many studies using multidimensional scaling or cluster analysis of emotion words (Clore, Ortony, & Foss, submitted; Fillenbaum & Rapoport, 1971; Mees, 1985; Shaver et al., 1987), few attempt to link the results to emotion-antecedent appraisal processes. In a study with 235 German emotion adjectives, the author used multidimensional scaling and cluster analysis methods to obtain structural models of the perceived similarity relationships. The data showed that the resulting structures are indeed compatible with the SEC model. An admittedly somewhat speculative interpretation of the dimensions and the dendrogram nodes lends support to the idea that the structure of the emotion-antecedent evaluation process is reflected in the hierarchical organization of the semantic space formed by major emotion terms (Scherer, 1984b). Further studies and analyses suggested a tetraeder model of emotional meaning which can be linked to the SEC criteria (Gehm & Scherer, 1987, in press a). It is claimed that similar analyses can be made of other published similarity studies (taking care to exclude methodological artifacts which are often due to a biased selection of the labels used, cf. Scherer, 1984b, p. 52-55; Gehm & Scherer, in press a, p. xx).

Componential analyses of emotion labels. Rather than asking subjects to determine the similarity of emotion words, they can be given a list of the appraisal criteria or components with the task of rating many emotion labels on which of the appraisal criteria are likely to produce the respective emotion. Several studies of this type (Frijda, 1987; under review; Scherer, 1983) have confirmed the respective theorists intuition and support the predictions in Table 6. While such data, which obviously reflect cultural schemata or folk theories of emotion, cannot be used to empirically investigate which appraisal patterns actually precede particular emotional states, they do seem to be useful to predict under which appraisal circumstances particular labels are likely to be used in a culture since labeling is not independent of cultural emotion schemata.

Responses to componentially simulated situations. In order to experimentally study the role of different combinations of appraisal factors one can "synthesize" experiences by constructing vignettes of emotional situations in which appraisal factors are systematically varied. Subjects are then asked to put themselves into this situation and to imagine their likely reactions. Weiner and his collaborators were among the first to use this technique to determine the emotional effects of causal attribution. Weiner, Russel, & Lerman (1979) found that pride and other self-esteem related emotions depended on the attribution of internal causes for success whereas depression, apathy, and resignation were caused by internal and stable causes for failure. In similar studies it was shown that anger tends to be produced by the attribution of controllable causes, pity by the attribution of uncontrollable causes (Meyer & Mulherin, 1980; Weiner, 1980; Weiner, Graham, & Chandler, 1982).

Scherer (1984b) has suggested to use facet theory approaches as a theoretical basis for such simulation studies. In two studies on shame, Borg, Scherer, & Staufenbiel (1986a, in press) constructed a "mapping sentence" (see Borg, 1981; Guttman, 1957) for the appraisal process preceding shame experiences and designed a set of situations where the major elements of the mapping sentence were varied systematically. Subjects were then asked to indicate how much shame they would probably experience in each of these situations. The results show that the manipulated factors account for more of the variance than one would expect by chance and that the facets "comprehensiveness of the value system concerned", "degree of violation", and "agency" accounted for the distribution of the responses in a multidimensional space.

Roseman (1984) used the simulation approach to test the predictions made in his cognitive emotion theory and reports that the results in general confirmed the predictions (with the exceptions of those related to the motivational/situational state and the legitimacy dimensions).

While this approach is methodologically very satisfactory, it is likely that the data again mostly reflect cultural schemata or folk theories on emotion antecedent appraisal. In addition, there is a danger that the manipulation of antecedent factors becomes obvious to the subjects.

Appraisal ratings of recalled emotion experiences. Another approach, which seems more ecologically valid, is to ask subjects to recall emotional experiences and to obtain self-reports of the criteria used in the evaluation of the respective situations. Weiner and his collaborators used this technique successfully in an attempt to replicate results on affective consequences of causal attributions obtained in simulation studies reported above (Weiner et al., 1979, 1982)

Based on the results of earlier cross-cultural studies of emotional experience (Scherer, Summerfield, & Wallbott, 1983; Scherer et al., 1986), the author and his collaborators used this technique in a large questionnaire study of emotional experience with several thousand respondents in 27 countries all over the world. Respondents were asked to describe recent situations which had provoked fear, anger, sadness, joy, disgust, shame, and guilt respectively. In addition to reporting the duration and intensity of the subjective feeling and the nature of the verbal, nonverbal, and physiological responses, they were asked a number of questions on how they had evaluated or appraised the event (the questions having been formulated in accordance with the SEC model). Table 7 shows the results for these questions (adapted from Wallbott & Scherer, 1986).

Table 7 about here

While it is apparent that this method is much too gross to allow a detailed scrutiny of the predictions made in Table 6, the results generally support the predictions. Further analyses, using nonmetrical regression approaches, show that the answers to these questions, based on the SEC model, allow to unambiguously differentiate the different emotions (Gehm & Scherer, in press b). Since the questions used in this study had to be extremely brief and simple, given the scope of the study, it is reasonable to assume that more comprehensive questions, possibly using a direct interviewing procedure, will provide a satisfactory empirical test of the predictions.

This assumption is confirmed by the work of Smith & Ellsworth (1985, 1987) who used this method to test the predictions made in their cognitive theory of emotion-antecedent appraisal. In the first study (1985), subjects were asked to recall past experiences of 15 different types of emotion and to rate these on each of eight dimensions they had proposed. The results showed specific appraisal patterns for each emotion, largely in line with predictions. In a second study (1987), Smith & Ellsworth used an actually occurring emotional state rather than recall in asking students to report on their cognitive appraisal patterns and their feeling states before and after an examination. Among other findings, they showed that apathy is based on attributing agency to others, and anger to perceived lack of legitimacy.

Higgins (1987) and his collaborators assessed the appraisal of discrepancies between actual and ideal self on the one hand and of actual and "ought" self on the other hand, and related these data to recalled emotional states. They found, as predicted, that actual/ideal discrepancies produce dejection-related emotions (e.g., disappointment, dissatisfaction, sadness), whereas actual/ought discrepancies produce agitation-related emotions (e.g. fear, threat, restlessness).

No attempt has been made in this section to document in detail exactly which cell predictions in Table 6 have been confirmed by the empirical studies reviewed. This is due to two reasons. First, as mentioned above, some of this literature has been used to refine the earlier predictions and thus the entries in Table 6 are not, strictly speaking, independent of the data. Second, none of the empirical studies has used the level of detail in describing the appraisal criteria as proposed here. Consequently, the results are not always directly applicable to the cells. Further empirical research tailored directly to a test of the predictions in Table 6 is needed and is in preparation. However, it should be recognized that the bulk of the empirical data available in the literature strongly support the general approach suggested here as well as many of the detailed predictions.

ANS, vocal, and facial response predictions for modal emotions.

It has been suggested above as a working hypothesis that the major verbal emotion terms might indeed refer to empirically demonstrable modal emotions in the sense of a fuzzy set of similar componential pattern processes. Based on this working hypothesis, some detailed predictions on the probable ANS, voice, and face responses for these modal emotions will be ventured in this section. The following procedure has been used to derive these hypotheses: The predictions on the SEC profiles underlying label use (shown in Table 6) are used as assumptions concerning the specific sequence of SEC results that should produce the modal emotion labelled by the respective term. It is further assumed that these SEC results have patterned the different subsystems in the way predicted in Table 5. Consequently, by combining the predictions in Tables 5 and 6, and using some extrapolation, the hypotheses presented in this section have been arrived at.

Table 8 about here

Table 8 shows the predicted pattern for the physiological variables that could reasonably be expected to be assessed experiment, given the present state of art. The indications on intensity of the expected change are mostly based on the theoretically predicted dominance of the ergotropic or trophotropic systems respectively. In those cases where the predicted profiles do not follow directly from the ergotropic-trophotropic system characteristics, other functional considerations, as expressed in Table 5, have been taken into account.

