

Unconscious Processes in Emotion

The Bulk of the Iceberg

KLAUS R. SCHERER

This chapter reviews some of the central emotion processes and the respective role of consciousness (or its absence). Contrary to what seems to be current practice, I attempt to refrain from classifying phenomena into conscious and unconscious, which implies a divide between two separate categories. Rather, I assume that a large majority of emotion processes functions in an unconscious mode and that only some of these processes (or their outcomes) will emerge into consciousness for some periods of time. I like Freud's metaphor of an iceberg, the bulk of which is invisible (the unconscious) with only a small tip above the surface (the conscious). If we assume that the fluid in which the emotion iceberg floats (the mental soup) can vary in consistency, buoyancy will determine the degree of emergence (the buoyant force is equal to the weight of the liquid that the object displaces. If the liquid is denser, the buoyant force is greater. Steel sinks in water but floats in mercury). Similarly, increases in density of mental processing may result in a greater emergence of processing into consciousness.

The major purpose of this chapter is to analyze theoretically the conscious and unconscious processes in emotion elicitation and differentiation. Specific research is cited as illustration, but no coherent, let alone exhaustive, review is intended. To identify contrasting positions and to stimulate

1. *What is the scope of your proposed model? When you use the term emotion, how do you use it? What do you mean by terms such as fear, anxiety, or happiness?*

In this chapter, I present a comprehensive component process model of emotion that defines emotion as an episode of interrelated, synchronized changes in the states of all or most of five organismic subsystems (cognition, neurophysiological support, motivation, motor expression, subjective feeling) in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism. Emotion-constituent evaluation is described as recursive sequences of appraisal at several levels of processing (sensory-motor, schematic, conceptual) based on a set of universal criteria. This account allows for an almost unlimited number of differentiated emotional qualities to emerge, depending on the respective appraisal profile and sequence (for further details, see Scherer, 2001a, 2004a). Verbal labels such as fear, joy, or anger are seen as language-based categories for modal emotions, i.e., frequently and universally occurring events and situations that generate similar appraisal profiles (Scherer, 1994).

2. *Define your terms: conscious, unconscious, awareness. Or say why you do not use these terms.*

It would be inappropriate to attempt to define "consciousness," given the extraordinary multiplicity of definitions currently in existence. Thus, a generic core of understanding of consciousness and unconsciousness is presupposed. However, I suggest separating these notions from assumptions made about the nature of cognitive processing, such as automatic, effortful, or implicit.

3. *Does your theory model with what is conscious, what is unconscious, or their relationship? If you do not address this area specifically, can you speculate on the relationship between what is conscious and unconscious? Or if you do not like the conscious-unconscious distinction, or if you do not think this is a good question to ask, can you say why?*

Importantly, it is assumed that a large majority of emotion processes function in an unconscious mode and that only some of these processes (or their outcomes) will emerge into consciousness for some periods of time. This process is seen as linked to the degree of synchronization between organismic subsystems produced by emotion elicitation and the attention generated by a monitoring system. A process whereby parts of an integrated representation of the underlying component processes emerge into consciousness, as a prerequisite for verbal labeling and communication, is suggested and illustrated in this chapter (see Scherer, 2004a, for further details).

debate, some issues are presented in an exaggerated fashion. Most important, the spirit in which the chapter is written is exploratory, as is appropriate for the vast and largely uncharted territory of the conscious and the unconscious in emotion.

Given the rampant terminological confusion in the area of emotion-theorizing and research, it may be useful to start with a definition of emotion. I have suggested seven different types of affective states in the form of a design feature analysis (see Figure 13.1), with examples of each: Preferences, utilitarian emotions, aesthetic emotions, mood, interpersonal stances, attitudes, and affective personality traits. These different constructs are compared on the basis of a set of design features (see Scherer, 2004b) that includes (1) typical intensity, (2) duration, (3) the degree of synchronization or coordination of different organismic systems during the state, (4) the extent to which the change in state is triggered by, or focused on, an event or a situation, (5 and 6) the extent to which the differentiated nature of the state is due to a process of antecedent appraisal or evaluation (either intrinsic, i.e., determined by the object, or transactional, i.e., determined by the object in interaction with the needs/goals of the appraiser), (7) the rapidity of change in the nature of the state, (8) the degree to which the state affects behavior, and (9) the relative importance for emotion induction via art or music. Specifically, emotion is defined as *an episode of massive, synchronous recruitment of mental and somatic resources to adapt to, or cope with, a stimulus event that is subjectively appraised as being highly pertinent to the needs, goals, and values of the individual.*

In this chapter, I focus on three major processes directly determined by the reactive nature of emotion that commonly occur during an emotion episode: (1) the detection and evaluation of the significance of a stimulus event for the individual; (2) the preparation of response tendencies; and (3) the integration of evaluative and proprioceptive information, resulting in subjective feeling states. A number of issues pertinent to consciousness and elaboration is explored for each of these processes. Researchers working on unconscious phenomena in affect and emotion have their preferred terms to distinguish conscious and unconscious processes in a larger sense. This is not the place for a detailed historical overview and assignment of responsibility for the definition and use of certain terms via conscientious citation. Even a cursory overview of the literature in this domain (Bargh, 1994; Bargh & Ferguson, 2000; Cohen & Schooler, 1997; Fazio, 2001; Greenwald & Banaji, 1995; Hameroff, Kaszniak, & Scott, 1996; Kihlstrom, 1994; Lambie & Marcel, 2002; Leventhal, 1984; Shallice, 1972; Schneider & Shiffrin, 1977) suggests a number of adjectival pairs, in addition to conscious and unconscious, that are regularly used: explicit versus implicit, controlled versus automatic, effortful versus effortless, and conceptual/

