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# Trends in Studying Emotions

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*Summary.* – The purpose of this introductory study is to briefly sketch the main developmental trends in the psychological investigation of emotions within the past several decades. The topics elaborated include theoretical conceptualizations and research strategies in observation, measurement, and in the content analysis of affective phenomena. In this endeavor, only the topics of human, normal, and adult dynamics of affective phenomena are considered. Discernable changes and stable viewpoints, as well as some perennial problems in the study of human emotions are summarily reviewed in their developmental perspective.

The scientific study of emotional phenomena in psychology has been, by some, traditionally somewhat put aside, or its topic was at least reduced to only an incidental quality of the other, more precisely describable psychological states and processes. Emotions gained the reputation of one of the stumbling blocks of psychology's efforts to become a truly objective science, comparable in the rigorosity of approaching its subject matter to that of the natural sciences.

On the contrary, others dedicated most of their professional work just to show that emotions not only form the core of human life and action, but that they can be studied using the rigorous theoretical and methodological instruments of the contemporary modernist view of science.

As the present author started his own research into the dynamics of emotions some forty years ago (Balcar, 1971; 1974), he observed an upsurge of interest in emotion research. This followed shortly after the return of cognitive processes out of their temporary shadow area of science, to which they had been shifted off by

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both psychoanalysis and behaviorism for a quarter of a century. The corner for “cognitive psychology” was turned in the fifties and sixties of the past century with names like George Kelly, Noam Chomsky, and Ulrich Neisser (see, e.g., Neisser, 1967), and was followed with proclamations of interdisciplinary branches like “cognitive science” and “cognitive neuroscience”.

Shortly thereafter, in the sixties and the early seventies, the re-discovery of human emotionality again as a regular object of rigorous scientific investigation was marked, among others, by the Loyola Symposium in 1968, where especially Magda Arnold, the author of a foregoing two-volume “sign of the times” (Arnold, 1960a; 1960b) contributed organizationally and scientifically in an outstanding way (Arnold, 1970). In the monograph cited, most of the excellent researchers in the field presented the state of art of their own conceptual thinking and empirical inquiry. Soon thereafter, the analogous terms of “affective psychology”, “affective science(s)”, and “affective neuroscience” were coined in emotion research, as well as in the names of books and book editions, university programs and research centers (as a matter of fact, the term of “affective psychology” was used already half a century before – see, e.g., Young, 1927).

Nowadays, at the end of the first decade of the 21<sup>st</sup> century, the interest in the study of emotions under the headings mentioned seems to still flourish, as seen from the number of books, articles, and research projects devoted to this topic. The question we want to ask is how the ways of approaching the study of the human, normal and empirically investigated dynamics of emotion have developed, changed, or altered their scope in the course of these last decades. Looking at the analyses and meta-analyses available to us, we shall attempt to infer eventual developmental trends within the field from a methodological point of view. First, we shall approach this topic from its place in the broader field of discernable methodological developments in general psychology as its relational frame of reference, before we narrow our search to the domain of emotionality proper.

## **METHODOLOGICAL BASES FOR THE PSYCHOLOGY OF EMOTIONS**

It is customary to start a treatise on emotions with complaints on the state of art concerning the elementary condition of studying anything, i.e., how the topic under scrutiny, the emotion itself, is to be conceived and, relative to that, defined. However, it may be shown that many of the ambiguities that keep plaguing the concept of emotion correspond very well to the problems of determining the subject matter and subordinate concepts of psychology in general. Analyzing various and, at times, almost contradictory definitions of the subject and method of psychology, we

want to state our, to a large extent, both consensual and logical understanding thereof.

First, the subject matter of psychology, should it be a scientific discipline of its own, must unavoidably be that of the “subjective reality”, i.e., experience in its broadest sense. Phenomenological methods of observation aim quite naturally at its core. However, socially useful psychological inquiry has to make the private experience public, comparable and controllable. The first basis of psychological data, the experience itself, evoked by stimulation and leading to action, is therefore in need of a valid and meaningful description of its phenomena for that purpose, through which it manifests itself and is accessible for public scrutiny. The first data basis is, therefore, the “experiential” one, as manifested in the individual’s voluntary and subjectively meaningful reports.

Second, as the goal of a theory is not only the description but, primarily, the explanation of the phenomena observed, the relations of experience both to its conditions and to its manifestations also necessarily belong to the subject matter of psychology. This is searched for in terms of the inherent relations of the content and the course of experience with the inner structures and functions of the body as well as with those of the immediate environment on the one hand, and with its somatic and behavioral effects on the other. Thus the “situational”, “physiological” and “behavioral” data are the secondary, yet inevitable databases of psychology.

As stated above, the experience studied by psychology is, of course, related to the actual (or imagined, remembered, etc.) part of the environment the person is in physical or mental contact with. However, this environment psychologically influences his or her states and processes not only directly by its physical effects, but also, in particular, as mediated by the properties of the experiencing person, i.e., on the basis of his or her sensations, perceptions, and meanings he or she attributes to it. This is the (psychological) “situation” – the meaning of the (physical) environment (which is sometimes called the “objective situation”), as experienced by the person. The decisive role of the personal interpretation of the stimulating circumstances, as opposed to their objective qualities, has been recognized in psychology since time immemorial, and also experimentally demonstrated, e.g., by Siemer, Mauss, & Gross (2007). Therefore, the influence of the situation is, foremost, to be assessed using volitional or non-volitional meaningful manifestations (mostly in the form of volunteer subjective reports) of the individual’s experience of it.

For the psychological study of emotions, consequently, it is of prime importance how emotional experience relates to its stimulating conditions in the external situation and/or internal state of the mind and body, and to its effective manifestations in the expressive and/or goal-directed behavior as well as in the physiological responding by the individual.

## CONCEPT OF EMOTION IN PERSONALITY DYNAMICS

The concept of personality as the “man as a psychological whole” parallels that of the human organism as the “biological whole” of an individual. These “wholes” do not of course designate independent entities, but rather different aspects of the “in-dividual” person as such. The person as a whole human being includes much more than biology and psychology. In particular, there is also the noological aspect comprising, among others, the realities of existential values, conscience, and of the free as well as responsible choice of attitude and action that defy any reduction to psychologically and physiologically predetermined events.

To illustrate the notion of the personality function, of which emotional events are a component, we sketch the course of events in a simple drawing in Figure 1.1. A circular nature of the personality and, therewith, also that of the emotion process of receiving stimulation and performing actions is only roughly sketched here, leaving out, especially, many of the feedback loops effective in its course.

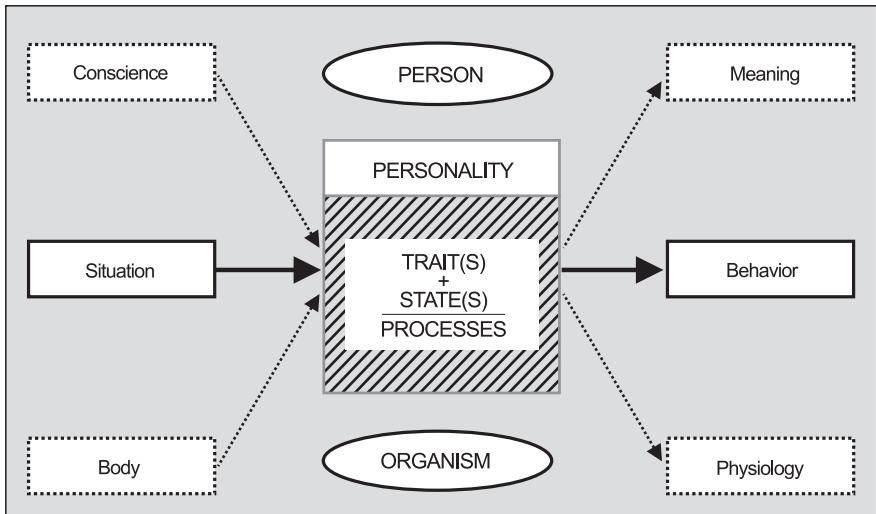


Figure 1.1 Model of personality function.