Table 9 about here

Table 9 contains the predictions for the facial expression patterns predicted for the modal emotions. Again, Ekman & Friesen's FACS-based action units are used for the description of the patterns, since they seem most useful for an empirical test of the hypotheses. The intensity indications are based on the presumed strength of the physiological arousal as well as the specific functional requirements listed in Table 5. It should be noted that not all of the action units listed as operative in any one modal emotion are expected to occur simultaneously. In many cases, different subgroups of action units will be involved.

Table 10 about here

The vocal expression predictions for the major modal emotions are listed in Table 10. A detailed description of the acoustic variables used as well as a justification for the patterns hypothesized can be found in Scherer (1986a).

Since body movement patterns are very variable and often depend on instrumental activities and since only very few discussions of the functional uses of body movements in individual emotions are to be found in the literature, no prediction table has been worked out for this response modality.

The major difficulty in this exercise is the problem of allowing for the effects of a consequent SEC result on the state change produced by the antecedent SEC -- particularly in those cases where the same structures are involved (i.e. the sympathetic part of the ANS). Obviously, given the present state of our knowledge, it is impossible to specify precisely the degree of change to expect or all the interaction effects. Thus, the hypotheses presented here are rough approximations and will require constant revision, not only because of new empirical data but also because of the steady growth of our knowledge concerning ANS and SNS operation.

What is the evidence for the predictions in Table 8 to 10 to date? The physiological literature is very confusing, precisely because the important distinctions between similar emotional states (quiet enjoyment vs. exuberant joy, hot anger vs. cold anger) have not been consistently made in the literature. Therefore, it is difficult to know whether failure of replication is due to the fact that different states have been investigated under the same label (see also Frijda, 1986, p. 164). While there is some evidence from studies using physiological measurement for many of the predictions in Table 8 (see reviews by Frijda, 1986; \hman, 1987; Stemmler, 1984), the empirical data are far from satisfactory. Obviously, in addition to the usual problems of studying the highly private phenomenon of emotion, it is particularly difficult to study this phenomenon in its full-blown form within the confines of the physiological laboratory. Self-report studies of physiological symptoms in recalled emotion situations generally support the predictions in Table 8, to the extent that the verbal description of symptoms can be linked to specific variables (see Scherer et al., 1986; Schmidt-Atzert, 1981; Shaver et al., 1987; Shields, 1984).

While facial and vocal expression are more easily observable, and could, ideally, be scored in field observations of emotional behavior, studies with realistically induced states or actually observed naturistic expressions are as scarce as for the physiological domain. However, in these response modalities one can use posers to portray facial and vocal emotion expressions corresponding to the modal emotions, allowing to objectively study the expressive patterns produced. By obtaining accuracy data based on judgments of the portrayals one can be reasonably certain that at least the ritualized emotional communication patterns, if not spontaneous expression, are studied. The patterns obtained from facial (Ekman & Friesen, 1978; Wiggers, 1982) and vocal (Scherer, 1986a) measurement of such portrayals correspond in large part to the predictions in Tables 9 and 10.

Clearly, systematic empirical tests of these predictions using realistic induction, field observation, and possibly imagination and recall, will have to be conducted in the future (with due respect for the ethical constraints involved). Contrary to past procedures, however, researchers should not be content to induce or identify a state on the basis of their intuition which situation corresponds to a given emotion label. In order to render different emotion-antecedent situations or inductions comparable and replicable, one has to be sure that the same state has been produced in all subjects. Only a detailed assessment of each subject's subjective evaluation of the antecedent situation can assure this comparability. It has been suggested to use a facet system based on the SEC model as a standardized measurement grid for this purpose (Scherer, 1983, 1984a).

Apart from the need for comparability among studies, the theoretical basis for the predictions made here requires that the presumed appraisal patterns underlying the modal emotions discussed in this section actually evoke the emotion episode to be studied in terms of the different response modalities. The natural language labels used as emotion identifiers in the research literature to date are obviously far too vague and imprecise as to be useful for experimental operationalization. It is suggested, then, to use the SECs (or a similar system of appraisal criteria) to operationalize the states to be induced or the situations to be selected in the field. Obviously, individual differences between subjects will play a much greater role in this type of research. Given the powerful contribution to the variance from individual differences, particularly in psychophysiological studies, it seems preferable to manipulate this factor rather than adding it to the error variance.

Empirical investigation of the sequence hypothesis

Given the difficulty of producing as well as assessing different SEC results and the speed of change in the subsystems concerned, empirically testing the predictions ventured above requires methodologically sophisticated research strategies. In this section, some useful paradigms will be presented.

As an example of an investigation of sequential micro-changes we can refer to the attempts to differentiate orienting response and defense response in cardiac and skin conductance measures (Graham, 1979). Since there seem to be different types of directions of change for these two components of the reaction to sudden, unpleasant stimuli, it is possible not only to provide empirical support for the assumption of a sequence of evaluation, i.e. the novelty check occurring before the hedonic valence check, but also to assess timing and relative intensity.

Since the subsystem changes become increasingly complex with added SEC results, the exact onset of the later checks may be even less easily determined on the basis of physiological parameters, particularly since the latter are likely to manifest different latency times and recruitment curves. Given the time-critical role of endocrine secretions, it would be very helpful if these could be assessed in situ rather than while they are circulating in the bloodstream or measured in the form of derivatives. It is to be hoped that advances in neuroendocrinological assessment techniques will make this feasible, at least for the animal model.

The highly complex interrelationships between different autonomic parameters render it very difficult to associate a particular measure or direction of change with a concrete SEC result. This task might be somewhat easier in the action system, where the onset of potential changes in clearly specifiable groups of skeletal muscles can be measured using various EMG techniques or via micro-coding of observable muscle movements (e.g. using Ekman & Friesen's, 1978, Facial Action Coding System). Given the rapidity of facial muscle movement this would probably require high-speed film rather than videotape recording.

This approach should allow us to investigate not only some of the specific predictions made above but also to test the sequence hypothesis. For example, corrugator activity is expected as a result of a goal-state discrepancy and is predicted to have its onset before lower face muscle activity, like tensing of the orbicularis oris, which is postulated as an effect of a positive result of the (later) coping potential check. The final result of this consecutive innervation of these different muscles groups would be the well-known anger face.

Micro-measurement of the sequence of onset and relative strength of different facial muscle groups, hypothesized to be differentially associated with various information processing results, would be of major significance in an empirical test of the componential patterning model. Such studies would also provide a critical test between the componential sequencing predictions made by the present model, and the innate motor programs postulated for a limited number of basic emotions by discrete emotion theorists (Ekman, 1984; Izard, 1977; Tomkins, 1962), since the latter assume a unique pattern of muscle innervation and would thus probably argue for a simultaneous onset of the different parts of the pattern.

The approaches described so far allow to test the sequence hypothesis in naturally occurring emotional episodes. In addition, one can think of a number of experimental approaches to test the hypothesis. One possibility would be to vary the order in which subjects are exposed to information relevant to their adaptation to a given event, e.g. the type of goal or need affected, the obstructiveness or conduciveness of the event, or the amount of control and power available to them in the situation. It would be predicted that the appropriate emotion would occur faster if the information is provided in the sequence proposed. A variant of this approach could be used with subjects who are to judge the emotion experienced by another person. Again, the relevant information could be provided in different orders (e.g. via video clips, or via verbal messages). Again, the prediction would be that judgments would be faster and more accurate if they are provided in the sequence predicted for the SECs.

While fraught with some methodological problems, one could also try to use video feedback methods to ask subjects to recall the sequence in which they evaluated an experimental, emotion-inducing event, by attempting to recall their train of thought. Hopefully, EEG methodology will improve to the point where it may become possible to roughly trace different evaluation patterns independent of verbal report. To some extent, the predictions ventured above on CNS patterns, i.e. concerning alpha blocking and evoked potential components, might already be amenable to systematical testing of the sequence hypothesis.

Comparison with other theories of emotion

It has been mentioned at the outset that the component process model is a very eclectic theory of emotion which attempts to incorporate those aspects of earlier theorizing that seem pertinent. In this section, the conceptualizations proposed and the predictions offered by the component process model will be systematically compared with some of the major theoretical approaches in the literature.