<i>Design feature</i>	<i>Intensity</i>	<i>Duration</i>	<i>Synchronization</i>	<i>Event/situation focus</i>	<i>Intrinsic appraisal</i>	<i>Transactional appraisal</i>	<i>Rapidity of change</i>	<i>Behavioral impact</i>	<i>Induction via art/music</i>
Type of affective state: brief definition (<i>examples</i>)									
Preferences: evaluative judgments of stimuli in the sense of liking or disliking, or preferring or not, over another stimulus (<i>like, dislike, positive, negative</i>)	L	M	VL	VH	VH	M	VL	M	H
Utilitarian emotions: relatively brief episodes of synchronized response of all or most organismic subsystems to the evaluation of an external or internal event as being of major significance for personal goals and needs (<i>angry, sad, joyful, fearful, ashamed, proud, elated, desperate</i>)	H	L	VH	VH	M	VH	VH	VH	H
Aesthetic emotions: evaluations of auditory or visual stimuli in terms of intrinsic qualities of form or relationship of elements (<i>moved, awed, surprised, full of wonder, admiration, bliss, ecstasy, fascination, harmony, rapture, solemnity</i>)	L-M	L	M	H	VH	L	VH	L	VH
Mood: diffuse affect state, most pronounced as change in subjective feeling, of low intensity but relatively long duration, often without apparent cause (<i>cheerful, gloomy, irritable, listless, depressed, buoyant</i>)	M	H	L	L	M	L	H	H	M
Interpersonal stances: affective stance taken toward another person in a specific interaction, coloring the interpersonal exchange in that situation (<i>distant, cold, warm, supportive, contemptuous</i>)	M	M	L	H	L	L	VH	H	L
Attitudes: relatively enduring, affectively colored beliefs and predispositions toward objects or persons (<i>loving, hating, valuing, desiring</i>)	M	H	VL	VL	L	L	L	L	M
Personality traits: emotionally laden, stable personality dispositions and behavior tendencies, typical for a person (<i>nervous, anxious, reckless, morose, hostile, envious, jealous</i>)	L	VH	VL	VL	L	VL	VL	L	L

FIGURE 13.1. Design feature definitions for major types of affect. VL, very low; L, low; M, medium; H, high; LH, very high. From Scherer (2004b). Copyright 2004 by the *Journal of New Music Research* (www.tandf.co.uk). Reprinted by permission.

propositional versus schematic. Although individual authors may make sharper distinctions, there is a common tendency to assume a high degree of overlap between unconscious, implicit, automatic, effortless, and schematic, on the one hand, and conscious, explicit, controlled, effortful, and conceptual/propositional, on the other. In addition, there is a tendency to view these pairs as binary, dichotomous alternatives rather than as opposite poles on an underlying dimension. Both of these assumptions seem to require more extensive debate (see also Clore & Ketelaar, 1997).

To what extent are these modalities interrelated? It is likely that there is a high degree of empirical covariation between some of the modalities. But these relationships are probably much too complex to justify treating the terms *unconscious*, *implicit*, *automatic*, and *effortless* as synonyms. For example, on the one hand, an automatically triggered reflex may require little effort and could remain opaque to consciousness unless it is externalized as overt behavior, as in the case of the knee jerk. On the other hand, reflexes should, by definition, be explicit. Implicit processes should be effortful because they require a lot of inference to determine the behavioral meaning. If attention is one of the required resources, it is unlikely that the process will be automatic and remain entirely unconscious. The lack of appropriate conceptual distinctions may actually hinder the careful analysis of the precise nature of the processes involved in the emotion mechanism. Thus the modalities or dimensions discussed earlier should be treated as independent, continuous dimensions in a multidimensional space. In consequence, the processes under study in a particular research project should be qualified, at least roughly, with respect to their position on each of these dimensions separately. Although difficult and necessarily speculative, such an approach could produce interesting insights into the nature of the mental processes that underlie emotion. It would certainly force us to be more precise in the conceptualizations and potentially even in the operationalizations used in this research.

THE DETECTION AND EVALUATION OF THE SIGNIFICANCE AND IMPLICATIONS OF A STIMULUS EVENT FOR THE INDIVIDUAL

The presence of an emotion is an indicator that the individual has detected an event that is likely to have significant consequences for his or her needs, goals, and values. The reason that we can be confident of this statement is that the principle of economy underlying much of evolution would not permit an important investment of resources, as constituted by a massive, synchronized response across several organismic systems, unless there were a

real need for adaptation. The better we understand the process of significance detection and evaluation, the better we understand emotion. The significance of a stimulus event resides in its meaning, and its meaning, in its behavioral (as compared with semantic) sense, is defined by potential consequences for the individual's needs, goals, and values. There seem to be two major mechanisms for meaning assignment: pattern matching and rule-based inference (see also Smith & Neumann, Chapter 12).

It is generally assumed that, from an individual's past experience, the matched schemas or the inferences from specific features will produce a certain type of behavioral meaning. For example, if one has had negative experiences with doctors, a negative attitude may be activated each time one sees a man in a white coat, independent of the context. However, in many cases, the current context, and particularly the current motivational state of the person, contributes massively to the emergence of the behavioral meaning of an event (and the consequent emotional reaction). In other words, *behavioral meaning* is, in large part, constituted by an individual's assessment of the probable consequences of a particular stimulus event occurring at a particular time, and this assessment is determined by the individual's motivational state, available resources, and the respective sociocognitive context. This point is so important that it bears restating: *Although some of the behavioral meaning of a schema or an inference is stored in memory in the form of association with other memory and knowledge content as well as past affective reactions, much of the behavioral meaning in a particular situation is determined by an interaction between these stored meaning components and their evaluation in the light of the current motivational state and available resources for outcome control.*

To my knowledge, until recently (see Ekman, 2004), neither basic emotion theorists nor dimensional theorists have been centrally concerned with the nature of the processes that detect pertinent events, evaluate their consequences and meaning for the individual, and thus differentiate the resulting emotions and their behavioral effects (Scherer, 2000b). In contrast, this evaluation is the major focus of interest in componential appraisal theories of emotion (see Ellsworth & Scherer, 2003; Scherer, 1999; Scherer, Schorr, & Johnstone, 2001, for overviews), which attempt to conceptualize the behavioral meaning of an event for the individual (and thus the resulting emotion) on the basis of profiles of evaluation criteria such as novelty, agreeableness, goal conduciveness, coping potential, and norm compatibility (see Scherer, 2001a). For example, appraisal theorists might describe the behavioral meaning of an event, such as being threatened by a mugger, as novel, disagreeable, goal obstructive, difficult to cope with, and immoral. The predicted emotion would be a variant of a fear-anger blend. Importantly, appraisal theorists consider the evaluation and the resulting emotion

as a continuous and constantly changing process. The variability is due to situational changes as well as to reappraisals of the consequences. Furthermore, the motivational state of the individual as well as his or her resource supply are likely to change, sometimes rather abruptly. In consequence, behavioral meaning must be an emergent quality, subject to constant and often sudden change.

