Flashback: Reshuffling Emotions

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Abstract:

Each affective state has distinct motor-expressions, sensory perceptions, autonomic, and cognitive patterns. Panksepp (1998) proposed seven neural affective systems of which the SEEKING system, a generalized approach-seeking system, motivates organisms to pursue resources needed for survival. When an organism is presented with a novel stimulus, the dopamine (DA) in the nucleus accumbens septi (NAS) is released. The DA circuit outlines the generalized mesolimbic dopamine-centered SEEKING system and is especially responsive when there is an element of unpredictability in forthcoming rewards. We propose that when the outcome of this interaction is unexpected or unanticipated then Panksepp's "cognitive or expectancy reset" mechanism involving the cognitive dissonance would yield the subjective emotion of surprise. In order to appropriately react to the environment's stimuli one needs fundamental processes that would enable one to distinguish between what is novel and what has been already experienced, as well as the different degrees of novelty. Novel events are those whose essential features of the representation (visceral and perceptual) are altered and being discrepant provoke more sustained attention. Novelty arises from salient and arousing events and the organism experiences surprise, as coming out of a habitual state. In this framework, we shall look at established theories of emotions and propose a different approach to their taxonomy.

Keywords: habituation, change, novelty, arousal, taxonomy of affective processes, SEEKING system.

Imagine a life in which incoherent plans are made and discarded immediately, in which there is no appropriate evaluation of the happening in significant events, a life without motivation and meaning. In such a life the element that colors, puts value on our actions, bestows upon us a unique personality and manipulates our interaction with the physical and social environment, is absent. This fascinating element, intriguingly difficult to analyze, is none other than the emotion.

I. Flashback

1.1 Philosophical approach to affective states

Discussions related to emotions flooded philosophical speculations of the ancient, medieval and renaissance time and, to them, in the 17th and 18th century, the modern mind added new concepts. To the psychologists' "ordinary" emotions, theologians, of the Judeo-Christian tradition, likewise, supplied their "religious emotion-types", i.e. gratitude, contrition, love of God, piety, compassion, etc. The terminology expressing emotions changed with the change of the approach and that of time. Thus, Aristotle's *pathos* (i. e. pathos), important in moral life, changed for the Roman Stoics into "emotion", as they adopted Cicero's translation of the Greek *pathos* into the Latin *perturbatio* (i.e. disturbance) and afterwards it turned out to be *affectus* (i.e. affect) for Seneca. Stoics connected emotions to cognition and, throughout several centuries, debated with the Epicureans on the place of emotions for a good life. Others preferred *passio* (i.e. passion), connecting emotions with "suffering" and "endurance". Galen, the Greek physician and philosopher, pursued Plato's tripartite model of the human mind, i.e. the reasoning, the desiring, and the emotive parts, and offered a biological and physiological basis of each one. His theory of the body's humors intended to explain a person's dispositions and temperament, i.e. sanguine, phlegmatic, choleric, and melancholic. Descartes described emotion as "passion" and meant by that "the perceptions, feelings or emotions of the soul which we relate specifically to it, and which are caused, maintained and fortified by some movement of the [animal] spirits"[1]. There are, in his opinion, six primitive "passions", i.e. wonder, love, hatred, desire, joy and sadness, and these could be the ingredients used for a good life. Spinoza's emotions, the affections of the soul, are yielded by one reality, encompassing mind and body, and are responsible for making the difference on the quality of life by motivating one to act or restrain. Hume challenged the inferior place of passion in philosophy and disputed the role of reason. For him, emotions were the very essence of human social and moral life. Hobbes called them also "passions" and assimilated them to appetites and aversions whereas Kant considered them as conative phenomena. Twentieth century Anglo-American philosophy and psychology included emotions in cognitive processes as well and for that behaviorism was one strong reason.

[1] Cited in Solomon, R. C., Lewis, M., Haviland-Jones, J.M., and Barrett, L. F., (eds.) "Philosophy of Emotions", *Handbook of Emotions*, New York: Guilford Press, 3rd. ed., 2008.