Central and peripheral theories. One of the classic controversies in the emotion literature has concerned the question of whether emotional experience, subjective feeling, is produced by feedback from peripheral systems, particularly the ANS and the SNS (as claimed by James, 1884, and Lange, 1885; and in the form of a facial feedback hypothesis by Tomkins, 1962/63, and Izard, 1971, 1977) or whether it is a direct concomitant of the central processes that control emotional responding (Cannon, 1927, 1929). The component process model suggests that both positions are partly correct: since subjective experience or feeling, as representing the state of a monitoring subsystem, is seen as reflecting the state of all other subsystems, both peripheral and central factors contribute to the differentiation of subjective experience. However, the model suggests that central factors, i.e. the information processing subsystem, have priority, in terms of both significance and temporal delay. Since the evaluation of ongoing events is at the core of the appraisal process giving rise to emotion, attention focussing within the monitor subsystem should be closely directed at the central appraisal processes (except if there is no novel input or concern with re-appraisal, or if there is a special need to appraise internal signals from peripheral systems). Thus, central or peripheral input may be more or less dominant depending on the internal state of the organism, its present concerns, and the rate and significance of external stimulation. In terms of speed, central processes within the CNS act obviously much faster on the monitor system than the more slowly reacting peripheral systems, particularly if ANS responses are first mediated through endocrine release.

Arousal theories. The notion that most emotions are characterized by a differential degree of ergotropic (or sympathetic arousal) as held by Cannon (1929), Duffy (1941) and others is reflected in the componential patterning predictions described above. However, the component process model does not restrict the differentiation to the degree of sympathetic arousal. In line with modern conceptions of different axes of physiological responding and using the functional argument of the ANS serving the specific adaptational needs of the organism in preparing specific behaviors, a differentiated pattern of support system states is predicted for each particular combination of SEC results which requires a differential behavioral response.

While the component process model shares the assumption of cognition-arousal theorists (Schachter, 1975; Mandler, 1984) that there are as many different emotional states as the number of cognitive interpretations of situations and events, it differs with respect to the notion that the differentiation is only present at the cognitive level (i.e. in the information processing subsystem) whereas other subsystems, particularly the ANS, are undifferentiated. On the contrary, as shown above, componential patterning theory predicts that the states of all organismic subsystems will be as differentiated as the particular sequence of SEC results since, according to the theory, "cognitive" differentiation will produce an equivalent differentiation in the other subsystems (see also Lang, 1984). Since the differentiation depends on individual SEC results and since some outcomes can be similar across situations, the degree of differentiation of emotional states can vary strongly and may in some cases be difficult to discern by direct observation. Effects like those studied in the Schachter-Singer (1962) type experiments (if their existence can indeed be reliably established, see Reisenszein, 1983) or excitation-transfer effects (Zillmann, 1978) can be accomodated by the component process model if the assumption that feeling is the reflection of both information processing system and support system is complemented by postulating the need for consistency or consonance in the monitoring system (based in part on past experience of the relationship between specific appraisal patterns and support and action system responses). This need for consonance may even result in the elicitation of active search processes in the appraisal system. The latter is not expected to be a passive input processing device, it may be actively directed toward a search for appraisal results that can produce internal consonance.

Theories of discrete emotion. Componential patterning theory shares with discrete emotion theories (Izard, 1977; Tomkins, 1962, 1963) the postulate of differentiation of emotions in the various subsystems. However, discrete emotion theory postulates the existence of a small number of innate, basic emotions with clearly specified sets of response characteristics which are released in a unitary fashion by neural programs. The component process model, by contrast, does not assume a fixed number of basic emotions with a limited number of differentiated response sets. Rather than assuming that specific antecedents trigger - somewhat in the manner of innate releasing mechanisms - unitary response patterns, the componential patterning theory postulates that the state changes in the organismic subsystems are directly dependent on the nature of the evaluation process. This assumption, combined with the strongly functional approach taken in this model, allows, as shown above, a reasoned derivation of predictions concerning specific response patterns based on the functional significance of individual SECs. Even though discrete emotion theorists generally also favor a functional approach, it seems to be much more difficult to theoretically derive the functional significance of highly complex response patterns from these theories.

It should be noted that the point of dissension concerns the assumption of discrete emotion theory that the differentiated emotional states labeled in a highly similar fashion by most languages are produced by innate neural programs, not that there are indeed a certain number of very frequently occurring modal emotions. The component process model allows for the fact that a certain number of specific appraisal outcomes and their concomitant patterning in the other subsystems occur very frequently due to the biological and social constraints of social life and are treated and labeled in a prototypical manner in many cultures (see also prototype theory, Shaver et al., 1987; where the emphasis is placed on the prototypical representations of these modal emotions).

The conceptualization of the states referred to by "fundamental emotion labels" as modal outcomes of SEC appraisal and patterning has the advantage over discrete emotion theory's notion of neural programs, that the multitude of affect blends can be directly explained without additional assumptions (Scherer, 1984a, p. 311). The analogy of "a painter mixing basic colors on a palette" can be used to describe the "affect blend" notion in discrete emotion theories. It is not quite clear, however, how exactly the mechanism of blending is supposed to work, particularly since relatively little emphasis is placed on an explanation of emotion-antecedent eliciting factors. In contrast, in the component process model the mechanisms responsible for "blending" (although this term is not very useful in the context of this theory) follows directly from the basic assumption - the notion that each specific combination of SEC outcomes produces a different emotion. A blend in discrete emotion theory terminology would consist of an outcome that shares parts of the SEC and response patterns of two or more "basic" emotions. This mechanisms could be likened to a kaleidoscope in which different mixtures of color and light result from the way in which the kaleidoscope pieces -- the SEC results -- arrange themselves after the instrument has been shaken. Obviously, the kaleidoscope pieces are unlikely to follow random arrangements (see also Emde, 1984). As repeatedly shown above, there is strong evidence to suggest that emotional response systems are in part biologically patterned with respect to both species-specific biological constraints in information processing and response organization. In particular, it seems highly likely that there are some innate, "prewired" connections between certain information processing patterns and corresponding changes in subsystems. To account for this, in the above analogy one can use the image of kaleidoscope pieces connected via strings which would tend to constrain the number of possible combinations after repeated shaking.

A further difference between the theories is, as mentioned above, that the component process model does not share the assumption that feedback from the facial musculature is the major factor determining subjective experience but assumes feeling to reflect all subsystem states.

In spite of these differences in details of the theoretical assumptions, the component process model owes much to discrete emotion theory and many of the actual predictions, particularly on differentiated patterning are very similar.

<u>Motivation theories</u>. There are a number of important theories which despite of stemming from very different traditions share the emphasis on biological motivation systems as constituting the root of the emotion system. One of the earliest of these models is Plutchik's (1962, 1980) "psychoevolutionary" approach, which, based on Scott's (1958) list of elementary animal motivational and behavioral systems, assumes that the emotions directly follow from the universal fundamental behavior tendencies. Panksepp (1982) uses neuropsychological evidence to postulate four fundamental neural circuits which are seen to represent basic motivational-emotional systems. Buck (1985) views emotion as a readout system for motivational potential in a small set of primary motivational/emotional systems. In addition to their emphasis on motivation, all of these theories share a strong commitment to the biological substrata of emotion and their phylogenetic continuity.