In consequence, all stimulation impinging on the organism must be constantly monitored for dynamic behavioral meaning. This meaning is emergent, based on an interaction between the nature of the event, its consequences, and the individual's motivational state. Given the complexity and changeability of the factors involved, it is unlikely that behavioral meaning can be constituted simply by matching situational features with schemas stored in long-term memory. The only exception might be powerful stimuli that have an unconditional impact, such as evolutionary threat, or other unconditioned stimuli that represent powerful aversive (pain) or appetitive (food, sex) functions. Yet even these might be mediated by motivational states. Thus it seems that pain sensitivity is mediated by both dispositional and state differences (Coderre, Mogil, & Bushnell, 2003).

In general, the ongoing evaluation of most day-to-day stimulus events will require comparative evaluation of an event with the current motivational and resource state. These operations go far beyond simple feature detection or even schema matching and are thus likely to be effortful. However, they must be largely automatic, given that they operate almost constantly. It would hardly be feasible to imagine a higher-order monitoring system controlling this process in any depth. For the same reason, much of this process is likely to operate outside of consciousness, because the attentional resources mobilized by conscious processing could not be invested in a continuous fashion. Because the significance-evaluation mechanism is *on* all the time, one might expect a shallow filter to operate to screen incoming stimulation for significant consequences, on the basis of a particular tuning or setting of the organism's motivational state. Only stimuli that are not filtered out as inconsequential will elicit deeper processing.

How does this process work? The enormous amount of research on the amygdala that has been stimulated by the pioneering work of LeDoux (2000) and Davis (1998; Davis & Whalen, 2001) suggests some beginning answers. There is much evidence to suggest that direct projections from the sensory thalamus to the amygdala serve to activate rudimentary defense reactions to powerful threats such as evolutionarily prepared stimuli (e.g., snakes, facial anger expressions) or conditioned stimuli based on painful unconditioned stimuli (Lunsvist & Öhman, Chapter 5; de Gelder, Chapter 6; Atkins & Adolphs, Chapter 7; Dolan & Morris, 2000; Vuilleumier, Armony, Driver, & Dolán, 2001; Vuilleumier & Schwartz, 2001; Whalen,

1998; Whalen, Curran, & Rauch, 2001; Whalen, Shin, et al., 2001). From this evidence, there is reason to believe that the amygdala plays an important role in the filtering process referred to earlier. This role is all the more probable because, contrary to popular opinion, the amygdala does not seem to be exclusively focused on the recognition of threat- or fear-relevant stimulation. In a careful review of the literature, Sander, Grafman, and Zalla (2003) have accumulated evidence that suggests that the amygdala is a generalized device for the low-level detection of significance or pertinence in a general sense. In other words, the amygdala seems capable of deciding, on the basis of rather rudimentary information conveyed directly from the sensory thalamus, that a particular stimulus is potentially significant for the needs and the well-being of an organism. The baffling question is, of course, how the amygdala does it. Could it be that a certain number of pertinent schemas, "the most significant of . . .," are stored in this subcortical structure, and if so, in which form? Or does the amygdala, which is highly connected to most subcortical and cortical regions, rely on schemas stored in a distributed fashion? Is the inventory of the schemas that reflects vital behavioral meaning the same for every individual, that is, genetically determined by evolutionary preparation? Or does the experience and the motivational makeup of the individual influence the target patterns stored in this central gatekeeper structure? Does the information processing that takes place in the amygdala take into account the current motivational and resource state of the organism, implying some kind of comparison, or at least tuning, or is it limited to matching the input features to invariant schemas? The research agenda for affective neuroscientists specializing on the amygdala should keep the discipline busy for some time.

Most important, despite the fascinating demonstration of the existence of a "low road" (direct thalamo-amygdala projections) and a "high road" (via the cortical association areas) of information processing by LeDoux and others, one should not forget that the process is generally integrated. Activation triggered by external stimulation speeds along both roads, and although the more rapid lower road may start producing some generalized autonomous nervous system (ANS) efference after 80 milliseconds of stimulus onset, travel on the high road is not far behind, and the first results of cortical processing will arrive at the amygdala 50–100 milliseconds later. Thus it cannot be a question of either/or but rather of how processing along the two routes is integrated and coordinated. One can assume that this integration and coordination can take many different forms, ranging from predominance of the lower road, with only minor involvement of the higher level (as in the case of stimulation to which satisfactory adjustment can be made on the basis of low-level regulation); to almost exclusive involvement of the cortical level (as in the case of logical deductions in a philosophy

seminar). In addition, it is not only the level but also the quality of processing that is at stake. Is simple schema matching sufficient or are inference and comparison required? Is the process highly routinized and able to unfold automatically or is an active, effortful, and controlled search required? How many tasks have to be dealt with at the same time and how much attention is available for each? As suggested earlier, we can expect that the quality of the respective evaluation process must be described as a trajectory through a multidimensional space formed by the dimensions of effort, automaticity, explicitness, and consciousness. Leventhal and Scherer (1987) have suggested that the type of processing with regard to content (types of appraisal) and level (sensory-motor, schematic, and conceptual) is determined by the need to arrive at a conclusive evaluation result (yielding a promising action tendency). If automatic, effortless, unconscious processes do not produce a satisfactory result, more controlled, effortful, and possibly conscious mechanisms are brought into play to determine the behavioral meaning of a stimulus event and prepare an adaptive response.

THE PREPARATION OF RESPONSE TENDENCIES

The function of emotion is to prepare adaptive behavioral reactions. In consequence, one of the most important processes is the preparation of appropriate action tendencies. The conceptualization of this essential set of processes varies considerably over the three theoretical traditions. Dimensional theorists, in line with their emphasis on valence, mostly discuss the preparation of approach or avoidance tendencies (Carver, 2001). Discrete or basic emotion theorists assume highly integrated response patterns for each of the basic emotions, particularly with regard to motor expression and physiological response specificity (Ekman, 1972; Izard, 1971). In contrast, many appraisal theorists postulate that response preparation depends directly on the results of the appraisal process (Roseman, 2001; Scherer, 1984, 2001a; Smith & Scott, 1997). I have postulated that each significant result on an appraisal dimension triggers a response in all components of emotion and that these sequential changes are cumulatively integrated. Each result of a particular check in the cognitive component is expected to affect every other component of the emotion process (even though the effect may be slight in many cases). The effects of subsequent checks cumulatively add to the pattern of change (see Scherer, 2001a, Fig. 2). Given the theoretical prediction of a fixed but recursive, sequence and of detailed response characteristics in different peripheral domains (e.g., motor expression and physiological responding), these claims can be empirically investigated (for a discussion, see Barrett, Chapter 11). This is particularly

interesting with regard to the temporal unfolding of these processes, for which there is currently little evidence in the literature. Electroencephalographic work in progress in our lab (Grandjean & Scherer, 2003) provides the first evidence for the assumption that the checks underlying the appraisal process are not simultaneous but occur sequentially, as predicted. For example, the cerebral processes at the cortical level related to the experimental manipulation of novelty, investigated with electroencephalographic methods, seem to occur earlier than the processes related to the relevance appraisal.