1.2 Interdisciplinary approach to affective states

Despite its lengthy history in human thought, the nature of emotion is still elusive. For many centuries, the approach to emotion studies have been exclusively pursued by philosophers and psychologists, currently, however, emotion is a topic of different branches of interdisciplinary research. This widening of interest seems now reasonable given that emotions arise, as Oatley (1999) noticed, with the meeting of two worlds: nature and culture. Scherer, Wallbott, & Summerfield (1986) emphasized that emotional experiences happen in social interactions, hence the analyzing of "pure" emotional expressions in a nonsocial setting, such as a laboratory, might be questioned. Adolphs (2001) claim that "the subject matter of emotion is the relation between organism and environment, the effect that interaction of the two has on organism's survival and well-being. Emotions thus pertain to the *value* that stimuli and situation have for the organism".

What elicits an emotional experience? There are several theories concerning this. Watson (1919) proposed that events themselves induce emotions, as in stimulus-response theories. Cannon (1929/2003) argued that psychological processes, patterns of neural activity of the brain, are the causes, while James (1894) believed that they are evoked by the peripheral autonomic activity. Tomkins (1962) considered that facial and other expressions induce emotions, whereas James (1980) thought that behaviors such as attack and flight stimulate them. Motivational processes, such as hunger, were seen by Tomkins to bring about emotions, although Parkinson (1997) regarded the desire to intimidate an opponent as motivational and thus the cause of emotional reactions. Appraisal theory (Roseman, 1984; Frijda, 1986; Oatley & Johnson-Laird, 1987; Scherer, 1992; Smith & Lazarus, 1991; Stein & Levine, 1987) claims that emotions are reactions to evaluation (appraisals) of events and situations.

In psychological discussions, emotions are generally set apart from cognition and conation as well as reflexes. However, most contemporary authors agree that emotions' behavioral schemata are to be distinguished from other conceptual areas based on their duration, complexity and their adaptive value. Accordingly, on basis of their duration, emotions could be seen as short and long lasting, referring thus to reflex reactions and affects or personality traits, respectively. From the point view of their complexity, on the one hand, they are regarded as very simple, primitive and hard-wired behavioral patterns, as in the case of reflex responses and some basic survival related appetitive behaviors. On the other hand, they are considered more complex and learned cognitive

activities. From the perspective of their adaptive value, emotions are considered as phylogenetically advanced adaptive response patterns, based on the integrated activity of several components and providing high survival value (Gainotti, 2001).

The emotional system can also be conceived as a set of responsive dispositions, where each one would indicate a particular relation with the environment. First, there are affect dispositions, producing feelings of pleasure and pain and corresponding functional attuning. (Cacioppo, Gardner & Bentson, 1997; Russell & Barrett, 1999; Rolls, 1999) Second, there are provisions for global motivational variations in tonic activity, effort and alertness (Pribram & McGuinness, 1975), inhibition (Gray, 1990), as well as the attentional arousal mechanisms, and the autonomic arousal (Bradley & Lang, 1994). Third, there are specific motivational dispositions that, when activated, produce major variations in action readiness – dispositions for motivation like "seeking" or desire, self-protection, confrontation, play, or submission (Panksepp, 1998). Their activation corresponds to different "basic emotions". Fourth, there are dispositions for various individual autonomic reactions – for motor responses such as facial expressions, voice intonation, postures (Frijda, 2001).

The discrete states and variables of emotions are difficult to analyze in laboratory, thus, for long, unobservable emotional processes have been approached through the examination of facial expressions on which the universality of 'basic emotions' is mostly based. Darwin (1965) was very interested in studying emotions, and analyzed them from an evolutionary perspective. Approaching people of different cultures, he determined that there is a set of universal, "basic emotions", each of which is distinctive in its adaptive implication and psychological expression. Before Darwin, as he mentions in his *Expression of Emotions in Man and Animals* (1872/1998), the facial expression of emotions had been studied by the painter Le Brun who published his "Conferences" in 1667. "Anatomy and Philosophy of Expression" was published by the physiologist Sir Charles Bell in 1806. In 1862, G. B. Duchenne published his "Mecanisme de la Physionomie Humaine", in which he analyzed the movements of facial muscles. He permitted Darwin to copy from his works the photographs he needed to use. Darwin thought that emotions and the way we express them are products of our animal ancestry. He saw the "basic emotions" to be biological in nature. Bowler (2005) argues that Darwin's need to minimize the gap between humans and animals, to convince his readers of his evolutionary theory brought him to the study of facial expressions.