The component process model shares both the insistance on the importance of motivation and on the role of the biological, phylogenetic origin in emotion. However, the relationship between motivation and emotion is conceptualized differently. Like Tomkins (1962/63) and Frijda (1986), the present author considers the emotion system to be directly tied to motivation in that only stimuli or events that are relevant to the concerns of an individual are likely to evoke emotions and serve to focus the organism's attention and behavioral effort on the adaptive responses required. However, contrary to the motivation theorists cited above, the emotions are not seen as part and parcel of basic motivational/behavioral systems. In many motivation-based theories it is difficult to see where the distinction between motives/goals/needs/concerns as elicitors of emotion on the one hand and emotion as motivational force behind adaptive behavioral responses lies. This distinction is central in the component process model - motivation is one of the most important antecedent (independent) factors (the criterion in the goal/need significance SEC; with the relationship between the reality created by an event and the concern-related expectation of the organism as the decisive eliciting factor) and at the same time a dependent factor in form of the action tendency in the executive system, which obviously has strong motivational force. Clearly, the motive factor which contributes to the elicitation of emotion (e.g. need for achievement) is often very different from the emotion-produced motive (e.g. anger-induced aggressive urges toward the teacher held responsible for one's failing an exam). It may be that the term "motivation" is at the root of the trouble: it might be useful to distinguish between concerns/needs/goals (states the organism strives for) and activated action tendencies (the direction and energy of behavioral systems).

Given the limited number of elementary motivational/behavioral systems, most motivation theorists embrace the idea of a small number of basic or fundamental emotions (with all the problems concerning an appropriate criterion to decide on the number; see Frijda, 1986, pp. 85-90). As was discussed in relation to discrete emotion theories, the component process model departs from this assumption, both in terms of the limitation of number and the notion of blends.

Cognitive theories. As mentioned at the outset of the discussion of the appraisal mechanisms, the component process model and particularly the idea of sequential evaluation have been strongly influenced by the classic formulations of evaluation or appraisal by Arnold (1960) and Lazarus (1966; Lazarus et al., 1980, 1984). To some extent, the major contribution of the present approach to the appraisal notion is an attempt to specify the nature of the criteria used in evaluation and the nature of the process.

A certain degree of face validity for the appraisal criteria suggested in the form of SECs seems to be bestowed by the fact that other researchers have independently developed similar theoretical notions. As far as "cognitive" dimensions of emotion are concerned, one is rather astounded by both the number of recent proposals and their high degree of convergence. In one way or another, all of the following authors have proposed lists of dimensions, criteria, facets, or other structural features of emotion-preceding cognitive appraisal that can be directly compared to the SECs proposed above: Abelson, 1983; Beck, 1967; Bower & Cohen, 1982; Clark & Fiske, 1982; Clore & Ortony, 1984; Ortony, Clore, & Savis, in press; Dahl & Stengel, 1978; Davitz, 1969; De Rivera, 1977; Epstein, 1984; Frijda, 1986; Fromme & O'Brien, 1982; Higgins, 1987; Kemper, 1978; Oatley & Johnson-Laird, 1987; Lazarus, Coyne, & Folkman, 1984; Roseman, 1984; Smith & Ellsworth, 1985; Solomon, 1976; Stein & Jewett, 1982; Weiner, 1985.

A systematical comparison of these approaches to each other and to the SECs proposed here can be found elsewhere (Scherer, in press). While the number of dimensions and their conceptual definition vary widely in these different proposals, virtually all of the checks have been proposed in a similar form by one or several of these authors. Table 11 shows a comparison of some of the more comprehensive lists of criteria suggested in the literature. Consequently, it does not seem unreasonable to assume that these features play a major role in the elicitation and differentiation of emotion. However, few of these other theorists have attempted to describe the complete process of emotion-related appraisal and none has postulated a fixed sequence of specific checks. Furthermore, cognitive theorists are generally not concerned with a detailed specification of the patterning of the response modalities for the differentiated emotions produced by cognitive appraisal.

An exception is the theory proposed by Frijda (1986) which is very close to the present theoretical formulation.

Table 11 about here

Space is not sufficient to deal with the large number of recent cognitive theories that deal with affect-cognition interrelationships as related to memory, imagery, problem solving, and other cognitive activities (Bower & Cohen, 1984; many contributions in Clark & Fiske, 1982; Dörner, 1985; Lang, 1984; and others). Even though their concern is somewhat different they do not seem to be incompatible with the component process model and a more detailed analysis of the cognitive bases of the appraisal process, particularly on the schematic and conceptual levels, will require an integration of several of these approaches into the present model.

Dimensional theories. The idea that emotions can be arranged in a multidimensional space has been put forward very early in experimental psychology (Wundt, 1903) and has been evoked as a taxonomic principle by many scholars since. This persistence is certainly partly due to the surprising regularity with which three to four dimensions (hedonic valence, activity, potency, attention, among others) have been found in similarity rating studies of emotion terms and facial expressions (see Davitz, 1969; Plutchik, 1980). Russell (1980) argued for a circumplex model of affect on the basis of this consistency (but see Scherer, 1984b, and Gehm & Scherer, in press b, for a methodological critique).

The development of the component process model by the present author actually started with his incidental observation (Scherer, Abeles, & Fischer, 1975, p. 138) that the three major dimensions of feeling seem to reflect the major criteria of emotion-antecedent appraisal (intrinsic pleasantness/goal conduciveness = hedonic valence; goal obstruction/urgency = activation; coping potential = potency; in terms of the SECs). One can make a case that dimensional theories provide an explanation of the meaning structure of the response domain of subjective feeling (Scherer, in press b). In this sense, they may be complementary to the component process model in providing access to the higher order factors in the structure of the monitor system. In general, dimensional approaches can be considered as theories of emotional meaning and, consequently, cannot be considered on the same level as theories trying to explain emotion antecedents and response characteristics.

Socio-cultural theories. In the section on the socio-cultural context of appraisal, the important role of the factors highlighted by these theorists has been affirmed. Yet, cpt does not share some of the more extreme views concerning the social construction of emotional experience which at times may neglect the role of the biological roots of the emotion mechanism.

Learning theories. Learning theories (e.g. Millenson, 1967; Mowrer, 1960) are no longer very prominent in the psychology of emotion. This may be partly due to the Zeitgeist. It is also a reflection of the fact, however, that most of these theories had a rather limited explanatory range. Most theorists attempted to show the role of the emotions in explaining approach and avoidance behavior and the importance of signal events. Most of the mechanisms proposed in these theories are not incompatible with the type of processing suggested for the sensory-motor and schematic levels of appraisal. On the contrary, further development of the model will require a more detailed specification of the acquisition of those sensory-motor integrations and those schemata that cannot be considered to be part of the prewired biological equipment of an organism

Conclusions

In this paper three major aims were to be accomplished: 1) to establish the usefulness of a psychological construct that defines emotion as a syndrome of several components, and as a phylogenetically based adaptive mechanism, 2) to stress the dynamic nature of emotion as a process of continuously changing states of these components, and 3) to propose that the differentiation of emotional states can be predicted on the basis of specific information processing patterns, i.e. the results of a sequence of stimulus evaluation checks. One of the consequences of this position is to place less emphasis on natural language emotion labels and on the "basic" discrete emotions that are usually seen as associated with these.

Given the major role assigned by this model to the evaluation of events in generating emotions, alternative emotion-eliciting processes have been somewhat neglected. However, this does not imply that emotional states can only occur as the result of evaluation processes such as described in this article. There are a number of examples, such as free-floating anxiety, emotions induced by proprioceptive feedback, or schema-triggered affect, for which it is difficult, at least given our present knowledge, to envisage concrete antecedent evaluation processes. Similarly, the process of empathy-generated affect cannot be explained by the present model (see Hoffman, 1984, for a comprehensive theoretical formulation). Therefore, the explanatory domain of the model in its present form is limited to emotional states provoked by external events or events recalled from memory.

At this point it may be useful to examine the theoretical issues and controversies mentioned at the outset in terms of the positions suggested by the component process model:

With respect to the complex relationships between emotion and cognition (see Clarke & Fiske, 1982; Izard, Kagan, & Zajonc, 1984; Zajonc & Markus, 1984) the present model seems to claim priority for cognition in eliciting emotion. It is indeed the case that evaluation in the information-processing subsystem is assumed to trigger the componential patterning process. However, as has been underlined repeatedly, the evaluation does not have to be cognitive in the sense of conscious, neocortical processes but may often consist of simple, subcortical matching processes on the schematic or even the sensory-motor level. Furthermore, the importance of multiple feedback and feedforward relationships between different subsystems has been mentioned in several places. This implies, of course, that changes in the action, support, and monitor subsystems will influence information processing. The analogy of a "cognitive-emotional fugue" proposed by Lewis, Sullivan, & Michalson (1984) nicely illustrates these complex interdependencies and the constant change of the relative predominance of different systems over time.