How is emotion to be conceived in this process? Most of the positive definitions encountered in literature (see, e.g., Kleinginna, Jr. & Kleinginna, 1981) assume emotions (or their experiential part, the feeling) to be a process (as if) parallel to other psychological and physiological processes in the individual – like perceiving, remembering, thinking, breathing, circulating, etc., though interacting with them in numerous many-sided ways. This, of course, would require proving, despite of all mutual conditionality, the basic independence of emotions in the sense

of either “being there, or not” when other particular processes are taking place. There are, however, other possible ways of viewing emotions that may deserve deliberation. We shall mention two of them.

1. Emotion is (merely) an attribute or quality of other processes. This would say, in effect, that emotion is always there, be it expressed in a way that pushes the factual contents of the experience processed almost aside, or in a way that makes the emotional side of the stream of experience consciously imperceptible. In a very powerful metaphor, emotion is likened by some to the color of objects. Not only Plutchik (1980; 2002) chose to depict the variety of basic emotions in the form of a “color wheel”. The analogy of emotion to color is more radically employed by Solomon & Corbit in their process view (1974; Solomon, 1980), who described temporal antagonism in the course of experiencing particular emotions as the exact counterpart of the negative afterimage occurring in color perception. Their theme found, perhaps unwittingly (as not quoted), its “colorless” and more general echo in Apter’s (1989) “reversal theory” of emotion, motivation and personality. Would it not be more feasible to attribute to emotion just the nature of a sometimes dimmer, sometimes brighter, or at times even blinding quality of all the ongoing cognitive, motivational, or conative processes?

2. Emotion is, as above, inherent in all kinds of external or internal stimulation processing. It is not, however, their constantly concomitant “coloring” aspect but, instead, is merely a particular stage in the processing of their cognitive, motivational, or conative contents. This was also originally our own answer to the question of conceptualizing emotion (Balcar, 1975, pp. 95-96): “*We conceive emotion as a stage of signal nature in a stimulus pattern processing, wherein its immediate appraisal from the organism’s view takes place and is, at the same time, experienced as a spontaneous impulse to action. ... All that passes between the organism’s input and output through psychological transformation (unlike, e.g., a simple spinal reflex), also passes through the stage of emotion.*” This was actually inspired by the at that time ongoing dispute whether the emotional experience precedes that of the stimulus perceptual recognition, or vice versa. We have adopted, then, the conception that emotions are “*a particular, very elemental kind of intelligence*” (Balcar, 1973, p. 356), and that they are fulfilling two conjoint roles at once – the orientational (processing information) and the dynamic (impelling to action) ones.

In personality theorizing or modeling, like in Figure 1.1, where would the phenomenon called emotion be most at home? Except for the situation where we expect to find only the potential for eliciting, developing, and terminating its appearance, all conceptual parts of personality structure and dynamics, as well as their behavioral expressions may show discernable affective components. There are stable temperamental and motivational traits, psychological states and processes, and covert or overt actions that do, or at least may, display emotional qualities.

This, again, casts some doubts as to conceiving emotion as a state or process of its own. An individual's state or process always comprises much more than just an emotion, which, consequently, may possess the attribute of a partial state or a partial quality of the process in the person's constantly ongoing inner stream of events.

## DEFINING EMOTIONS

The two main avenues of the definitional approach to emotion(s) consist of describing the 1) phenomenological nature of emotion – “What it is (like)”, or, its 2) functional nature – “What it does (and how)”. Clore, Schwartz, & Conway (1994, pp. 323-324) frame this distinction from their historical roots up to the contemporary theory of emotions: “*One hundred years ago, two of the most influential psychologists were Wilhelm Wundt and William James. Both were centrally concerned with affect but in different ways – Wundt was a structuralist and James was a functionalist. Wundt ... was concerned with the underlying structure of emotions, and his conclusions were similar to those of recent investigators concerning the dimensions of emotional quality ... But James was more concerned with function than structure. ... Emotion is again a central problem in psychology, and the distinction between structure and function is still important.*” Thus, the first approach aims at explaining its occurrence phenomenologically, in terms of a “cause – event” frame of reference, the second one does so functionally, in terms of its “purpose – effect” frame.

Most of the definition categories surveyed by Kleinginna, Jr. & Kleinginna (1981) belong to the phenomenological account. They content analyzed 92 definitions and 9 skeptical statements available at that time and classified them “*into an outline of 11 categories, on the basis of the emotional phenomena or theoretical issues emphasized ... Two traditional experiential categories of affect and cognition; three physical categories of external emotional stimuli, physiological mechanisms, and emotional/expressive behavior; definitions that emphasize disruptive or adaptive effects; definitions that emphasize the multiaspect nature of emotional phenomena, those that distinguish emotion from other processes, and those that emphasize the overlap between emotion and motivation; and skeptical or disparaging statements about the usefulness of the concept of emotion. The definitions are evaluated, trends are identified, and a model definition is proposed*” (p. 345).

Out of this type of defining emotions, attempts are made to analyze the “phenomenon emotion” into its constituent components in the time course of it, and in their substantial connectedness both with each other and with other preceding, concurring, and resulting events. The general conceptual “model” of emotion corresponds with that of the basic components of the personality process, as depicted in Figure 1.1. An emotion is elicited in a particular situation and state of the body,

is modulated by the actual structural and dynamic properties of the individual person, and manifests itself in his or her experience, physiology, and behavior.

In reviewing the trend in defining emotion(s) in the course of time, no particular tendencies to change can be discerned. Perhaps, besides the continuing multiplication of the definitions offered, attempts at still more comprehensive and complete formulations may be observed, making them sometimes longer in order to more precisely express the particular theory and its core concepts behind them. However, there are many earlier formulations that, though not as precisely worded, attempt the same and are not any shorter.

SIGNAL OF	Detrimental event ("Punishment")	Beneficial event ("Reinforcement")
Appears	FEAR	HOPE
Disappears	RELIEF	DISAPPOINTMENT
		Reversible, or not?

Figure 1.2 Mowrer's (1960) anticipations of events and situational structure of emotions.

## TAXONOMY OF EMOTIONS

Within this approach, there have always been contrasting views on how the field of human emotions could be theoretically best described – which type of taxonomy would better suit the reconstructed phenomenal reality and would be better supported by the accumulated data. The question of the scientific expediency of mapping the field of emotion either in terms of discrete emotions (usually represented by the affective terms of everyday language, such as joy, sadness, fear, anger, hope), or in terms of the more general dimensions of an “emotional space” in the domain of experience (such as pleasantness-unpleasantness, excitement-calmness, intensity of feeling), in that of physiology (such as either general, or specific autonomic arousal-inhibition), or in that of expressive or goal-oriented behavior (such as approach-avoidance, fight-flight) has been answered using diverse criteria.

At a more general level, this contrast corresponds to that of personality description either using individual traits and states on the one hand, or using types on the other one. In the last half of a century, these different approaches – both in personality as a whole and in emotion as a partial component of it – have been progressively developing from contradictory approaches into complementary ones,

(Circumstance-Caused)	Positive Emotions Motive-Consistent		Negative Emotions Motive-Inconsistent		
	Appetitive	Aversive	Appetitive	Aversive	
	Unexpected	Surprise			
Uncertain	Hope		Fear		
Certain					Low Control Potential
Uncertain	Joy	Relief	Sadness	Distress	
Certain					
Other Caused Uncertain	Hope		Frustration	Disgust	High Control Potential
	Joy	Relief			High Control Potential
Other Caused Uncertain	Liking		Dislike		Low Control Potential
Uncertain			Anger	Contempt	High Control Potential
Uncertain					
Certain					
Other Caused Uncertain	Pride		Regret		Low Control Potential
Uncertain			Guilt	Shame	High Control Potential
Certain					
Uncertain					
Certain			Non Characterological	Characterological	

Figure 1.3 Dimensionally nested separate emotional states of Roseman’s revised structural appraisal theory of emotions (Source: Roseman, Antoniou, & Jose, 1992).

as conceived today: “The historical tensions between dimensional and discrete-emotions approaches frames theoretical debates today. Currently, a number of emotion researchers consider the discrete-emotions and dimensional approaches as complementary rather than as contradictory ...” (Izard & Ackerman, 2000, p. 255).