Darwin's book begins and ends stressing on three principles, which rule the ways animals and humans express their emotions. First, there is the principle

of serviceable associated habits that links some modes of expression to adaptive behavior, as when fear is expressed by bodily changes designed to prepare for fight. Second, there is the principle of antithesis emphasizing that emotion can be expressed by behavior, which is exact opposite of that elicited automatically by the opposite behavior. A dog exhibits affection for its owner through a behavior that differs from the one in case of fear and anger. Third, a principle that links expression to direct action of the nervous system, as when fear elicits trembling. Throughout his book, Darwin never used the expression "basic emotions", instead he begins the second chapter by mentioning "special expression of man ... [which are] innate or universal, and which alone deserve to rank as true expressions". His evidence for them universality comes out of answers he received to 16 questions. The answers were collected by Englishmen living or traveling in Africa, America, Australia, Borneo, China, India, Malaysia and New Zealand.

Tomkins (1962), taking up Darwin's work after a century of neglect, listed a series of emotions associated with their respective facial expressions. He considered these expressions to be inherited and under the control of subcortical centers in the brain.

Several years later, Ekman (1973) used Darwin's method of showing six photographs expressing emotions and asking different people, from 21 countries, to judge the emotions shown. Ekman studying the autonomic changes associated with six "basic emotions" (happiness, sadness, fear, anger, disgust, and surprise) found that each one of them was associated with specific bodily patterns. Ekman (1994), influenced by Darwin (1872/1997) and Tomkins (1962), classified the characteristics of basic emotions, which distinguish them from one another and other affective phenomena.

Panksepp (1998:33) summarized four possible ways of viewing the role of affective consciousness in the generation of adaptive behaviours in emotional situations: (I) the "commonsense" view that emotions cause bodily responses; (II) the possibility that the emotions and bodily responses are independently but concurrently organized; (III) the counterintuitive James-Lange type of view that emotions arise by the way we bodily respond in emotional situations; and (IV) a more realistic view, which suggests that all levels of information processing in the generation of emotional responses interact with each other.

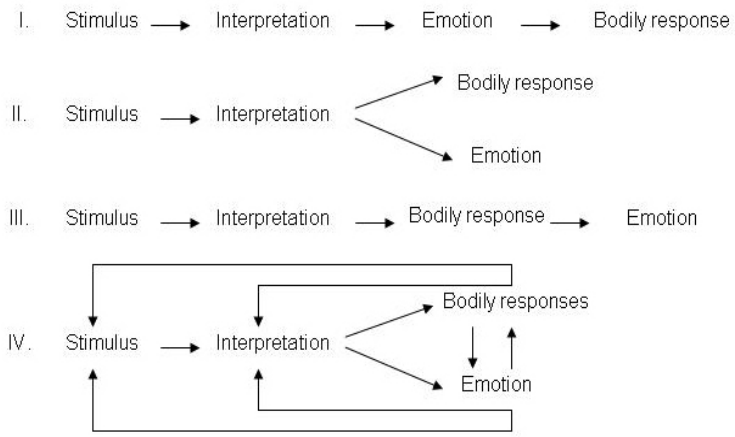

Figure 1. Four possible ways of viewing the role of affective consciousness in generation of adaptive behaviours in emotional situations (from Panksepp, 1998: 33).

1.3 Debates on Emotions

1.3.1. Primacy debate: appraisal vs. arousal

Zajonc (1980) claimed that simple familiarity with something creates affective reactions, such as liking or disliking, for that item. Objects were presented subliminally while participants were engaged in another task. The results revealed that though the participants showed no recognition of the subliminal items, they gave them higher preference ratings than novel items. Zajonc argued that the form of experience that we call feeling accompanies all cognitions, preceding them and lacking awareness, and concluded that cognition is not necessary in order to have affective experiences.

Lazarus (1984) argued that cognitive appraisal underlies and is an integral feature of all emotional states. LeDoux (1989, 1995) has shown that emotions, especially fear, are recognized by the brain's two routes, subcortical and cortical, suggesting that Zajonc's hypothesis of direct elicitation of emotion without the need of cognition might be right.