The model proposed here retains a distinction between motivation and emotion. However, motivation is seen as an antecedent and as a component of the emotion process. More specifically, one has to ask which motivational antecedents are causally linked to emotion elicitation (related to the evaluation of events in terms of salient needs or goals), and which motivational response tendencies are elicited in turn by the emotional state. As with cognition and emotion, the motivation-emotion relationships are so close as to warrant to talk of a "motivational-emotional fugue".

The question concerning the number and kinds of emotions is answered in a way which differs markedly from earlier conceptualizations. It is suggested that the results of the SEC sequence and the patterning process produces a very large number of differentiated emotional states. The phenomenologically limited number of major emotional states and the existence of a restricted number of verbal emotion labels is explained by the fact that biological constraints and recurring events in organism-environment interaction result in a predominance of particular SEC patterns, and "modal" emotional states.

As far as the issue of differentiation is concerned, the present model assumes that each component of the emotion process is separately affected, and thus differentiated, by each SEC outcome. To the extent that two emotional states share the same outcome on a particular SEC, they will share the response modality patterning. Thus, the fact that many negative emotions share a discrepancy, obstructiveness outcome of the goal significance SEC accounts for the strong ergotropic arousal component in many of these states. In general, the model predicts, on the basis of functional arguments, a high degree of differentiation in all components of the emotion process.

The model strongly endorses the notion of complex interrelationships and patterns of mutual influence between the emotion components. Thus, excitation-transfer, facial feedback, catharsis, and other effects described in the literature are all compatible with the model. They are not seen as mutually exclusive explanations, however. It is suggested that the conditions under which one or the other of these effects are likely to occur need to be studied in great detail and may involve the nature of component states involved, the response times of the systems involved, the type of synchronisation, the allotment of attention, and many other factors.

Finally, the phylogenetic continuity of the emotion mechanism is strongly asserted. The claim is made that most animal species can be said to show emotions, even though their range and complexity depend on the degree of differentitedness or capacity of the component subsystems, particularly the information processing subsystem. Similarly, the ontogenetic development of emotion is seen to follow the increasing differentiation and sophistication of the subsystems involved. The insistence on functional considerations and on phylogenetic continuity in the model imply a postulate of a large degree of universality of emotion processes across cultures. Yet, the model allows for sizeable cultural differences with respect to evaluation criteria (for example differences in values) and group- or culture-specific pull effects concerning the expression of emotion for communicative purposes.

Much of this paper has been highly theoretical and some of it admittedly speculative. The hope is that this effort can contribute towards attempts made in the direction of obtaining convergence of emotion theorists on a minimal working definition of the concept of emotion. Such a convergence, and ideally a consensus, would free the field from the rather barren terminological discussions which have dominated in the past and prepare the way for more focussed research activity. Furthermore, even though the theoretical framework proposed here could seem overly ambitious, the detailed predictions might stimulate some hypothesis-guided research with a potential of greater cumulativeness than that of studies undertaken without a theoretical framework or with only rather general assumptions.

The theoretical approach advocated here might be useful for a fresh look at two problems that have vexed the medical and psychological disciplines for some time -- stress and emotional disturbance.

Stress research, because of its major importance for many health issues in modern civilization, has become a fashionable topic and a major industry (particularly in the form of how-to-avoid-stress books, psychoactive drugs, and psychotherapies). While few stress researchers would call the emotional nature of the stress response into question, it is surprising that with very few exceptions (e.g. the work of Lazarus and his group, see Lazarus, 1984) there have been almost no links between stress and emotion research. A greater convergence of these two fields might help overcome an impasse that stress research seems to have encountered at the moment, given that there has been little progress in precise predictions as to what events will elicit which responses in particular individuals. Like many other stress researchers, our group found in two large scale laboratory stress studies that individual differences in response to the stressors were such that it was very difficult to draw any general conclusions, even though we had used subjects selected for particular coping styles (see Scherer, Wallbott, Tolkmitt, & Bergmann, 1985).

Based on this experience, and similar reports in the literature, the author has recently argued (Scherer, 1986c) that the Selyan "general impact model" which has dominated stress research for the past 50 odd years might need to be replaced with a model based on normal emotion theory. Specifically, it has been claimed that stress should be seen as a case where the emotional response to a challenging situation does not result in successful adaptation within a "normal" period of time, which may vary for different events and different emotions. In other words, it is suggested that normal emotions return the organism to an equilibrium after the problem of adaptation has been solved -- which may be after a shorter period of time for emergency emotions like fear or after a longer period for adjustment emotions like sadness (see Scherer, Wallbott, & Summerfield, 1986, pp. 132-134, 180-181, for empirical evidence on different time courses of various emotions). Emotional stress, then, consists in the prolonged duration of the affective response over and above its "normal" or modal time course, thus strongly taxing the resources of the organism. The failure of the emotional arousal to return to an equilibrium could be due to many reasons -- persistence of a threatening situation, inability to cope or to adjust, or even inappropriate normative demands in a social setting.

As far as individual differences are concerned, the SEC approach proposed here could help to trace individual differences in the appraisal of stress-inducing events or situations. Thus, the inability to document a general stress response to many stressors, particularly social ones, could be explained by the fact that different emotions are evoked on the basis of different evaluation patterns. Following the componential patterning model, we would expect major differences in the physiological and behavioral indices under these circumstances. It is not unreasonable, then, to expect that stress research based on the model of normal emotions, as outlined here, might be better able to predict individual stress response.

Research on affect disturbance, e.g. pathological anxiety or depression, has been equally beset by problems related to the enormous importance of individual response differences, as well as by serious nosological problems. Without wanting to minimize the important progress that has been made in biological approaches to affect disturbance (e.g. relating the symptoms to enzyme deficiencies or other neurophysiological malfunctioning, see Whybrow, Akiskal, & McKinney, 1984), it is suggested that research in this area could also benefit from closer ties to the study of normal emotions.

Taking depression as an example, it would seem useful to identify in greater detail the type of disturbed appraisal processes that might underly different types of depressive illness. The underlying assumption is that affect disturbance can be viewed as inappropriate functioning of the SECs, i.e. the SEC sequence yielding results that others consider "abnormal" in the light of the respective circumstances. Such "faulty" appraisals could be produced by misattributions of causation or of the significance of events or by incorrect internal criteria used for checking such as the self-perception of control or power to deal with the world. Especially as far as the latter two criteria are concerned, the present approach converges with the influential lines of thought proposed by Beck (1967) and Seligman (1975). In terms of the present model, one could take each of the SECs and determine potentially abnormal evaluation dispositions, i.e. the tendency to consistently mis-appraise a multitude of stimulus events.

Using the SEC criteria proposed above, one could arrive at the following classification (from Scherer, 1987):

1) Malfunctioning of the intrinsic pleasantness check

Anhedonia	Reduced sensitivity to pleasant stimulation
Euphoria	Exaggerated sensitivity to pleasant stimulation

2) Malfunctioning of the goal significance check

Chronic dissatisfaction and frustration	Overestimation of discrepancy to goal/need expectation
Apathy	Inability to evaluate significance and conduciveness of events

3) Malfunctioning of the coping potential check
Mania Overestimation of control and power
Anxiety disorders Worry about adequacy of power, but
feeling that control is possible
Hopelessness Underestimation of control
Helplessness Underestimation of power

Using the predictions made above relative to the neurophysiological and expressive component changes, one can attempt to derive specific hypotheses concerning the symptomatology of different groups of depressive patients (see Scherer, 1987, for an example worked out for vocal behavior).

These two examples provide a first indication of how a comprehensive model of normal emotion might be used in a more integrative approach to many types of affective phenomena. As in the case of normal emotion, the scope of the model proposed may seem overly ambitious given the dearth of knowledge in many of the areas discussed and given the lack of conceptual agreement in the field. Yet, even though the proposal in its present form may be a long way from a viable model or theory of emotion in all its different varieties, including disturbance or pathology, it would seem worth striving towards the idea of such a model.