Over the decades, the phenomenally-based theories have been growing in complexity (for a typical example, compare Figure 1.2 and Figure 1.3), and their present versions usually connect the dimensional axes with discrete emotion patterns nested within them. However, the question of expediency remains in the relation to the practical tasks of emotion psychology that require more simplicity.

A possible answer might result from more empirically than theoretically derived projects, asking people to rate emotions as to their similarity/dissimilarity, with the ratings being subject to multivariate analysis. The two kinds of possible results of such research might look as shown in Figure 1.4. The resulting map of the emotional space displaying a rather even distribution of discrete emotion concepts would speak in favor of preferring dimensions. Should the distribution display loci of noticeable density within the otherwise only scarcely occupied sub-spaces around them, the “centers of gravity” thus arrived at would be more expedi-



ent to serve as anchors for representing individual and – regarding the dimensions utilized – naturally discrete emotion “types” or individual concepts.

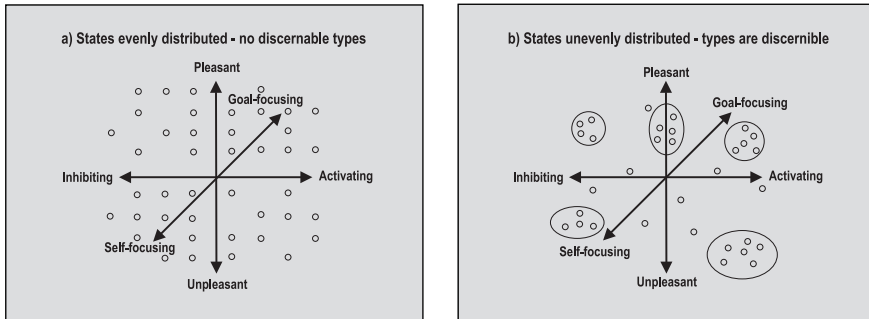


Figure 1.4 Emotion dimensions vs. types.

Another issue related to taxonomy is that of the Darwinian concept of “basic emotions” (Darwin, 1872). In the search for the further indivisible, inborn, universal and in their nature automatic and unchangeable emotional reaction patterns, many theorists arrive at a set of affective phenomena supposed to be the fundamental elements of human (as well as animal) emotional life. Clore *et al.* (1994) call attention to the “*little agreement on ... how many basic emotions exist*” (p. 329), and show instances of different emotion theorists setting their number anywhere between 2 and 11.

Nevertheless, advocates of the concept continue to clear misunderstandings stemming from the different meanings of the term “basic” and present quite a few assenting findings. Thus Ekman (1999) redefines the criteria for accepting an emotion as “basic”, while introducing the notion of them as “emotional families”: “*Each emotion is not a single affective state but a family of related states ... [whose] themes are the product of evolution, while the variations reflect learning*” (p. 55). Solomon (2002) reviews the history of the search for the “*atoms in our emotional chemistry*” (p.115). He cautions against the threat of reductionism connected with it, but concludes in a balanced tone that “*the notion of “basic emotions” is neither meaningless nor so straightforward as its critics and defenders respectively argue, but it is historical and culturally situated and serves very different purposes in different contexts, including different research contexts*” (p. 124).

The debate continues with, e.g., Izard (2007a; 2007b) as one of the resolved defenders of the “basic emotions” position, and Barrett (Barrett, Mesquita, Ochsner, & Gross, 2007) as a neo-constructivist militant critic of Izard’s position, with both arguing not only with the psychological analyses of feeling, but also by the force of bio-psychological hypotheses and findings.

In defending the position of discrete emotions while taking into account the undeniable dimensionality of affective experience and action, more sophisticated

procedures are applied. Shaver, Schwartz, Kirson, & O'Connor (1987) conducted hierarchical cluster analysis resulting in three levels – the general positive and negative affective reactions, five basic “prototype” emotions, and the subordinate specific emotions that are assumed to be differentiated out of the basic emotions on the basis of the situational context. Another example is Power’s (2006) “structural equation modeling approach”, analysing the data from an emotional experience episodes rating checklist and comparing six possible “models” using confirmatory factor analysis. He arrived at a solution comprising of five correlated basic emotions, which, on the one hand, are loaded with the general dimension of affect, and, on the other hand, they themselves factor-load the ratings of 20 more specific emotion concepts.

The overall trend of this issue shows signs that the “basic emotions” position is somewhat losing ground in theory, but not so much so in empirical research projects (e.g., Rainville, Bechara, Naqvi, & Damasio, 2005). One stream of the present theoretical developments linked with appraisal theories stresses the diverse influences of social learning on the emotions actually experienced, and it expects them to occupy different loci at continuous common dimensions of affective experience, which accounts for their interindividual and intraindividual diversity. Another stream retains the hypothesis on affective “invariants”. It does not, however, consider them to be complete emotional gestalts, but rather individual “emotion components” that combine to produce the actual emotion states experienced. Individual emotions are conceived of as “multicomponential phenomena” (Scherer, 2005, 2009; Frijda, 2007). It may be noted that in the accounts of the emotion components, they typically correspond to a great extent to the general modalities of observation, i.e., to the situational, experiential, physiological, expressive, and goal-behavioral modalities, with some variations in the terms used.

## **FUNCTIONS OF EMOTIONS**

The old controversy whether emotion in humans is generally a disruptive event or an adaptive one was actually resolved by the Yerkes-Dodson law (1908) quite long ago. However, its explanatory power has a serious flaw in the fact that it is rarely possible to operationally determine the ranges of emotional intensity that are favorable or detrimental for mastering the task at hand. Moreover, effective operations of dosing the emotion-eliciting stimulation based on such knowledge seem beyond the reach of the exacting claims of experimental proof, though not always beyond that of the not-so scientific requirements of practicing trainers, educators, preachers, health preventionists, or salesmen.

Throughout the years and decades the same is assumed, explored, and confirmed despite of the various conceptualizations of the role of emotions within the

range of their adaptive functioning. Emotions take part in cognition, motivation, and action on the levels of conscious and non-conscious situation appraisal, affective experience, physiology, spontaneous expression, and goal-directed behavior. Their various specific tasks in the course of individual biological, psychological, and existential coping with the demands of life, from that of redirecting attention, over the whole range of life functions, to that of guiding planned action, are analyzed by many personality students as a component of the individual structures and processes that organize, drive, and communicate personally important concerns.

In such analyses, the question of the functional dependence of emotions is explored. Primarily, emotion is seen as “*tied to personal values, goals, goal hierarchies, belief systems, and personal resources as well as social (environmental) events of importance*” (Lazarus, 2006, p. 91), with other variables (such as needs or attitudes) possibly either added or further differentiated, and their functional significance confirmed.

On the other hand, there are attempts at formulating the adaptive functions of individual discrete emotions, mostly on the level of the “basic emotions”. For example, Izard & Ackerman (2000) undertook such research looking primarily for the adaptive functions of selected emotions in a person’s life. They assumed that “*each discrete emotion serves unique functions in coping and adaptation ... [in that it] motivates and organizes perception, cognition, and actions (behavior) in particular ways*” (p. 262). Particular ways of serving a person’s needs are specified for interest, joy/happiness, sadness, anger, shame, fear. Furthermore, they assume that emotions do so not episodically, but continually, and also that their activation is subject to individually different stimulation thresholds, which are in large part responsible for interindividual differences in experiencing emotions in life.