THE INTEGRATION OF EVALUATIVE AND PROPRIOCEPTIVE INFORMATION AND THE EMERGENCE OF SUBJECTIVE FEELING STATES

As suggested earlier, an emotion episode essentially consists of synchronized processes of event evaluation and response preparation involving several components. Each of these processes can be expected to have its own projections and proprioceptive feedback loops, allowing for rudimentary, largely automatic regulation. However, if these processes are to be controlled and regulated at a higher level, the information needs to be centrally represented and, at least in part, to emerge into consciousness. The reason is that the complete process of central evaluation and peripheral responses is unlikely to be centrally stored over an extended period of time, both because of capacity limitations and the need for meaning analysis on a macro level that can guide control and regulation efforts. In consequence, we need to model the process that underlies the emergence of integrated representations of central processing and proprioceptive feedback into consciousness.

Figure 13.2 illustrates these notions. A Venn diagram with a set of overlapping circles represents the different aspects of monitoring (see also Kaiser & Scherer, 1997; Scherer, 1994). The first circle (A) represents the raw reflection or representation of changes in all synchronized components in a monitoring structure in the central nervous system, integrating the representation of central processing and somatosensory feedback (Iwamura, 1998). This structure is expected to receive massive projections from both cortical and subcortical central nervous system (CNS) structures (including proprioceptive feedback from the periphery). Even though this representation will only become partly conscious, the information represented here is of central importance for response preparation (and thus behavioral adaptation), learning, and rudimentary coping and regulation. One might call the content of the circle *integrated process representation*.

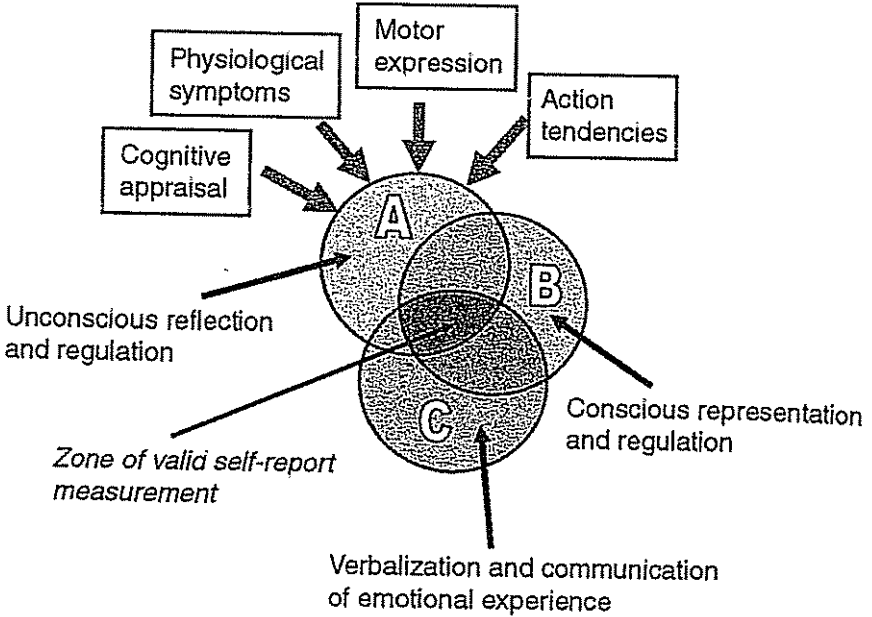


FIGURE 13.2. Three modes of the representation of changes in emotion components: unconsciousness, consciousness, and verbalization.

The second circle (B), only partially overlapping with the first, represents that part of the integrated process representation that enters awareness (possibly when a high degree of component synchronization requires a high level of controlled regulation and social communication) and thereby becomes conscious. This circle represents the quality and intensity of the conscious feeling state generated by the eliciting event. It would seem that the content of this circle is close to what philosophers and psychologists have referred to as *qualia*.

The third circle in Figure 13.2 represents the individual's ability (which may or may not be realized) to *verbally report* the subjective experience during the emotion episode and thus share it with significant others (including emotion researchers). The fact that this verbalization circle overlaps only partially with the conscious feeling circle is meant to suggest that we can verbalize only a small part of our conscious experience, as a result of (1) the limited availability of appropriate verbal categories (in a particular language and/or to a particular individual), and (2) the individual's intentions to control or hide some of his or her innermost feelings. Most important, the constant flow of consciousness cannot be completely described by a discrete utterance. Thus verbal report must, by necessity, be an approxi-

mation that identifies the most salient elements of the experience in the form of a state definition that uses concepts provided by the emotion-related semantic concepts in a language (for a more complete description of the Venn diagram, see Scherer, 2004a; for an alternative view, see Barrett, Chapter 11).

Admittedly, this schema does not do much to advance our understanding of the processes involved, but it may help us ask appropriate research questions concerning (1) the nature of the integration of information from different modalities into a coherent representation, (2) the conditions for emergence of this representation into consciousness, and (3) the encoding of conscious representations into verbal statements.

The central projections from both the cognitive processing and the motor and physiological responding need to be integrated within each domain, across the different domains, and over time. I believe that these extremely complex dynamic integration processes have been severely neglected by past work on emotion. They constitute a major challenge for investigators in this area, because the processes of integration are likely to be largely unconscious but result in a holistic, phenomenal experience or feeling that is at least, in part, conscious. In what follows, I briefly sketch the integration processes that seem to be required: (1) the integration of appraisal results, (2) the integration of peripheral component effects, and (3) integration across components and time.