Footnotes

%>%1%<%The term "emotion" will be used as follows throughout the article. It is postulated that an emotion system generates an emotion process consisting of a sequence of fluctuating, quickly changing emotional states. Portions of this continuous temporal process are subjectively delineated as discrete emotions. The term "emotion" without an article will be used to refer to a general phenomenon or mechanism (both in terms of system and process characteristics), similar to the use of "motivation" in relation to "a motive". Used with an article, "an emotion" or "the emotion of fear", the term refers to a discrete instance, a segmented, delimited episode in the emotion process (often one which can be labeled verbally). The terms "affect" and "affective" are used synonymously with "emotion" and "emotional".

%>%2%<%Obviously, these levels correspond to the phases of cognitive development as postulated by Piaget (1952). More recent phase theories assume that later levels do not replace but are only superimposed on earlier levels, with a much higher degree of overlap (Mounoud, 1981).

%>%3%<%This does not mean that all depressives are characterized by trophotropic dominance. As will be suggested in the concluding section, "depression" is too broad a category and may need to be refined according to the specific pattern of "pathological" appraisal.

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Table 1

Relationships between organismic subsystems
and the functions and components of emotion

Function	Subsystem	Component
Evaluation of stimulation	Information processing	Cognitive
System regulation	Support	Neurophysiological
Preparation and direction of action	Executive	Motivational
Communication of reaction and intent	Action	Expressive
Monitoring, attention focussing, and reflection	Monitor	Subjective feeling

Table 2

Description of Stimulus Evaluation Checks (SECs)

1. *Novelty check.* Evaluating whether there is a change in the pattern of external or internal stimulation, particularly whether a novel event occurred or is to be expected.

2. *Intrinsic pleasantness check.* Evaluating whether a stimulus event is pleasant, inducing approach tendencies, or unpleasant, inducing avoidance tendencies; based on innate feature detectors or on learned associations.

3. *Goal/need significance check.* Evaluating whether a stimulus event is relevant to important goals or needs of the organism (relevance subcheck), whether the outcome is consistent with or discrepant from the state expected for this point in the goal/plan sequence (expectation subcheck), whether it is conducive or obstructive to reaching the respective goals or satisfying the relevant needs (conduciveness check), and how urgently some kind of behavioral response is required (urgency subcheck).

4. *Coping potential check.* Evaluating the causation of a stimulus event (causation subcheck) and the coping potential available to the organism, particularly the degree of control over the event or its consequences (control subcheck), the relative power of the organism to change or avoid the outcome through fight or flight (power subcheck), and the potential for adjustment to the final outcome via internal restructuring (adjustment subcheck).

5. *Norm/self compatibility check.* Evaluating whether the event, particularly an action, conforms to social norms, cultural conventions, or expectations of significant others (external standards subcheck), and whether it is consistent with internalized norms or standards as part of the self-concept or ideal self (internal standards subcheck).

Note. Reproduced from Scherer, 1986a, p. 147. By permission of the American Psychological Association.

Table 3

Processing Levels For Stimulus Evaluation Checks

	Novelty	*Pleasantness*	*Goal/need Conduciveness*	*Coping Potential*	*Norm/self Compatibility*
Conceptual Level	Expectations: cause/effect, probability estimates	Recalled, anticipated, or derived positive-negative evaluations	Conscious goals, plans	Problem solving ability	Self ideal, moral evaluation
Schematic Level	Familiarity: schemata matching	Learned preferences/aversions	Acquired needs, motives	Body schemata	Self/social schemata
Sensorimotor Level	Sudden, intense stimulation	Innate preferences/aversions	Basic needs	Available energy	(Empathic adaptation?)

Reproduced from Leventhal & Scherer, 1987, p.17

Table 4

Organismic and social functions
of executive subsystem changes following SEC results

SEC result	Organismic functions	Social functions
NOVELTY		
- novel	Orienting Focussing	Alerting
- not novel	Homeostasis	Reassuring
INTRINSIC PLEASANTNESS		
- pleasant	Incorporation	Recommending
- unpleasant	Expulsion Rejection	Warning Decommending
GOAL/NEED SIGNIFICANCE		
- relevant and consistent	Relaxation	Indicating stability
- relevant and discrepant	Activation	Indicating activity
COPING POTENTIAL		
- no control	Readjustment	Indicating withdrawal
- control/high power	Goal assertion	Dominance assertion
- control/low power	Protection	Indicating submission

Table 5

Component patterning theory predictions
for CNS, endocrine, ANS, and SNS changes
following major SEC outcomes

NOVELTY CHECK

Novel:
GENERAL: orienting response, interruption of ongoing activity
CNS: EEG alpha blocking, P300 component in evoked cortical potential
ENDOCRINE: corticosteroid secretion
ANS: brief inhibition of respiration followed by sudden inhalation, HR deceleration, vasomotor changes, skin conductance responses, pupillary dilatation
SNS: local tonus changes
FACE: AUs 1,2 (brows up), 5 (lids up), or 4, 7 (frown, scanning), 26 (jaw drop, open mouth), 38 (open nostrils); gaze directed
VOICE: interruption of phonation, ingressive (fricative) sound with glottal stop (noise-like spectrum)
BODY: interruption of ongoing instrumental action, raising head, straightening posture

Not novel:
No change

INTRINSIC PLEASANTNESS CHECK

Pleasant:
GENERAL: sensitization of sensorium
CNS: -
ENDOCRINE: -
ANS: inhalation, HR deceleration, increase in glandular secretions, particularly salivation, pupillary dilatation
SNS: local tonus changes
FACE: AUs 5 (lids up), 26 (jaw drop, open mouth), 38 (open nostrils) or 12 (lip corners pulled upwards), 25 (lips part); gaze directed
VOICE: faucal and pharyngeal expansion, relaxation of tract walls, vocal tract shortened due to AU 25 action (increase in low frequency energy, F1 falling, slightly broader F1 bandwidth, velopharyngeal nasality, resonances raised / "wide voice")
BODY: centripetal hand and arm movements, expanding posture, approach locomotion

Unpleasant:
GENERAL: defense response, desensitization of sensorium
CNS: EEG alpha blocking
ENDOCRINE: corticosteroid secretion
ANS: HR acceleration, increase in SC level, decrease in salivation, pupillary constriction,
SNS: slight tonus increase
FACE: AUs 4 (brow lowering), 7 (lid tightening), eye closing (possibly intermittent), 9 (nose wrinkling), 10 (upper lip raising), 15 (lip corner depression), 17 (chin raise), 24 (lip press), 39 (nostril compression); or 16 (lower lip depressed), 19 (tongue thrust), 25 (lips part), 26 (jaw drop); gaze aversion
VOICE: faucal and pharyngeal constriction, tensing of tract walls, vocal tract shortened due to AU 15 action (more high frequency energy, F1 rising, F2 and F3 falling, narrow F1 bandwidth, laryngopharyngeal nasality, resonances raised / "narrow voice")
BODY: centrifugal hand and arm movements, hands covering orifices, shrinking posture, avoidance locomotion,

Table 6
Predicted appraisal patterns for some major modal emotions

	ENJ/HAP	ELA/JOY	DISP/DISG	CON/SCO	SAD/DEJ	DESPAIR	ANX/WOR
NOVELTY							
- Suddenness	low	hi/med	open	open	low	high	low
- Familiarity	open	open	low	open	low	v low	open
- Predictability	medium	low	low	open	open	low	open
INTRINSIC PLEASANTNESS	high	open	v low	open	open	open	open
GOAL SIGNIFICANCE							
- Concern Relevance	open	self/rela	body	rela/order	open	open	body/self
- Outcome Probability	v high	v high	v high	high	v high	v high	medium
- Expectation	consonant	open	open	open	open	dissonant	open
- Conduciveness	conducive	v con	open	open	obstruct	obstruct	obstruct
- Urgency	v low	low	medium	low	low	high	medium
COPING POTENTIAL							
- Cause: Agent	open	open	open	other	open	oth/nat	oth/nat
- Cause: Motive	intent	cha/int	open	intent	cha/neg	cha/neg	open
- Control	open	open	open	high	v low	v low	open
- Power	open	open	open	low	v low	v low	low
- Adjustment	high	medium	open	high	medium	v low	medium
COMPATIBILITY STANDARDS							
- External	open	open	open	v low	open	open	open
- Internal	open	open	open	v low	open	open	open