The functional nature of emotions, however, is in the foreground, particularly in attempts at construing models of individual emotions of material or of abstract nature, i.e., in the form of human behavior imitating robots, or in that of computer programs modeling normal or disturbed personality functioning.

## **STUDYING EMOTIONS**

As stated above, the main problem with psychology’s aspirations to be a part of today’s objective and empirical science is the nature of its subject matter. The stream of experience can be objectively anchored using only inferences from its overtly observable markers. For inferring the emotional quality of subjective events, five typical approaches (e.g., Balcar, 1973) have evolved that are, at present, identical with the “components” of emotion listed by Scherer (2005, p. 698). We shall comment the trends observed in each of these approaches successively.

1. *The situational/appraisal approach: eliciting emotions.*- There is a consensus that, under normal circumstances, emotions are typically evoked by external stimuli received from the environment, alongside the stimuli coming out of the individual's internal states of body and mind.

As exemplified by Mowrer's (1960) neo-behaviorist "situational" concept of emotions (Figure 2 a), it is not the physical properties of environmentally (or even internally) originated stimuli that decide about the nature of the emotion evoked, but it is rather their experienced relation to the satisfaction or dissatisfaction of the "organism's" motives. This "signal" property of an emotionally effective stimulus corresponds to the psychological distinction between the terms "environment" as the physical composition of the effective part of the surrounding world, and "situation" as the individual's perception of it. Even then, the psychology of emotion is in chronic need of a representative taxonomy of emotionally effective situations. There are attempts to derive one either from the known biologically wired-in motivations and/or survival needs, or from the various psychological dimensions or types of situation (e.g., the "core relational themes" for individual emotions in Lazarus, 1991), or event perceptions that prove effective in motivating particular classes of behavioral and physiological responses.

A sign of the times in psychological research (or, more skeptically expressed, that of its theoretical "pendulum effect") is expressed by Lazarus (2006, p. 282) "*We should abandon our reluctance to think of mind in subjective terms*". Moving still more in this direction, the "situational" approach is transformed also terminologically to that of the subjective "appraisal", which is now an indispensable mark of most of the modern emotional theories. Its architecture was in the course of the past several decades scientifically elaborated primarily by Arnold (1960a), and developed by many followers, notably by Lazarus (Lazarus & Folkman, 1984; Lazarus, 2006). Lazarus distinguished the "primary" and the "secondary" appraisal – the first giving rise to a particular emotion, the second eliciting a corresponding emotion-coping action.

Arnold's originally simple notion of appraisal as the elicitor of emotion has since developed into a group of structured "models". Among the most prominent ones, the "component process model" (Scherer, 2009) "*focuses on the dynamic unfolding of emotion*" (p. 1308) and "*suggests that emotion differentiation is the result of the net effect of all subsystem changes brought about by the outcome profile of the SEC sequence*" (Sander, Grandjean, & Scherer, 2005, p. 322). The abbreviation "SEC" stands for the "stimulus evaluation checks" performed by the person, regarding the relevance, implications, coping potential, and normative significance. Each of these appraisal acts consists of more detailed checking operations. In this respect, this model (shown in its rough-drawn general outline in Figure 1.5) is a good example of the ever-yet differentiating theory and model building.

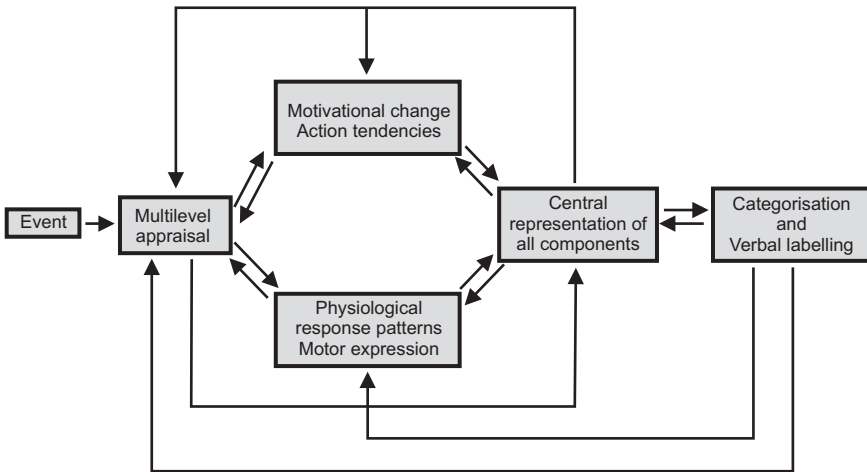


Figure 1.5 Scherer's component process model (Source: Scherer, 2009).

Tong, Ellsworth, & Bishop (2009, p. 822) summarize further developments in the appraisal studies: “Appraisal theories have evolved in several directions. First, different theorists have proposed different sets of appraisals to differentiate emotions ... Second, while appraisal theorists initially studied appraisals as antecedents of emotions ... subsequent studies showed that emotions can also shape appraisals ... which supports the view that emotions and appraisals are components of the same affective state ... Beyond these differences, appraisal theories share the assumption that each emotion is associated with a specific pattern of appraisals.”

Contemporary research on the appraisal origin of emotions is devoted to differentiating various kinds and levels of appraisal (for another example, the structural, procedural, and relational levels thereof – Smith, 2004), and to testing specific predictions, functionally relating them to other indices of emotion. In the line of the present conceptualizing of emotions not as a “one-shot” event, but rather as an interactive process containing many active feedback-loops, hypotheses of particular forward and backward effects in it are explored and confirmed.

The expansion of the appraisal theory subsequently subsumes all other emotion-mediating steps, from the situation meaning to the coping capacity, at the level of their informal assessment by the person. This opens the way for comments on two of the topics explored, namely on the role ascribed to the division “conscious – non-conscious” in emotional appraisal, as well as in the emotion experience and expression, and on the unfolding of the emotional state into a process inherently structured in the course of time.

2. *The experiential approach: feeling and reporting emotions.*- Feeling is undoubtedly the *sine qua non* of emotion, even when “subliminal” or “unconscious” in appearance and when, consequently, its presence is inferred from other data sources than from the phenomenological reports. Whereas the topic of unconscious feelings is of interest particularly in personality and in clinical psychology research and theory, the empirical investigations in the branch of “affective psychology” focus, in this respect, on conscious emotions that can be introspected and reported.

The methods of getting at the center of the feeling experience naturally grow in their variety. Originally, most of the experimental studies asked the subjects to report their immediate feelings in real time in the course of experimentally induced events. This is, of course, an impossible task, as feelings lived when evoked are a rather different experience than feelings lived and at the same time introspected and, moreover, reported to someone else. Therefore, variations in asking for reports were introduced.

An important class of methods is retrospective reports. The subjects are asked to describe their feelings either in an experimental setting, or in their natural daily situations, after the fact, relying on their memory. The intervals between the actual experience and its memory mediated report may vary from minutes to years, and may be aided by various aids such as keeping a “diary of emotions”, actualizing the situations concerned, etc. This avoids the difficulty with simultaneous observation and reporting. However, it introduces more opportunity to – whether consciously or not – “edit” the reports as to fit them to the already pre-established categories of the personal feeling-schemes, prescribing (mostly unconsciously) how the subject in fact feels, or, moreover, how he or she is expected to feel under the circumstances.

In all these and other ways of reporting about the experienced feeling, the cornerstone is the meaning of what is reported. Though there are other ways of meaningful signaling, like with gestures, pictures and other nonverbal means of communicating, the main vehicle for a subjective report is the language, with all its subtlety of semantic nuances, as well as with all the ambiguity of transforming the meaning as intended to that as expressed and understood.