Integration of Appraisal Results

In trying to predict the emotions resulting from different patterns of appraisal, theorists in this tradition have generally used profile matching or regression analysis (for a review, see Scherer, 1999) without paying too much attention to the problem of the integration of the appraisal results with regard to both the different evaluation criteria or dimensions and the changes over time. In my own model, I have proposed a recursive sequence of stimulus evaluation checks, with an accumulation of the expected efferent effects (see Scherer, 2001a, Figure 2). What remains to be done is to specify the nature of the integration functions that must underlie these cumulative processes. I have suggested attacking this issue by starting from a suggestion made by Anderson (1989), who postulates different types of integration functions based on the current goals of the organism, which transform subjective appraisal results into an implicit response (see Scherer, 2004a). It would be a major breakthrough to be able to model information integration in appraisal and to predict integration rules for combinations of specific appraisal criteria. For example, we found empirically (van Reekum et al., 2004) that the perceived coping potential has a dif-

ferent effect on psychophysiological responses as a function of goal conduciveness. As one might expect, coping ability is of less relevance and has less of an impact on the ANS when things are going according to plan. In Anderson's approach, this pattern would be modeled by a *configuration rule*, which predicts that the importance of one of the criteria depends on the level of another.

To what extent are these processes available to consciousness? Appraisal theorists are often chided for relying on verbal report in order to study event evaluation (Parkinson, 1997). The argument is that, given the rapidity and complexity of the underlying inference processes, individuals are unlikely to have access to the inner workings of the process. This is quite likely. However, it does not rule out that the individual is aware of the *outcome* of the inference process, for example, the realization of being faced with a goal obstruction that he or she is powerless to remove. This issue is related, of course, to the even more complex issue of what the objects of consciousness are. It is unlikely that the results of evaluations on individual appraisal dimensions enter awareness directly, in raw form, so to speak, because it is probably the interaction between different dimensions that is central rather than the nature of the individual ingredients. Despite this complexity, we may need to be more specific about these objects if we want to advance our understanding of the nature of emotion-antecedent evaluation processes. In order to address these issues in research, we obviously need to rely on self-report (heeding the problems of incomplete overlap of circles B and C in the schema described earlier). However, if we want to get at the integrated representation of the appraisal results, we may need to change our instruments and procedures, which, so far, have focused on individual appraisal dimensions.

Integration of Peripheral Component Effects

Proprioceptive feedback information is available from different response components such as vocal and facial expression or psychophysiological symptoms. The question of how different patterns of feedback from the somatic nervous system (SNS) and the ANS are integrated and when they enter consciousness has not been extensively studied to date. One possibility is that integration is, in part, predetermined by major functional circuits that underlie peripheral responding. For example, in Gellhorn's (1964) theory of ergotropic and trophotropic systems (or the more general notion of sympathetic and parasympathetic systems), individual responses are synchronized by the activation of the superordinate systems. One could assume that feedback integration reassembles those functional interrelationships. Although such a form of autoorganization might be a feasible

mechanism for ANS integration (albeit there is increasing doubt as to the unity of such large-scale systems), such a mechanism is unlikely to be operative in somatic integration, in particular, facial expression and action-related movement. In the case of adaptive behavior, the underlying determinant, and possibly the focus of integration, may be some form of motivational urge, such as an action tendency (Frijda, 1986). In the case of facial expression, there is much debate between theorists who suggest that the face expresses basic emotions (Ekman, 1972; Izard, 1971), a "social message" point of view (Fridlund, 1994; see also Owren, Rendall, & Bachorowski, Chapter 8), and appraisal theorists, who suggest that elements of facial expression might be directly triggered by the results of evaluation on particular combinations of appraisal dimensions (Scherer, 1992; Smith & Scott, 1997). Each of these assumed functions seems to imply a different type of integration process.

How do these processes enter awareness? Although we know that interoception, that is, the *conscious proprioceptive representation* of internal physiological changes, does not accurately reflect the physiological parameters (Barrett, Chapter 11; Vaitl, 1996), there might be more precise nonconscious representations that provide input to the process of integrating the various response domains in the ANS and SNS. In other words, raw proprioceptive feedback from peripheral physiological responses may not project directly to brain structures that underlie the emergence of consciousness but, rather, may contribute to a representation that integrates the changes in several response components. This integrated representation, in turn, may then reach consciousness without allowing the specification of details for individual classes of responses.

One of the problems with studies of interoception (or, for that matter, of emotion-specific physiological response patterns, in general) is that, to the best of my knowledge, not a single study has studied interoception during serious emotional upheavals, such as trying to flee from a terrorist bomb attack, being enraged by an unbearable insult, or experiencing extreme joy in seeing one's baby. Much of the experimental research, to date, has induced mild emotional states, if any, and it is not surprising that people are not good at verbally indexing subtle variations in physiological parameters. Nor is it surprising that it is difficult to find emotion-specific patterns in physiological responding if no specific emotions have been induced. Thus the issue remains open until more representative emotional states with higher specificity and higher intensity have been studied (if this will ever be possible). From the standpoint of evolutionary architecture, it seems functional that humans should not have a detailed conscious representation of minor adjustments of ANS parameters, because minor regulation should be performed automatically without taxing the control center.

In contrast, in the case of a strong emotion with massive, highly synchronized deviations from baseline across several response modalities, one would expect the changes to be represented in consciousness to allow high-level coping and regulation. The question is whether that emergence into consciousness happens in the form of an integrated representation (e.g., becoming aware of high arousal or excitation) or in the form of domain-specific representations (e.g., increased heart rate, short breath, perspiration, etc.). Most likely, both processes operate. People often do report specific symptoms in connection with an emotional experience (and, as suggested earlier, there is little evidence that strong symptoms during intense experiences cannot be accurately reported). At the same time, people also readily evaluate the degree of their arousal or excitation (to name but one possible integrated representation). So far, few studies have been conducted to evaluate the correlation between these impressions and objective indicators. Past research has shown, however, that there does not seem to be a single indicator of arousal. This is as it should be if, as one would expect, arousal or excitation reflects an integrated representation across several modalities.

As this brief overview suggests, an important effort of conceptualization and much basic research are needed to better understand the underlying feedback and integration mechanisms and the specificity of each domain. It is to be hoped that neuropsychological research on the projection and organization of proprioceptive feedback in different domains can provide fresh insight on these complex phenomena.

Integration across Components and Time

Although the issue of integration and the form in which raw or integrated representations reach consciousness are difficult to address, they are even harder to conceptualize and study across domains. If emotional episodes are subjectively experienced as an integrated whole, as one may assume from the way in which people normally talk about their emotions, there must be some kind of overall integration and representation *across the different components and across time*. Although we can focus on micro-momentary changes of feeling and particular cognitive processes or peripheral responses, it seems that we more typically become aware of our feelings in experiential chunks. In other words, there is some phenomenal unity to the feeling in a particular emotion episode, possibly linked to a cause-effect chain as well as to some type of closure. In consequence, there must be a powerful process of integration across components and over time. What is the structure of this integration, its gestalt or organizing principle? Here I again contrast the different suggestions made by dimensional

theories, discrete emotion theories, and my own version of componential appraisal theory.