	FEAR	IRR/COA	RAGE/HOA	BOR/IND	SHAME	GUILT	PRIDE
NOVELTY							
- Suddenness	high	low	high	v low	low	open	open
- Familiarity	open	open	low	high	open	open	open
- Predictability	low	medium	low	v high	open	open	open
INTRINSIC PLEASANTNESS	low	open	open	open	open	open	open
GOAL SIGNIFICANCE							
- Concern Relevance	body	order	order	body	self	rela/order	self
- Outcome Probability	high	v high	v high	v high	v high	v high	v high
- Expectation	dissonant	open	dissonant	consonant	open	open	open
- Conduciveness	obstruct	obstruct	obstruct	open	open	high	high
- Urgency	v high	medium	high	low	high	medium	low
COPING POTENTIAL							
- Cause: Agent	oth/nat	open	other	open	self	self	self
- Cause: Motive	open	int/neg	intent	open	int/neg	intent	intent
- Control	open	high	high	medium	open	open	open
- Power	v low	medium	high	medium	open	open	open
- Adjustment	low	high	high	high	medium	medium	high
COMPATIBILITY STANDARDS							
- External	open	low	low	open	open	v low	high
- Internal	open	low	low	open	v low	v low	v high

Abbreviations: ENJ/HAP enjoyment/happiness, ELA/JOY elation/joy, DISP/DISG displeasure/disgust, CON/SCO contempt/scorn, SAD/DEJ sadness/dejection, IRR/COA irritation/cold anger, RAGE/HOA rage/hot anger, BOR/IND boredom/indifference; v very, rela relationships, nat nature, cha chance, neg negligence

Table 7

Differences in situation evaluation aspects between emotions*

Variable	*Joy*	*Fear*	*Anger*	*Sadness*	*Disgust*	*Shame*	*Guilt*	*F*	*df (X/6)*	*Newman–Keuls post hoc*	*eta Emotion*	*eta Country*
Expectancy	2.1	1.5	1.5	1.6	1.5	1.5	1.6	198.4	14 353	J>S = G>F>all others	0.27	0.15
Unpleasantness	1.0	2.9	2.9	2.9	2.9	2.8	2.8	6 507.8	14 514	A = D>F = S>SH>G>J	0.85	0.05
Plan hindered	1.1	2.3	2.5	2.5	2.3	2.3	2.3	1 120.2	11 349	A = S>all others>J	0.60	0.10
Unfairness	1.1	2.0	2.5	2.1	2.3	1.8	1.8	650.4	10 618	A>D>S>F>SH = G>J	0.50	0.18
Responsibility (answer alternatives treated as different variables)												
Yourself	0.39	0.30	0.11	0.18	0.10	0.59	0.69	668.3	14 710	G>SH>J>F>S>A = D	0.45	0.13
Relatives	0.08	0.04	0.16	0.08	0.08	0.06	0.05	46.1	14 710	A>J = D = S>all others	0.13	0.11
Friends	0.13	0.04	0.17	0.08	0.10	0.07	0.06	53.0	14 710	A>J>D>all others>F	0.14	0.11
Colleagues	0.03	0.03	0.15	0.03	0.13	0.05	0.02	110.8	14 710	A>D>SH>all others	0.21	0.07
Strangers	0.01	0.13	0.12	0.04	0.19	0.04	0.01	154.9	14 710	D>F = A>S = SH>J = G	0.24	0.11
Authorities	0.04	0.06	0.13	0.05	0.11	0.05	0.02	59.7	14 710	A>D>all others>G	0.15	0.12
Natural forces	0.04	0.07	0.01	0.12	0.03	0.02	0.02	82.5	14 710	S>F>J>D>all others	0.18	0.10
Supernatural	0.03	0.03	0.00	0.04	0.01	0.00	0.01	26.6	14 710	S = J = F>all others	0.10	0.09
Fate	0.04	0.06	0.03	0.18	0.02	0.02	0.03	137.7	14 710	S>all others	0.23	0.10
Chance	0.07	0.09	0.03	0.05	0.07	0.05	0.04	17.1	14 710	F>D = J>S>all others	0.08	0.09
Others (*= relatives or friends or colleagues or strangers or authorities*)	0.30	0.31	0.73	0.28	0.62	0.25	0.17	490.1	14 710	A>D>F>J>S>SH>G	0.40	0.15
Fate (*= natural or supernatural or fate*)	0.11	0.17	0.05	0.33	0.07	0.05	0.06	260.9	14 710	S>F>J>all others	0.30	0.14
Coping (answer alternatives treated as different variables)												
No action necessary	0.61	0.12	0.14	0.19	0.28	0.17	0.13	419.8	14 791	J>D>S = SH>all others	0.38	0.09
Positive influence	0.22	0.20	0.36	0.17	0.19	0.25	0.33	62.0	14 791	A = G>SH>J>all others	0.15	0.07
Escape	0.01	0.18	0.09	0.05	0.13	0.15	0.17	90.4	14 791	F = G>SH = D>A>S>J	0.19	0.09
Pretend	0.04	0.12	0.13	0.11	0.17	0.21	0.17	54.9	14 791	SH>G = D>all others>J	0.15	0.06
Powerless	0.12	0.37	0.28	0.49	0.23	0.21	0.21	175.1	14 791	S>F>A>D>SH = G>J	0.25	0.09
Immorality	1.1	1.9	2.3	1.9	2.4	2.0	2.2	491.2	10 365	D>A>G>SH>F = S>J	0.45	0.22
Self positive	2.9	1.8	1.7	1.6	1.8	1.4	1.4	1 253.4	12 207	J>D>F = A>S>G = SH	0.61	0.12
Relations positive	2.8	1.9	1.5	1.9	1.5	1.7	1.8	828.0	11 447	J>S = F>G>SH>A = D	0.54	0.08

* All comparisons between emotions are significant below the 0.001 level; for expectancy (questionnaire item 7), pleasantness (item 8), plan hindered (item 9), unfairness (item 10), immorality (item 13), positive influence on self (item 14) and on relationships (item 15) answer alternative "0 = not applicable" was excluded from the analyses.

Reproduced from Wallbott & Scherer, 1986, pp. 784-785

Table 8

ANS response predictions for modal emotions

	ENJ/ HAP	ELA/ JOY	DISP/ DISG	SAD/ DEJ	DESPAIR	ANX/ WOR	FEAR	IRR/ COA	RAGE/ HOA
Physiological variables									
Respiration									
- rate	<<	>		<	>	>	>>	<	<
- depth			<	<				>	>
Cardiovascular System									
- heart rate	<	>	>	<	>	>	>>	>	>
- diastolic blood pressure							<	>	>>
- systolic blood pressure							>	>	>>
- vessel constriction/dilatation									
-- heart/muscles		>					>>		
-- internal/sexual organs					<	<	<<		
-- head/torso								>	>>
-- extremities							>		
-- skin		<					<<		
Glandular secretion									
- salivation	>>	>	<	<	<	<	<<		
- tears				>	>				
- sweat (SC)		>	>	>	>	>	>>	>	>
Gastric motility	>>	<			<	<			
Pupillary opening	>	>	<	<	>	>	>	<	<

Note: > refers to increase, < to decrease, = no change; double symbols indicate the predicted strength of the change