In accord with the attention devoted to the function of language as a means of communicating the feeling experienced, more projects have appeared within the last decades using affective expressions in the language as raw data, out of which the researchers attempt to abstract the expected dimensions of the “emotional meaning space”, and, in return, to locate the core emotional concepts within it. From the early factor analytic studies using, e.g., the semantic differential and similar rating scales (e.g., Davitz, 1969), the subsequent studies have grown in scope and sophistication.

The fact and functional significance of being aware of the emotion experienced is both a methodologically and substantially important issue. The Freudian psychodynamic concept of unconscious mental contents, most often in connection to that of the psychological defense mechanism of repression, has not overly intrigued the general psychology students. The notion of subliminal external or internal stimulation received better acceptance. This notion could be applied both to the stimuli at the emotional input, as well as to the stimuli produced by emotional response in physiology and behavior, or even in the realm of experience without necessarily presuming a purposive mechanism to explain it; the well-documented threshold phenomena on stimuli processing suffice. Nowadays, the trend in emotion study in this respect seems to lay emphasis not so much upon the reflective nature of becoming aware of emotion, as it does on the (unconscious) automaticity vs. the (conscious) controllability of emotionally significant information processing, including emotional responding and its regulation.

Barret, Ochsner, & Gross (2007) envisage that, in the frame of their preferred “parallel distributed processing model”, it will be evident that “*automatic and controlled modes of emotional processing differ more in degree than in kind*” (p. 203) – a view that we would readily accept for reformulating the one-time dichotomy of the conscious and unconscious experience as well.

*3. The physiological approach: somatizing emotions.*– The immediately sensed and observed connection of the feeling with the physiology led many of theorists to assume that the experienced feeling is just an outgrowth of the (peripheral) somatic events that are directly evoked by the perceived situation. This James-Langeian hypothesis was at first rather convincingly refuted by the Cannon-Bard theorizing on the basis of neurophysiologic arguments. Later on, however, the proposition that “*the experience of specific emotions results from the perception of specific and unique patterns of somatovisceral arousal*” (Barrett *et al.*, 2007, p. 379) received partial support, especially in the last decade of the 20<sup>th</sup> century (Damasio, 1999). As for the peripheral muscle activity, even if it is not proven to be the “cause” of the emotion experience, it has been shown that the stimuli incoming from the predominantly involuntary facial expression patterns at least shape the quality and intensity of the feeling in the course of its actual development.

It is hard to imagine the emergence of feeling without assuming the brain-physiologic processing of the incoming sensory data to have occurred earlier in the time-sequence of the causal chain of events (see, e.g., Barret *et al.*, 2007). As for the peripheral physiological changes, they are mostly regarded as causally concurrent with the feeling, both resulting from the central nervous system activity, and then mutually influencing each other during the course of the emotion.

New developments in physiology-based emotion research are undoubtedly stimulated by the progress in brain activity imaging. This has enabled substantial progress, changes or refinements of the earlier EEG-mediated (or, in rare cases, using the stimulation of specific brain regions in humans during surgery and recording the responses thereto) studies of the brain circuits activated in an emotion (e.g., Arnold, 1960b). The introduction of new neuroimaging methods have enabled to map the activity of various parts of the brain in their interconnected circuits in much more detail than ever before. In some cases, quite different patterns have been discovered for different “discrete emotional states”. On the other hand, the findings are very often loaded with much uncertainty, as they bring different measurement results in different studies.

The progress in this direction of emotion research allows us, contrary to the older Schachter & Singer (1962) concept of a generalized (for them it was peripheral) arousal as both the necessary and the sufficient physiological condition for any kind of emotion, to discover remarkable differences in both central and peripheral patterns of arousal or inhibition related to the affective quality. Thus, for example, Levenson (1988; 1992; 2003) surveying research reports and adding his own experimental findings, summarizes for the periphery: “*There is now sufficient empirical support for asserting the existence of a set of ANS distinctions among emotions*” (1992, p. 26). This is supported by other, more recent laboratory studies, like that by Christie & Friedman (2004) and others. It seems noteworthy that, in spite of the seemingly sharp discrete emotions vs. dimensions of emotions controversy, most of the research in question utilizes both points of reference in what is occasionally called “a hybrid discrete-dimensional model of affective space”.

Pursuing the research of the neurohumoral activity of the brain, some evidence is found for discrete emotions as being connected with the increased activity of a particular brain region (e.g. fear with amygdala, etc.). However, the attempts to distinguish the representations of the whole affective dimensions are, so far, turning out to be more promising (see, e. g., the evidence of the “core affect” represented by the dimension “pleasantness-unpleasantness” in Barrett *et al.* (2007); or the neurophysiologic representation of the dimensions of “valence” and “arousal” found by Collibazzi *et al.* (2010), marked by an increased level of activation in neural circuits passing through specific anatomical regions of the brain).

Thus, the general trends in the physiological line of emotion study appear to be leaning away from the prevalence of peripheral ANS activity observation and measurement toward more detailed and more differentiating analysis. This is directed both to the peripheral neural and hormonal emotion components, and to the central brain regions and circuits whose observed activation or inhibition are studied in the relation either to the dynamics of individual discrete emotions, or to the representation of the general affective dimensions of the dynamics of emotions.



4. *The expressive-behavioral approach: displaying emotions.*- The spontaneous and non-volitional expression of emotion in the positioning and movements of the face and other parts of the body, in the voice and other characteristics of speech, and in other displays of human attitude and activity is theoretically important not only as a part of the emotional “response” to events but is also considered by many as an important source that co-elicits and modulates its quality and intensity through the incoming sensations produced by it. Expressive behavior is closely tied both to its external, social communication and interaction context, and to the internal, instinctive (re)action mobilizing physiology of the organism. For some, like Ekman (1992; 1999; 2003) and Izard (2007b), its patterns are innate and culturally universal as originally posited by Darwin (1872). For others, like Ortony & Turner (1990), only the components of expression are innate, not the whole expression gestalt. The hypothesis that emotional expressions are all results of social learning and thus culture specific, does not seem to have many advocates now.

In the course of the last decades of research and theory construction, new interesting findings have been accumulated in support of the ever-closer interconnections between emotional expressions, before considered as “just a response” to the centrally evoked and experienced affective event. Thanks to ingenious experiments, it has been shown that voluntarily produced facial expressions (as if) of different emotional states generate involuntary changes in autonomic nervous activity as well as in the subjective experience for some people. The patterns of the ANS activity as well as those of the feeling produced were specific for the “basic emotions” expressions evoked (e.g., Ekman, 1992, p. 35).

As to the differences in emotional expression occasionally found among the members of some of the cultures compared, an important distinction was arrived at between the universal natural expression of a particular emotion and the culturally imposed rule upon it. The original involuntary movement patterns in such cases seem to be voluntarily suppressed or changed in front of observers of whose presence the subject was aware. Besides, the idea of a single expression gestalt for a single discrete emotion is to be relinquished in favor of that of a “family of relatives” which are in some respects similar and in other respects different.

Much research is further devoted to the very basic social communication function of emotions. Besides traditional topics like the personal and context-related conditions of the precise moment of emotion recognition or that of the distortion of the expression by introducing voluntary modification to it, there are new ideas and observations. Better cognitive mastery of emotional concepts was shown to facilitate recognition of the emotion expressed (Lindquist, Barret, Bliss-Moreau, & Russell, 2006). The role of the motor cortex and other brain areas in mediating the feeling-expression connection is investigated (Ekman, 1992, p. 35). New computer-aided technologies have enabled the construction of more precise mea-

surement of the expression patterns in various domains, such as the sound spectral analysis of voice and the EMG measurement of the small muscle activity under the skin of the face.

It is also worth mentioning new impetus in the emotion recognition methods. A diagnostic technique, the Multimodal Emotion Recognition Test, has been devised by Bänzinger, Grandjean, & Scherer (2009) to objectively measure the emotion recognition ability, differentiated here into that of the visual and that of the auditory recognition. A host of emotional recognition computer software is developed and is designed to replace human observers' judgments both of face and of voice patterns, though its validity under natural spontaneous emotion expression seems questionable as yet.