1.3.2. Whether or not "basic"

What is the need of such a distinction? An understanding of certain affective processes as basic would nevertheless create another category, i.e. that of non-basic emotions. Alternatively, there could be another case and that would probably lead to affective states as neither basic nor non-basic, an instigator state that might be by itself the cause of such states. Why do we need at all to make

divisions between innumerable affective processes one experiences throughout life, nay, within couple of hours?

We have already stated that the distinction among affective states is presumed to have started with Darwin's eagerness to connect human primates with their non-human evolutionarily related species. Darwin (1872/1998) considered that emotions could well fill up the explanatory gap between animals and our humanoid ancestors. "He who admits on general ground that the structure and habits of all animals have been gradually evolved, will look at the whole subject of Expressions in a new and interesting light". In his opinion, there are six "special expression of man ... [which are] innate or universal and which alone deserve to rank as true expressions".

Tomkins (1962/2008), following Darwin identified emotions associating them with corresponding facial expressions and connected these emotions with subcortical centres in the brain. Tomkins identified eight primary motivating mechanisms, the "inborn protocols that when triggered encourage us to spring into action"[2]. He divided them into "positive" and "negative" affects respectively, and a "very brief neutral reset button" that is associated with the emotion of surprise. (Table 2)

Positive	
Interest-excitement	eyebrows down, tracking behavior, attitude of looking and listening
Enjoyment-joy	smile, lips widened and out, slow and deep breathing
Resetting	
Surprise-startle	eyebrows up, eyes blink
Negative	
Distress-anguish	crying, arched eyebrow, corners of the mouth turned down, tears and rhythmic sobbing
Contempt-disgust	sneer, upper lip lifted
Anger-rage	frown, jaw clenched, face red
Fear-terror	eyes frozen open; pale, cold, sweaty; facial trembling with hair erect
Shame-humiliation	eyes cast down, head down

Table 2 Tomkins' classification of affects

Ekman (1994), influenced by Darwin (1872/1997) and his mentor Tomkins (1962/2008), classified the characteristics of basic emotions, which distinguish

[2] Tomkins, (2008) p. xiii.

them from one another and other affective phenomena as follows: (1) Distinctive universal signals (facial expression); (2) Presence in other primates; (3) Distinctive physiology (such as a specific ANS reaction for each emotion); (4) Distinctive universal antecedents – there are certain stimuli, preprogrammed evolutionarily, that will elicit each of these basic emotions. This does not deny the importance of learning in emotional responsiveness since learning contributes to the establishment of a connection between a stimulus and an emotion; (5) Coherence of response system (i.e. coherence between a given emotion, its facial expression, an ANS pattern and CNS activity; (6) Quick onset – emotions can begin within milliseconds of the presentation of an emotionally provoking stimulus; (7) Brief duration – usually in seconds rather than minutes or hours. This distinguishes emotions from moods; (8) Automatic appraisal mechanism; (9) Unbidden occurrence – emotional responses occur automatically to a given stimulus; they happen to us, they are not chosen by us; (10) Distinctive subjective experience; and (11) Distinctive thoughts, memories images.

Bechara, Damasio & Damasio (2000), asserted that the brain structures associated with the emotional states have all been independently associated with bodily responses. He also refers to drives and motivations, pain and pleasure as triggers or constituents of emotions but not as emotions in the proper sense. The same distinction is made by Panksepp (1998) between proper emotions and drives who does not consider hunger, thirst, and disgust to be emotions. From an evolutionary point of view, "basic emotions" are "rapid acting, failsafe devices that produce behavioral, physiological and cognitive responses tailored to certain critical features of the environment." (Griffiths, 1997:240)

Emotions of happiness, sadness, surprise, disgust, anger, and fear, have been claimed to be universal in respect of human population. (Ekman, 1994; Izard, 1995) Ellsworth (1991) argues that these expressions have been theorists' major "evidence" for holistic emotion programs that could not be broken down into smaller units. Even though universal prototypical patterns have been found for these "basic emotions", there is no evidence that the facial expressions are the indicators of emotions in spontaneous interactions. There are several problems in linking facial expressions with emotion-antecedent appraisal. The main problem is that there is no known mechanism of linking them. Besides, the dynamically changing emotional expressions are not easily linked to a static verbal label. In addition, the implicit and explicit social norms impose a powerful role of regulation and expression control that renders the study of such expressions rather difficult. Moreover, facial expressions are not necessarily an

indicator of emotional experience since they can serve several different functions. (Kaiser & Wehrle, 2001)