Table 9

Facial expression predictions for modal emotions

Action Units	ENJ/ HAP	ELA/ JOY	DISP/ DISG	SAD/ DEJ	DESPAIR	ANX/ WOR	FEAR	IRR/ COA	RAGE/ HOA
1 Inner brow raiser		>		>	>>		>>		
2 Outer brow raiser		>					>>		
4 Brow lowerer			>	>	>>	>	>	>	>>
5 Upper lid raiser	>	>				>	>		>
6 Cheek raiser	>	>							
7 Lid tightener			>	>	>>	>	>>	>	>
9 Nose wrinkler			>						
10 Upper lip raiser			>						>
11 Nasolabial furrow deepener									
12 Lip corner puller	>	>>							
13 Cheek puffer									
14 Dimpler									
15 Lip corner depressor			>	>	>>				
16 Lower lip depressor			(>)						>
17 Chin raiser			>		>			>	>>
18 Lip puckerer									
19 Tongue thrusting			(>)						
20 Lip stretcher						>	>>		
22 Lip funneler									
23 Lip tightener					>	>		>>	>
24 Lip pressor			>		(>)			>	
25 Lips part	>	>	(>)	>	>		>		>
26 Jaw drops	>	>>	(>)	>	>		>		>
27 Mouth stretches					>				
28 Lips suck									
38 Nostril dilator	>								>
39 Nostril compressor			>						
41 Lids droop				>					
42 Eyes slit								>	
43 Eyes close				>					
Gaze	dir	up	avert	down	var	down	dir	dir	dir

Note: > refers to increase, < to decrease, = no change; double symbols indicate the predicted strength of the change
Gaze: dir = directed toward object or person, up, down = direction of gaze, var = variable, avert = averted; Indications in parentheses refer to alternative patterns

Table 10

Vocal expression predictions for modal emotions

Acoustic parameters	ENJ/ HAP	ELA/ JOY	DISP/ DISG	SAD/ DEJ	DESPAIR	ANX/ WOR	FEAR	IRR/ COA	RAGE/ HOA
F0 Perturbation	<=	>		>	>		>		>
F0 Mean	<	>	>	<>	>	>	>>	><	><
F0 Range	<=	>		<	>		>>	<	>>
F0 Variability	<	>		<	>		>>	<	>>
F0 Contour	<	>		<	>	>	>>	<	=
F0 Shift Regularity	=	<					<		<
F1 Mean	<	<	>	>	>	>	>	>	>
F2 Mean			<	<	<	<	<	<	<
F1 Bandwidth	>	><	<<	<>	<<	<	<<	<<	<<
Formant precision		>	>	<	>	>	>	>	>
Intensity mean	<	>	>	<<	>		>	>	>>
Intensity range	<=	>		<			>	>	>
Intensity variability	<	>		<			>		>
Frequency range	>	>	>	>	>>		>>	>	>
High-frequency energy	<	<>	>	><	>>	>	>>	>>	>>
Spectral noise				>					
Speech rate	<	>		<	>		>>		>
Transition time	>	<		>	<		<		<

Note: > refers to increase, < to decrease, = no change; double symbols indicate the predicted strength of the change joint use of two symbols pointing in the opposite direction refer to cases where antecedent voice types exert influence in opposite direction

Table 11

Comparison of emotion-antecedent appraisal criteria suggested by different theorists

SCHERER	FRIJDA	ORTONY/CLORE	ROSEMAN	SMITH/ELLSWORTH	SOLOMON	WEINER
Novelty	Change			Attention		
- Suddenness						
- Familiarity	Familiarity					
- Predictability		Unexpectedness				
Intrinsic Pleasantness	Valence	Appealingness		Pleasantness		
Goal Significance						
- Concern relevance	Focality		App/Ave Motives		Scope/Focus	
- Outcome probability	Certainty	Likelihood	Probability	Certainty		
- Expectation	Presence	Prospect realization				
- Conduciveness	Open/Closed	Desirability	Motive Consistency	Goal/Path Obstacle	Evaluation	
- Urgency	Urgency	Proximity		Anticipated effort		
Coping Potential						
- Cause: Agent	Intent/Self-Other	Agency	Agency	Agency	Responsibility	Locus of Causality
- Cause: Motive				Agency		Stability
- Control	Modifiability					Controllability
- Power	Controllability		Power		Power	Controllability
- Adjustment						
Compatibility Standards		Blameworthiness				
- External	Value Relevance			Legitimacy		
- Internal						

Table 12

Malfunctioning of stimulus evaluation checks
as a source of emotional disorder

1) Malfunctioning of the intrinsic pleasantness check

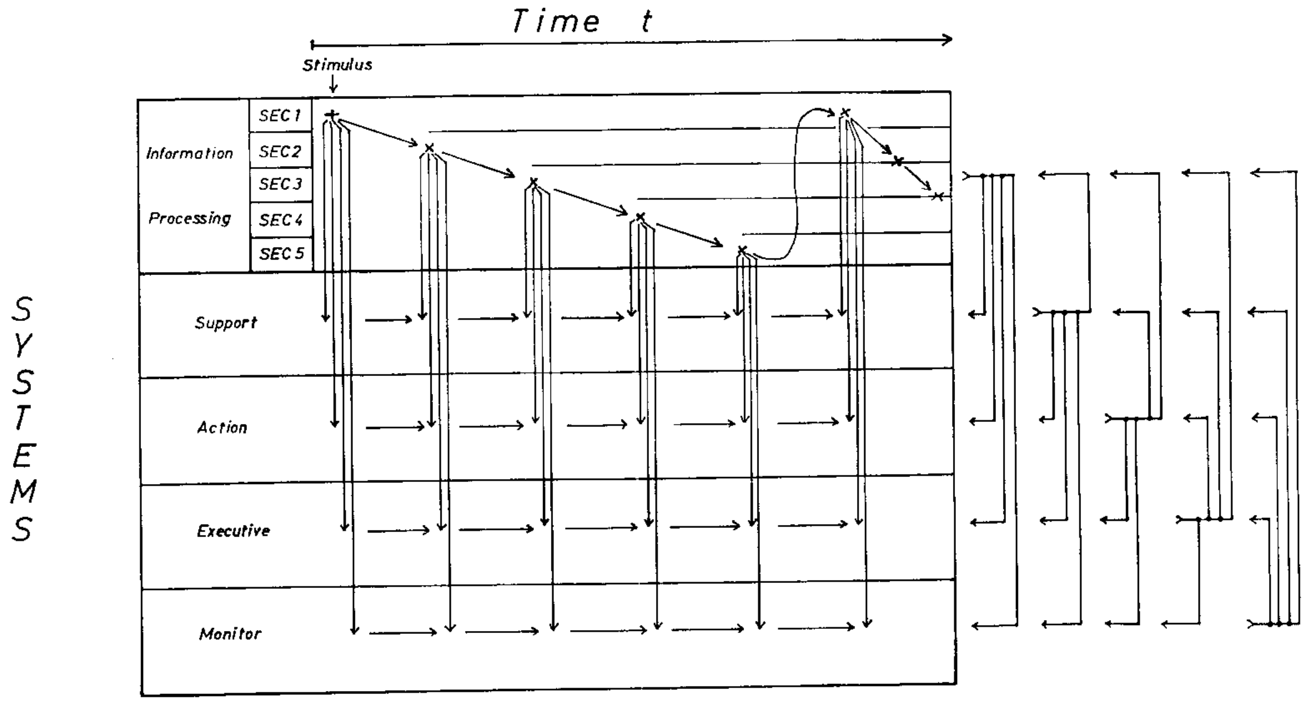
Anhedonia	Reduced sensitivity to pleasant stimulation
Euphoria	Exaggerated sensitivity to pleasant stimulation

2) Malfunctioning of the goal significance check

Chronic dissatisfaction and frustration	Overestimation of discrepancy to goal/need expectation
Apathy	Inability to evaluate significance and conduciveness of events

3) Malfunctioning of the coping potential check

Mania	Overestimation of control and power
Anxiety disorders	Worry about adequacy of power, but feeling that control is possible
Hopelessness	Underestimation of control
Helplessness	Underestimation of power


Time t
Stimulus
SYSTEMS
Information
Processing
SEC 1
SEC 2
SEC 3
SEC 4
SEC 5
Support
Action
Executive
Monitor