The overall trend in the theoretical understanding of the nature, structure, and function of spontaneous behavior expressions of emotions shows a marked shift from conceiving it as a peripheral reaction to a central event, anchored in feeling and physiology, toward recognizing it as an inherent part of the evolving process of emotion. This is accompanied by a still more complex and refined analysis of the newly discovered interconnections of emotional components through ongoing activity in the physio-psycho-behavioral circuits involved in a particular emotional state. Furthermore, the functions of emotional communication and of emotional eliciting of expressive behavior are subject to much more extended scrutiny, and moreover, to the searching for and the discovering of still more intersections with the course of feeling and physiology, as well as with the changes in situational contexts and behavioral intentions.

*5. The goal-behavioral approach: the enactment of emotions.*- Goal-oriented behavior has been tied to emotion especially in the speculations and investigations using animals as models. Instinctive actions like fight, flight, freezing, approach, feeding, and sex have been seen as parts of the instinctive programs containing corresponding basic emotional states. Transferring this knowledge to humans, the concept of feeling-driven purposeful behavior changed from being innate to being predominantly learned. The choice and performance of behavioral acts is considered to occur at different levels of conscious control, from the involuntary and unconsciously driven impulsive behaviors to the consciously and voluntarily chosen volitional actions, with the habitual, mostly semi-conscious behaviors in between.

The inherent connections of particular emotions to particular behaviors are, relative to the type of behavior control exerted, considerably weakened in comparison to those observed or assumed in animal instincts. In humans, conflicts of motives, emotions, habits and values are typical, and their resolution at the time of the emotion being elicited depends to a different degree on the concurrently evoked processes of unconscious and/or conscious decision making and on the

final choice of what to do. Therefore, in emotion theory, overt behavior is considered to be a true consequence of, among others, the course of the emotion process, not as a mere component of it. However, the overt action performed is then typically another situational and physiological source of stimulation that again elicits an emotional response and thereby modifies the actual emotional state with its input. Instead of a motor program of a specific behavior, a covert tendency to purposely behave in a certain way is considered to be an inherent component of emotion. It is assumed that “*emotions can be defined and identified by different sets of action tendencies ...[which] are the states of readiness to execute a given kind of action, involving both bodily arousal and psychological preparation*” (Zhu & Thagard, 2002, p. 27). This idea was present, among others, already in Arnold’s theory (1960a), and is a pronounced component of Frijda’s theory of emotions. Therein, Frijda (1986) specifies particular action tendencies connected with a set of discrete emotions. These tendencies may or may not be realized in the overt motor behavior, depending on other emotional, cognitive, or conative factors effective at the moment. The behavioral action generation is, in this way, an essential function of emotional regulation.

At the present, the trend in studying the nature and the role of goal-oriented behavior seems to point to a refined analysis of the motivational and cognitive precursors of the final modulation, execution, or suppression of the original action tendency as a part of the global emotional event. This is done in terms of investigating the influences and interactions of emotions with a person’s appraisals, motives and preferences, values and goals in relation to a particular situational context, learning experience, or reflections and anticipations (e.g., Nelissen, Dijkster, & de Vries, 2007; Baumeister, Vohs, DeWall, & Zhang, 2007).

## **COMPOUNDING EMOTION**

For decades, all of the approaches described continued to provide useful knowledge about emotions. As already mentioned, in influential emotion theories, particular “emotion components” have been connected with both discrete emotions and with the inferred emotional dimensions. It holds true that it is not possible to unequivocally relate the discrete patterns of data obtained in these different domains of observation and measurement to each other. Therefore, the individual studies usually start with one kind of data as their basis, and utilize other kinds so as to relate it with each other. Since psychology is fundamentally concerned with the study of subjective reality, it is not surprising that most research of emotion coping relies on some form of subjective report (introspective, retrospective, verbal, numerical, graphic, or pictorial rating scale, etc.).

However, there are still more reports published indicating that using refined measurement tools the cross-correlations of the specific events related to one affective state among the five different domains of observation are better than skeptics would expect. So far, mostly the coherence among two or three of them has been investigated. The results of new studies, utilizing still more sophisticated technology and methodology, are promising – see, e.g., Mauss, Levenson, McCarter, Wilhelm, & Gross (2005).

There are good reasons for neither demanding nor expecting to obtain perfect correlations among the different approaches to emotion observation. Contrary to the increasingly complex models of emotion that are required, e.g., for the purpose of computer modeling, which require precise instructions, including such as those for the probability variation allowed, the living human's affective processes are incomparably more complicated and subject to innumerable influences from the inside as well as from the outside, and also from the individual learning history, that affect their processing in the different systems in different ways. If in spite of this diversity reliable degrees of mutual cohesion reappear, this constitutes an encouragement for the assumption of the unitary nature of individual emotions'.

## **ELICITING AND MEASURING EMOTIONS**

The task of discerning the presence, intensity and quality of an emotional phenomenon or event is essentially that of the “signal detection”. This problem plagues all psychology and all science in general. We are never able to observe emotion in its “pure form” as separate from other states and processes. Any observation thus targeted yields some input originating both in the emotional event sought for and, at the same time, in the “noise” of other ongoing bio-psycho-neological events in the individual, in the same way as a particular experience and/or behavior is always the outcome of a whole set of different influences. This is the reason why it is essentially impossible to devise absolutely reliable measures of emotional events. Those that are in use are always bound to bring in some amount of this “noise” that sometimes may be mistaken for the emotion proper, or sometimes shows itself just in the remaining “unexplained variance” of the imperfect measurement.

The task of summarizing the methods and problems of measuring emotions was lately accomplished by Mauss & Robinson (2009). In their summary of the sensitivities of emotion measurement procedures recently applied in the response systems of experience, physiology, and behavior, they also include typical examples of the methods of eliciting the events under scrutiny. It shows that the emotion elicitation method often significantly influences the measures of the emotion obtained.

Though they report some optimistic findings, in reviewing the field of emotion measurement they comment on several methodological issues concerning the imperfect correspondance observed so far in the data obtained. In terms of the target of measurement, there still seems to be advantageous to prefer the dimensional approach to that of discrete emotions; however, for the future use of more sophisticated procedures, they do not rule out the possibility of gaining more support for the latter position than is so far available. Another comment concerns the methodological advantage of using the intra-individual assessment across time, instead of the inter-individual comparison of measures obtained. This brings about a better convergence of findings from the different domains of emotion assessment. The correlations thus obtained are, nevertheless, still moderate in strength, which may be attributed to the influences of other, moderating variables not included in the project or inaccessible for observation. Under the assumption that in spite of the lack of the inter-domain measurement coherence the data from the different observation domains still reflect the same affective state, they recommend to utilize different measures thereof as much as possible: *“For theories of emotion, this means, that there is no “thing” that defines emotion, but rather that emotions are constituted by multiple, situationally and individually variable processes* (Mauss & Robinson, 2009, pp. 228-229).

## **EMOTION REGULATION/COPING**

Besides the two general questions concerning the nature and function of emotions (“What is it?”, and “What does it do?”), a third issue has emerged with renewed force during the last decades: “What do we do / can we do with it?” – the question of how people regulate or cope with the elicited emotions in their course. Underlying this question is the fact that the “free” course of an elicited emotion may cause harm, in the same way that any other process without regulating feedback mechanisms does. In case of powerful motivators like emotions, the concept of regulation entails *“influencing which emotions one has, when one has them, and how one experiences and expresses these emotions. ... Emotion regulatory processes may be automatic or controlled, conscious or unconscious, and may dampen, intensify, or maintain positive or negative emotion, depending on an individual’s goals”* (McRae & Gross, 2009, p. 337). In the present much more complex view of emotions, the assumed sequence “first emotion, then regulation” is transformed in that the regulating processes have been incorporated into the emotion itself as a natural part of its course.