'Basic emotions' are considered as having evolved for their adaptive value in dealing with fundamental life tasks. Among these tasks, Lazarus (1991) mentions facing danger, processing towards attaining goals, experiencing irrevocable loss, "common adaptation tasks as these are appraised and configured into core relational themes". Stein & Trabasso (1992) consider that the main task is the attainment of a goal. Attaining it, happiness is the result; failure induces sadness; anger results by loosing it, while expectation of failure leads to fear. For Tooby & Cosmides (1990) the appraisal of a current event is influenced by our past experiences and are adaptive situations that recurred innumerable times in our evolutionary history.

Ortony & Turner (1990), Scherer (1992) and Kaiser and Scherer (1998) criticized the concept of "basic emotions" as fixed biological programs. They argue that there are classes of appraisals independent of "basic emotions". In connection with this, Scherer (1984) suggests that there are a large number of highly differentiated emotional states, which are not exhausted by assuming the "basic emotions". Facial expressions are not seen as "readout" of motor programs but rather as indicators of mental states and evaluation processes. Smith and Scott (1997) and Roseman (1984) argue that the link between the facial and appraisal dimension is based on the relation between facial expression and basic emotion. Unlike Ekman, they claim that single components of facial patterns do have a meaning and this meaning can be explained as manifestations of specific appraisal outcomes.

In spite of the disagreement, authors do agree that raising the eyebrows and raising the eyelids are associated with appraisal dimensions related to attentional activity, novelty, and unexpectedness. Moreover, there is consensus that corrugator activity (frown) encodes not only unpleasantness but more specifically perceived goal obstacles and the presence of goal discrepancies. (Kaiser & Wehrle, 2001)

1.4. A dichotomist approach to emotional experiences

The dichotomy of mind and body too influenced the attempt of theorizing emotions. When the "mind" led, the emotions have been approached through appraisal processes, through perception, attention and evaluation. Several models have been proposed to explain how we appraise events as well as the links from a particular event to specific emotions (Lazarus, 1991; Smith & Lazarus, 1991; Ortony, Clore, and Collins, 1988; Roseman, 1984; Scherer, 1984; Smith and Ellsworth, 1985). In their models, the emotions were triggered by the meaning

attributed by the subject to the encountered event. When the embodied and situated nature of cognition is considered, arousal, behavior and facial expressions become indicators of emotional experiences as well. Prinz (2004) situates the dichotomy in a single place by arguing that emotions are *embodied appraisals*, bodily states that track meaning in the environment. Fear, for instance, is the embodied evaluation that some aspect in the environment is dangerous.

Is there an irreducibly specific element for a particular "basic" emotion? Are there definite properties, such as level of arousal, intensity, positive or negative reactions, self-or-other-directedness, specifying the peculiarity of each of them? Experiences might be individuated according to their content and character, by the instantiation of phenomenal properties, by appealing to counterfactuals[3], by appealing to neural events or by appeal to some properties that must coexist during the same experience[4].

Since 1884 when William James published the article "What is an Emotion?", several theories have been proposed, siding either the body or the mind, i.e. either arousal or appraisal processes.

1.4.1 James-Lange Theory

William James (1884) published the first widely accepted theory, known as the James-Lange theory (the same theory was devised independently by James and Lange). James argued that the body reacts to certain situations (like danger) with bodily responses (increase breathing, heart rate etc).

According to James, different emotions are the result of our body reacting in different ways, so our emotions are just our perception of a bodily response. In this respect, "fear feels different from anger or love because it has a different physiological signature". (LeDoux, 1998:44)

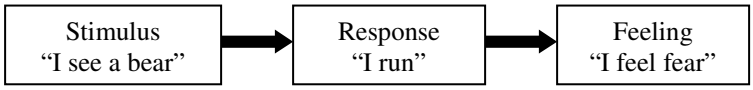

Figure 2 James-Lange theory of emotion

Crucially, in this theory each emotion is linked to a unique physiological response. So fear feels different to love because our body responds uniquely in fear-inducing and love-inducing situations.

[3] "If I could have the same experience of surprise without the fear, then they are separated experiences".
[4] The pitch cannot be perceived without volume.