Dimension theorists suggest that subjective experience is integrated along the dimensions of valence and arousal. Recently, Russell and Barrett (Russell, 2003; Russell & Barrett, 1999) have suggested that the representation of feeling in this two-dimensional space, prior to further elaboration, is the primitive *core affect* (see also Barrett, Chapter 11). This idea has a venerable history, having been first articulated by Wundt (1874), who proposed a tension–relaxation dimension in addition to valence and activation. The assumption is that the feeling constituted by these dimensions is a conscious phenomenon and accessible to introspection.

Basic emotion theorists have not felt the need to extensively discuss the issue of feeling and the role of consciousness, because the assumption of homogeneous emotion patterns entails the existence of feeling states that correspond to the patterning provided by the respective basic emotions. These states are accessible to consciousness and labeled by the respective verbal emotion labels. Thus, in this tradition, feeling states are integrated with regard to basic emotion families.

The position of appraisal theorists is less clear and possibly less homogeneous. Therefore, I describe my own position in greater detail (summarized from Scherer, 2004a). I have argued earlier (Scherer, 1984) that there are as many different emotions as there are distinguishable patterns of appraisal results. This explanation translates directly into the issue of integration and feeling. Briefly put, I suggest that multidomain integration is unique to the specific stimulus event and the appraisal results it generates. These results, and the proprioceptive feedback of the response patterns they produce, are integrated across components and over time, in the form of *qualia*—specific emotional experiences that are unitary, indivisible phenomena. I further suggest that it is the very process of synchronization, which I have proposed as the hallmark of emotion as an affective phenomenon, that elicits and organizes this process of integration. It seems safe to assume that this integration occurs outside of awareness. As Anderson (1989, p. 147) suggested earlier: “What does attain consciousness is often, perhaps always, a result integrated across different sense modalities at pre-conscious stages.”

What processes might mediate the emergence into consciousness of preconsciously integrated content? In a chapter urging the use of nonlinear dynamic systems theory for the description of emotion processes (Scherer, 2000a), I suggested that this point might be marked by a qualitative change in a monitor system that reacts to a degree of coupling or synchronization of the subsystems that surpasses the normal baseline fluctuations.

What is the justification for claiming that emotional experience is integrated in the form of qualia, or myriad different representations? Claiming such a mechanism seems to contradict the postulate for efficiency and parsimony I have advocated in several places earlier. However, if feelings represent a monitoring system that serves to regulate, it seems appropriate to assemble as much detailed information as possible in a central representation to fine-tune regulation attempts. Specifically, the integration of proprioceptive information from response components should maintain a maximal amount of detail in unconscious short-term memory (as symbolized by circle A in Figure 13.2). Many low-level regulation processes are likely to operate at this level and can benefit from a comprehensive representation of the behavioral meaning of the eliciting event and the response profile that was produced by the associated appraisal process.

When part of the unconscious representation becomes conscious or is to be stored in long-term memory (e.g., passing from circle A to circle B in Figure 13.2), further integration will be required. One could argue that it is at this point that integration along the lines of dimensions or basic emotion categories occurs. Yet based on the fact that we can obtain self-report on appraisal patterns, or experienced symptoms, or expression patterns in addition to emotion labels, it is likely that even at this level, detailed information is retained in less integrated form. Self-report is certainly biased by social representations concerning emotions, including stereotypes, but it is highly likely that individuals do have conscious access to central representations of their appraisals and response patterns, at least in the sense of *outcome consciousness* (as compared with process consciousness).

Further integration occurs when conscious experience is verbalized (the intersection of circles B and C in Figure 13.2). Although the common path for integration is constituted by the semantic field for emotional phenomena in the respective language, this does not mean that the integration necessarily occurs along the lines of discrete emotion categories, as represented by single words or concepts or by valence and arousal dimensions. Verbal report is not limited to simple naming; it can use complex expressions and even analogies or metaphors (Lakoff & Kövecses, 1987). Clearly, if respondents are forced to respond to a limited number of categories, as identified by labels or dimensions, they will integrate the information retrieved from memory in a form that allows them to decide among the alternatives or determine the overall valence or arousal level. However, this form of report does not constitute evidence that preformed categories or dimensions determine the integration early on in the process. Functionally, it makes sense to keep as much detailed representation as possible and to perform only as much integration as necessary.

The conceptualization of conscious affective feeling suggested here does not contradict the proposals made by dimensional or discrete emotion theorists but, rather, integrates these proposals. Although I would continue to hold that there are as many different emotional states as there are potential appraisal patterns, it is true that some appraisal profiles occur much more frequently than others, producing what I have called *modal emotions* (Scherer, 1994). These emotions correspond to the basic emotion categories that exist in all languages, reflecting the well-known fact that discrete verbal labels reflect objects, events, or concepts for which there is a strong need to communicate. Most likely, conscious feeling states corresponding to frequently encountered appraisal profiles form already coherent qualia even before verbalization (circle B in Figure 13.2). The act of verbal encoding probably serves to focus the feeling further and structure it around social and individual schemas.

With respect to dimensional theories, I suggested many years ago that the Wundtian dimensions of feeling might reflect underlying criteria of emotion processing (Scherer, Abeles, & Fischer, 1975, p. 138). Translated into the more recent notion of stimulus/evaluation checks, this means that (1) the valence dimension reflects appraisal of intrinsic pleasantness and goal conduciveness, (2) activation reflects pertinence and urgency, and (3) power/control reflects coping potential (see also Scherer, 2004a; Scherer, Dan, & Flykt, in press). Here I would disagree with Russell and Barrett's view that the valence and activation dimensions are somehow primary or reflect a primitive "core" of affective feeling. Rather, I see them as derivative or secondary in the sense that the individual is able to synthesize or project more complex feeling states onto those dimensions when required to do so. However, the issue is open to debate and focused empirical investigation.