Instead of the popular “mastering one’s emotions”, which assumed deliberate voluntary suppression of the “stirrings of the mind”, or their transformation to morally acceptable feelings, the Freudian or neobehavioristic theories of defen-

sive repressing or avoiding the awareness of particular emotional experience or that of its source took up their place. With the boom of modern stress and emotion research (reviewed by Lazarus, 2006), the concept of emotion-focused coping had been introduced, encompassing the assumedly unconscious defense mechanisms as its subclass, and differentiating between the automatic and voluntary attempts to change the intensity or duration of the experiential, somatic, or behavioral aspects of the emotional response.

The trend in the research of emotion regulation processes is in accord with the overall tendency to broaden the view to a larger scope of non-emotional influences and to analyze the subject matter in greater detail. As examples, we may refer to the following:

- Subdividing the ongoing regulation into different processes that influence the emotion in its course in time at different points – from the simple division into “appraisal” and “response” regulation strategies to the more structured breakdown, such as, for example, the process model of regulation distinguishing the “five families of emotion regulation strategies” in Gross & Thompson (2007).
- Conceiving of the various regulative strategies in the course of emotional event as simultaneous and different in their awareness level and in their automaticity vs. exertion. Their action may be observed on the levels of subjective experience, neural brain activity, or behavior, with complex ways of mutual interaction among them. The topics currently under study include concepts like situation selection, situation modification, intentional deployment, cognitive change, response modulation (Gross, 2008a; 2008b).
- Confronting the conscious, deliberate regulation strategies, earlier assumed superior while guided by reason (for a new research-based concept see Ochsner & Gross, 2005), with the automatic strategies, resulting from simple and possibly unconscious learning. Beyond the simple dichotomy, both sets of regulative actions are seen as located on a continuum between the extremes of fully aware and fully non-aware. New research (cf. Mauss, Bunge, & Gross, 2007) indicates that, although sometimes inferior and even pathogenic, the automatic regulatory processes may often be superior, and not only indispensable, but also providing “*the benefits of deliberate emotion regulation without the costs*” (Mauss, Cook & Gross, 2007, p. 698).
- Using new brain-imaging methods, the neural substrate functions of the regulation processes are depicted in far greater detail. Such investigations give rise to new ways of differentiating among them. This is expressed in concepts like the “bottom-up” and “top-down” processes of both emotion generation and emotion regulation, i.e., triggered by the perception of stimuli with affective value, and triggered by belief-determined reappraisal of the original stimulus, respectively (Ochsner & Gross, 2007).

- As in all emotion theory development, the intra- and inter-individual differences, due both to innate dispositions and to a great extent to social learning, are assuming a more significant place in this, basically, general psychology research (see John & Gross, 2007).

## **MODELING EMOTIONS**

Choosing or constructing a model of the original object to be studied is in modern psychology also a time-honored enterprise. As for human emotions, much of the theoretically and practically relevant model research has been done on animals. Conceptually, at least, some functions of emotional dynamics may be related to the machine-performed ones, as Chow, Ram, Boker, Fujita, & Clore (2005) posit. Conceptual flow-chart models are frequent in theoretical texts. Computer programs modeling emotions seem to be the latest challenge to this study approach.

Emotion process models deserving special attention, when looking for the developmental trends in emotion study, are those enabling hypothesis testing, using computational logic or calculus. In this respect, two promising types of computational models of emotion are emerging: the “artificial intelligence” type computer models (for earlier reviews, see Picard, 1997; Ruebenstrunk, 1998), and the neural structure and function expressing conceptual models, carrying the possibility of relating them to neurophysiologically measurable events in the brain (see Sokolov & Boucsein, 2000).

## **ARTIFICIAL INTELLIGENCE MODELS**

Interactive computer programs serving as a model of man are no new invention. In the 1960's, people like Loehlin (1968) and Colby (1971) accomplished this task using theoretically very simple means, yet yielding trustworthy results. The former is known for his “Aldous” program, modeling personality structure, dynamics and development depending on input data, inner transformations within it (including three emotions) and “behavioral” output data. Colby (1971) developed the “Parry” program that simulated the thinking of a paranoid individual. As normal or pathological traits, threshold parameters in the models were also set for eliciting emotion by the input “environment” data and for emotion manifestation in their output “behavior” data. Also, the interactions between two of such programs were attempted by modeling some of the social learning-induced personality change in the Aldous, and even modeling psychotherapy encounters in the Parry. Thus, the basis for applying the new discipline of “artificial intelligence” to psychological research was set at that time.

Ruebenstrunk (1998) presented a survey of many such personality and emotion simulating programs by the end of the last century. An example of the type of theoretical knowledge and definitional precision computer scientists demand from emotion theorists, together with examples of suitable theories, is shown in Dahl & Teller (1998, p. 6) where they write about the current trend in this endeavor: *“Today AI is moving beyond simulation and modeling to computer systems that embody an understanding of human cognition and motivation. In this context the importance of emotions has finally been recognized. ... In the area of human-computer interaction, a computer system with a functional theory of emotion could construct realistic models of users’ wishes and beliefs. In interactions with humans, such a system could understand and respond appropriately to users’ intentions.”*

Picard (1997) indicated five components that a computer system needs in order to attribute “emotions” to it. They include (1) emotional behavior, (2) fast primary emotions, (3) cognitively generated emotions, (4) emotional experience (cognitive awareness, physiological awareness, and subjective feelings), and (5) body-mind interactions. Analyzing flow-charts of the theoretical functions of emotions and showing the logical equations to synthesizing their influence upon, as well as interactions with, other psychological processes simulated, Picard examines some significant theories for this task and describes the attempted formalizations of them in several theoretical models developed for this purpose.

As a part of this endeavor, the “affective computing” as conceived in the artificial intelligence research aims at designing model algorithms simulating emotional processes within a broader individual or interactive system. Sometimes not only the data transformations and “emotional” outputs, but even technical devices – mechanical “robots”, are construed in order to recognize, interpret, and process human emotions by processing sensor-mediated facial expressions, gestures, or speech patterns; on the output side, they are programed to react to “emotionally” loaded stimulation patterns also with simulating emotional expression or behavioral action. In the overall “personality” of the robot, the programed emotions may simulate other “organism-serving” functions, such as controlling the man-machine communication, decision making, memory use and modifications, general body homeostasis and adaptation to the emergent map of the “environment”. Cañamero (2005), among others, points to the double eventual use of modeling emotions in autonomous robots: The transformation of their theoretically assumed functions into the physically observable events may, eventually, aid in the conceptual clarification and operationalization of the relevant aspects of theoretical notions, and in exploring and testing the theories and models of human emotions as well.

These models are, basically, functional models – assumptions concerning the real human neural structures underlying emotional processes and manifestations are not necessary. However, programing them requires very specific, though only



elementary, specifications of the theory behind the emotional processes in humans allowing for the operational definitions of the events to be translated into the computer language. Zadeh, Souraki, & Halavati (2006, p. 357), in introducing their model of emotions within the general model of mind, state: “*There is not yet a general computational definition for emotions and many of the related works in artificial intelligence are based on uncertain assumptions about the origin, features, and applications of emotions.*” This is a valuable impetus for emotion theorists, which are forced to express their concepts and hypotheses unequivocally for the programmers and their machines, even at the price of a painful reduction of the scrutinized phenomena as to the complexity of the variables involved and that of the interactions taking course. On the other hand, over the decades, the computer models keep growing in their own complexity, propelled in part by the demands the theorists make on them.