CONCLUSION

It is common knowledge that the relationship between emotion and consciousness is extremely complex. The current contribution renders the issue even more complex by (1) insisting on multiple dimensions, facets of consciousness, and associated processes, and (2) highlighting the importance of the neglected phenomena of subsystem synchronization and integration as decisive determinants of the emergence of feeling into consciousness. The latter processes, which have rarely been addressed in the literature, are central features of emotion. I do not tire of suggesting that multicomponent synchronization is the essential feature that distinguishes

emotional from nonemotional states, and I have speculated that the emergence of conscious feeling may be related to the degree of synchronization, which is related to the need for high-level controlled regulation (Scherer, 1984, 2001a). In discussing neuroscience approaches of relevance to current debates in emotion psychology (Scherer, 1993), I suggested that Damasio's (1990) model of time-locked or synchronized multiregion activation as a potential mechanism for memory recall might be an interesting example of CNS-based synchronization. Over the last 15 years, the notion of neural synchronization as a basis for multimodal temporal binding (Treisman, 1996) has become extremely popular. Partly because of an influential paper by Crick and Koch (1990), there have been several attempts to link neural synchronization to the emergence of awareness and consciousness. In a comprehensive overview of this literature, Engel and Singer (2001) point out that any theory about the neural correlates of consciousness must explain how multiple component processes can be integrated and how large-scale coherence can emerge within distributed neural activity patterns (see Dennett, 1991, for an alternative view). This is exactly what is required to understand emotion as conceptualized by the component process model. Engel and Singer review evidence showing that cross-system coherence and dynamic response selection can be achieved through dynamic binding of distributed information via temporal synchronization of neuronal discharges (with precision in the millisecond range). Concretely, Engel and Singer (p. 23) suggest that synchrony may be ideally suited to promote access of selected contents to working memory ("Synchronized assemblies may stabilize in some reverberatory state, endowing them with competitive advantage over temporarily disorganized activity"), thus becoming conscious. According to Engel and Singer (p. 24), the process of neural synchronization also explains integration: "Temporal binding may establish patterns of large scale coherence, thus enabling specific cross-system relationships that bind subsets of signals in different modalities."

To date, most of the empirical work has been done on perceptual and somatosensory processes in animals, apart from some pioneering work on human perception (Tallon-Baudry, Bertrand, Delpeuch, & Pernier, 1996). However, the general framework is extremely pertinent to the issue of emotion emerging into consciousness, as discussed in this chapter. I hope that the effort to disentangle different aspects of consciousness and to start speculating about underlying processes may help, in the long run, to pose more specific questions, amenable to systematic experimental research. It seems obvious to me that progress in understanding the underlying mechanisms critically depends on the development of a truly interdisciplinary domain of affective sciences and effective collaboration with the behavioral neurosciences.

ACKNOWLEDGMENTS

I gratefully acknowledge helpful comments and suggestions by David Sander, Didier Grandjean, and Ursula Scherer.

REFERENCES

- Anderson, N. H. (1989). Information integration approach to emotions and their measurement. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research, and experience: Vol. 4. The measurement of emotion* (pp. 133–186). New York: Academic Press.
- Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. S. Wyer, Jr., & T. K. Srull (Eds.), *Handbook of social cognition: Vol. 1. Basic processes* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.
- Bargh, J. A., & Ferguson, M. J. (2000). Beyond behaviorism: On the automaticity of higher mental processes. *Psychological Bulletin*, 126(6), 925–945.
- Carver, C. S. (2001). Affect and the functional bases of behavior: On the dimensional structure of affective experience. *Personality and Social Psychology Review*, 5, 345–356.
- Clore, G., & Ketelaar, T. (1997). Minding our emotions: On the role of automatic, unconscious affect. In R. S. Wyer, Jr. (Ed.), *The automaticity of everyday life: Advances in social cognition: Vol. 10. Advances in social cognition* (pp. 105–120). Mahwah, NJ: Erlbaum.
- Coderre, T. J., Mogil, J. S., & Bushnell, M. C. (2003). The biological psychology of pain. In M. Gallagher & R. J. Nelson (Eds.), *Handbook of psychology: Vol. 10. Biological psychology* (pp. 237–268). New York: Wiley.
- Cohen, J. D., & Schooler, J. W. (Eds.). (1997). *Scientific approaches to consciousness*. Hillsdale, NJ: Erlbaum.
- Crick, F., & Koch, C. (1990). Towards a neurobiological theory of consciousness. *Seminars in the Neurosciences*, 2, 263–275.
- Damasio, A. R. (1990). Synchronous activation in multiple cortical regions: A mechanism for recall. *Seminars in the Neurosciences*, 2, 287–296.
- Davis, M. (1998). Are different parts of the extended amygdala involved in fear versus anxiety? *Biological Psychiatry*, 44(12), 1239–1247.
- Davis, M., & Whalen, P. J. (2001). The amygdala: Vigilance and emotion. *Molecular Psychiatry*, 6(1), 13–34.
- Dennett, D. C. (1991). *Consciousness explained*. Boston: Little, Brown.
- Dolan, R. J., & Morris, J. S. (2000). The functional anatomy of innate and acquired fear: Perspectives from neuroimaging. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 225–241). New York: Oxford University Press.
- Ekman, P. (1972). Universals and cultural differences in facial expression of emotion. In J. R. Cole (Ed.), *Nebraska symposium on motivation* (pp. 207–283). Lincoln: University of Nebraska Press.

- Ekman, P. (2004). What we become emotional about. In A. S. R. Manstead, N. H. Frijda, & A. H. Fischer (Eds.), *Feelings and emotions: The Amsterdam symposium* (pp. 119–135). Cambridge, UK: Cambridge University Press.
- Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, H. Goldsmith, & K. R. Scherer (Eds.), *Handbook of the affective sciences* (pp. 572–595). New York: Oxford University Press.
- Engel, A. K., & Singer, W. (2001). Temporal binding and the neural correlates of sensory awareness. *Trends in Cognitive Sciences*, 5(1), 16–25.
- Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. *Cognition and Emotion*, 15(2), 115–141.
- Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.
- Frijda, N. H. (1986). *The emotions*. Cambridge, UK: Cambridge University Press.
- Gellhorn, E. (1964). Motion and emotion: The role of proprioception in the physiology and pathology of the emotions. *Psychological Review*, 71, 457–472.
- Grandjean, D., & Scherer, K. R. (2003, June). *Appraisal processes in emotion elicitation: A topographic electrophysiological approach*. Poster presented at the Human Brain Mapping conference, New York.
- Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review*, 102(1), 4–27.
- Hameroff, S. R., Kaszniak, A. W., & Scott, A. C. (Eds.). (1996). *Toward a science of consciousness: The first Tucson discussions and debates*. Cambridge, MA: MIT Press.
- Iwamura, Y. (1998). Hierarchical somatosensory processing. *Current Opinion in Neurobiology*, 8, 522–528.
- Izard, C. E. (1971). *The face of emotion*. New York: Appleton-Century-Crofts.
- Kaiser, S., & Scherer, K. R. (1997). Models of “normal” emotions applied to facial and vocal expressions in clinical disorders. In W. F. Flack, Jr., & J. D. Laird (Eds.), *Emotions in psychopathology* (pp. 81–98). New York: Oxford University Press.
- Kihlstrom, J. F. (1994). The rediscovery of the unconscious. In H. Morowitz & J. L. Singer (Eds.), *Santa Fe Institute studies in the sciences of complexity: Vol. 22. The mind, the brain, and complex adaptive systems* (pp. 123–143). Reading, MA: Addison Wesley.
- Lakoff, G., & Kövecses, Z. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago: University of Chicago Press.
- Lambie, J. A., & Marcel, A. J. (2002). Consciousness and the varieties of emotion experience: A theoretical framework. *Psychological Review*, 109(2), 219–259.
- LeDoux, J. (2000). Cognitive–emotional interactions: Listen to the brain. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 129–155). New York: Oxford University Press.
- Leventhal, H. (1984). A perceptual motor theory of emotion. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 271–292). Hillsdale, NJ: Erlbaum.
- Leventhal, H., & Scherer, K. R. (1987). The relationship of emotion to cognition: A functional approach to a semantic controversy. *Cognition and Emotion*, 1, 3–28.

- Parlkinson, B. (1997). Untangling the appraisal-emotion connection. *Personality and Social Psychology Review*, 1(1), 62-79.
- Roseman, I. J. (2001). A model of appraisal in the emotion system: Integrating theory, research, and applications. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 68-91). Oxford, UK: Oxford University Press.
- Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, 110, 145-172
- Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, 76, 805-819.
- Sander, D., Grafman, J., & Zalla, T. (2003). The human amygdala: An evolved system for relevance detection. *Reviews in the Neurosciences*, 14(4), 303-316.
- Scherer, K. R. (1984). On the nature and function of emotion: A component process approach. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 293-317). Hillsdale, NJ: Erlbaum.
- Scherer, K. R. (1992). What does facial expression express? In K. Strongman (Ed.), *International review of studies on emotion* (Vol. 2, pp. 139-165). Chichester, UK: Wiley.
- Scherer, K. R. (1993). Neuroscience projections to current debates in emotion psychology. *Cognition and Emotion*, 7, 1-41.
- Scherer, K. R. (1994). Toward a concept of "modal emotions." In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 25-31). New York: Oxford University Press.
- Scherer, K. R. (1999). Appraisal theories. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion* (pp. 637-663). Chichester, UK: Wiley.
- Scherer, K. R. (2000a). Emotions as episodes of subsystem synchronization driven by nonlinear appraisal processes. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self-organization: Dynamic systems approaches to emotional development* (pp. 70-99). New York: Cambridge University Press.
- Scherer, K. R. (2000b). Psychological models of emotion. In J. Borod (Ed.), *The neuropsychology of emotion* (pp. 137-162). Oxford, UK: Oxford University Press.
- Scherer, K. R. (2001a). Appraisal considered as a process of multi-level sequential checking. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 92-120). New York: Oxford University Press.
- Scherer, K. R. (2001b). The nature and study of appraisal: A review of the issues. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 369-391). New York: Oxford University Press.
- Scherer, K. R. (2004a). Feelings integrate the central representation of appraisal-driven response organization in emotion. In A. S. R. Manstead, N. H. Frijda, & A. H. Fischer (Eds.), *Feelings and emotions: The Amsterdam symposium* (pp. 136-157). Cambridge, UK: Cambridge University Press.
- Scherer, K. R. (2004b). Which emotions can be induced by music? What are the underlying mechanisms? And how can we measure them? *Journal of New Music Research*, 33(3), 239-251.

- Scherer, K. R., Abeles, R. P., & Fischer, C. S. (1975). *Human aggression and conflict: Interdisciplinary perspectives*. Englewood Cliffs, NJ: Prentice Hall.
- Scherer, K. R., Dan, E., & Flykt, A. (in press). What determines a feeling's position in three-dimensional affect space? *Cognition and Emotion*.
- Scherer, K. R., Schorr, A., & Johnstone, T. (Eds.). (2001). *Appraisal processes in emotion: Theory, methods, research*. New York: Oxford University Press.
- Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review*, 84(1), 1-66.
- Shallice, T. (1972). Dual functions of consciousness. *Psychological Review*, 79(5), 383-393.
- Smith, C. A., & Scott, H. S. (1997). A componential approach to the meaning of facial expressions. In J. A. Russell & J. M. Fernandez-Dols (Eds.), *The psychology of facial expression* (pp. 229-254). New York: Cambridge University Press.
- Tallon-Baudry, C., Bertrand, O., Delpuech, C., & Pernier, J. (1996). Stimulus specificity of phase-locked and non-phase-locked 40 Hz visual responses in human. *Journal of Neuroscience*, 16, 4240-4249.
- Treisman, A. (1996). The binding problem. *Current Opinion in Neurobiology*, 6, 171-178.
- Vaitl, D. (1996). Interoception. *Biological Psychology*, 42(1-2), 1-27.
- van Reekum, C., Banse, R., Johnstone, T., Etter, A., Wehrle, T., & Scherer, K. R. (2004). Psychophysiological responses to emotion-antecedent appraisal in a computer game. *Cognition and Emotion*, 18(5), 663-688.
- Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. *Neuron*, 3, 829-841.
- Vuilleumier, P., & Schwartz, S. (2001). Beware and be aware: Capture of spatial attention by fear-related stimuli in neglect. *NeuroReport*, 12(6), 1119-1122.
- Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science*, 7(6), 177-188.
- Whalen, P. J., Curran, T., & Rauch, S. L. (2001). Using neuroimaging to study implicit information processing. In D. D. Dougherty & S. L. Rauch (Eds.), *Psychiatric neuroimaging research: Contemporary strategies* (pp. 73-100). Washington, DC: American Psychiatric Association.
- Whalen, P. J., Shin, L. M., McInerney, S. C., Fischer, H., Wright, C. I., & Rauch, S. L. (2001). A functional MRI study of human amygdala responses to facial expressions of fear versus anger. *Emotion*, 1(1), 70-83.
- Wundt, W. (1911). *Grundzüge der physiologischen Psychologie*, 6th ed. [Principles of physiological psychology]. Leipzig, Germany: Engelmann. (Original work published 1874)