As an example of the latest developments in this respect, we may refer to the ICEA project (Sanz, López, Rodríguez, & Hernández, 2007; Sanz, Gómez, Hernández, & Hernando, 2008) that aims at developing a cognitive systems architecture integrating cognitive, emotional and self-maintenance processes, based on the architecture and physiology of the brain. This may show what may be the latest trend in the artificial intelligence modeling the mind in general and emotions in particular: to model not only the conceptually-anchored function, but, at the same time, to approximate the presently-known structural basis of this function within the nervous system as much as possible. Here, the AI modeling of emotions connects with the conceptual modeling of the neural mechanisms involved.

## NEURAL MODELS

Modeling specific emotions with examples is briefly sketched by Fellous (2007). Among the neural-inspired models he distinguishes the “biophysical” ones, implementing specific neural pathways and describing specific neural populations or neurons at the level of individual action potentials, and the “connectionist” ones, reconstructing neural processing principles with emphasis on the connectivity and level of activation of typical neurons, or groups of neurons. Biophysical models aim at predicting the dynamic network behaviors of the units of their analysis; connectionist models give a larger view of the computations achieved by a set of brain areas, and implement some form of learning with attention directed to the changes in the synaptic connection patterns. The models developed so far of both types show that the “emotional flow” does not follow only sequentially through the assumed individual emotional brain modules. These are, actually, just “*part of complex recurrent networks, so much so that their activity intimately depends on the activity of many other modules, being emotional or not*” (Fellous, 2007, p. 7).

There are quite a few attempts at modeling (with the possibility of computer testing) some part of human emotionality, like emotional conditioning, or modeling the emotional functions of some part of the brain, like the amygdala. As we are looking for very general trends in emotion study development in our text, we mention as examples only the most comprehensive work illustrative of research progress in the domain reviewed.

A general and well-structured example of the neural model was presented by Sokolov & Boucsein (2000). As to its nature, it connects elements of both of the model types distinguished above. Inspired by the well-described neural process of color perception, the authors assume a similar functional structure of complementary patterns of emotion-specific neural events. These are materialized in the form of individual activation/inhibition patterns of neural action potentials in a limited number of input channels. A part of their model depicting the assumed dynamics of these “either-or” decision points in the particular emotion detection is shown in Figure 1.6, wherein empty dots represent facilitation, black dots inhibition in the action potential elicitation in the – here represented as individual neurons – information receptors.

Further on, the detected emotional quality is subject to subsequent processing. This occurs through the media of both neuron and transmitter action. The particular emotion elicitation occurs step by step in the hypothalamus, thalamus, basal ganglia, and cortex, where it is combined, in the temporal cortex, with the sensory information received there. A symmetric net of several “bottom-up” as well as “top-down” neural pathways activated both sequentially and in parallel complete the model (not shown here). This model builds upon a vast survey of electrophysiological brain studies done by others, which is completed by the authors’ own experimental results at this point. In conclusion, they interpret their findings as evidence for the “*low dimensionality of the subjective and autonomic [four-dimensional] emotion space*” (Sokolov & Boucsein, 2000, p. 115).

One of the candidates waiting for translation into a representative model of the whole emotion process and who was also suggested as well-suited for modeling with the help of artificial neural network is the so far only conceptual model by Sander, Grandjean, & Scherer (2005). Its eventual advantage consists in comprising all of the theoretically assumed and empirically supported sequential components of the emotion process, and also in formulating its propositions in a way that allows for their experimental testing. The authors provide a thorough analysis of the “appraising mind – appraising brain” connections already known, or at least expected and to some extent supported by research findings. In this advanced elaboration of the conceptual model already mentioned before (Scherer, 2005; 2009), a computational model reflecting the hypothesized neural network architecture is suggested but not yet realized.

The developmental trend in both the artificial intelligence and the conceptual neural modeling of emotions in the last decade aims at improving the descriptive

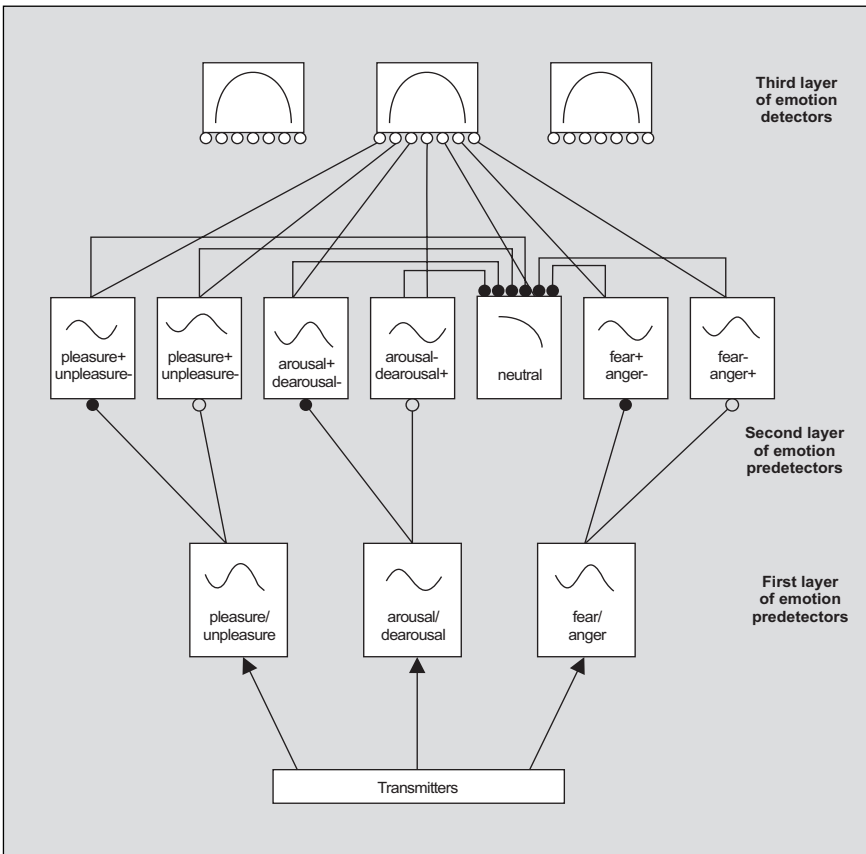


Figure 1.6 Sokolov and Boucsein's formal model of the emotion (pre)detection (Source: Sokolov, & Boucsein, 2000).

static-rule models with such that apply fuzzy logic and/or probability representations regarding events and observations pertinent to emotional states. This “*enhances our capabilities of capturing the intrinsic uncertainty of human common-sense reasoning and decision-making*” (Hua, Rui, & Jizhou, 2006, p. 1534), and thus yields more versatile tools for analyzing the uncertainty observed in the results obtained as well as in the prediction of the system outcomes.

## CONCLUSIONS

Kuppens, Stouten, & Mesquita (2009, p. 1249) conclude in their analysis that “*Contemporary emotion theories ... conceptualize emotions as multicomponential*

and dynamic processes that do not necessarily cohere in fixed packages and continuously change over time.” (p. 1249). This reflects the possible recognition that the search for those general “fixed patterns” has somehow reached its limits, and that further progress in both describing and explaining emotional events needs to rather include the differential points of the “ways in which emotions are elicited, experienced, and expressed”.

We have already exemplified this change in research strategies by reminding that in the “situational/appraisal” approach, the direction shifted from the general nature of emotion elicitors toward the subjective meaning of the circumstances of eliciting. Against the simplicity of the assumed inborn basic emotion mechanisms, attention is redirected towards the plasticity of the evocation of emotional states, and to their more complex nature and effects. This is to be explained by the influence of a person’s life experience in all five emotion study avenues, showing itself in the inter- as well as intra-individual variation of the actual emotion quality and intensity, including its course in time. In terms of personality study methodology, it seems that in the domain of emotions the “pendulum” is thus drifting, once again, toward the “situationist” view, stressing more the variation of present or preceding circumstances and events, as opposed to the person’s innate and fixed general and species-specific dynamic patterns of emotional responding and acting.

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