1.4.2 Cannon-Bard Theory

Walter Cannon (1929) was a physiologist studying "emergency reactions" like fear, hunger, and pain. He noted that the autonomic nervous system (ANS) was activated in many emotions in a uniform way. He thought this must be in anticipation of action, rather than as a reaction to it and therefore the James-Lange theory could not be correct. In addition, we often feel the emotion before the ANS kicks in, suggesting James must be wrong.

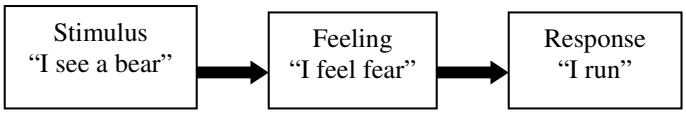

Figure 3. Cannon-Bard theory of emotion

We also know that certain physiological states can affect more than one response. For example, Dutton and Aron (1974) asked men to tell a story to an attractive woman whilst either standing on a safe or unsafe bridge. Stories from the unsafe bridge had a higher sexual content, due to arousal from danger causing more sexual thought. This is an example of a singular bodily response (response to danger) influencing a non-danger related feeling, suggesting again the James-Lange theory of specific bodily responses linked to specific feelings needs to be modified.

1.4.3 Appraisal Theories

Appraisal is now considered a central process in emotion theories. Only recently, the conscious and unconscious pathways to emotion have been investigated.

Arnold (1960) was concerned with the missing piece of the puzzle "What causes the reaction in the first place?" For Arnold, their must be some sort of appraisal process which allows us to analyze a situation which then produces an action tendency (bear → run), the feeling of which is the outcome of this process (Figure 4).

For example, anger is often aroused in response to feeling offended by someone's words or actions. However, offence requires an evaluation of the situation and can involve a wide-range of cultural norms and values. In the Inuit culture, displays of anger are rarely seen (Briggs, 1970), suggesting that appraisal may be quite different across social groups (or even individual people).

According to appraisal theorists like Arnold (*see* also Lazarus, 1991) this is unconscious as it happens, but we should be able to reflect back on the appraisal process afterwards to examine what happened. In order for a stimulus to produce

an affective response, the brain has to appraise its significance. Action tendencies are consequences of these appraisals.

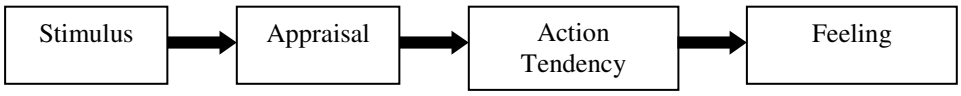

Figure 4. Arnold (1960) theory of emotion

Phillips et al. (2003) have reviewed the emotion literature taking into account a substantial amount of neurobiological research and have argued for a model of emotion, which includes a regulatory stage. They argue that three main components are important for emotion perception: (1) Appraisal and identification of the emotional significance of a stimulus; (2) Production of a specific affective state in response, including autonomic, neuroendocrine and somatomotor (facial, gestural, vocal, behavioural) responses and conscious emotional feeling; and (3) Regulation, so the emotional experience, expression or subsequent actions can be modified to be contextually appropriate if necessary.

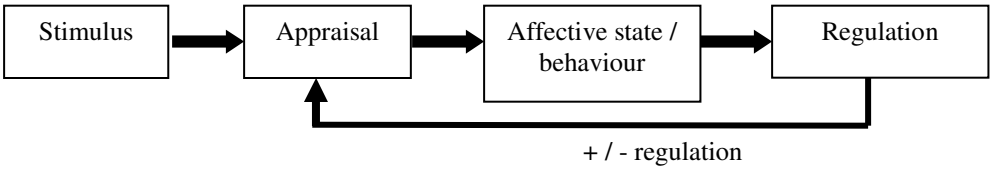

Figure 5. Phillips et al. (2003) model of emotion

This theory suggests that a stimulus that is identified as emotive and produces affective states may be dependent upon the activity of two neural systems: (1) the ventral system (including the amygdala, insula, ventral striatum, and ventral regions of the anterior cingulate gyrus and prefrontal cortex) important for the identification of emotional significance of the stimuli; and (2) the dorsal system (including the hippocampus and dorsal regions of the anterior cyngulate gyrus and prefrontal cortex) where cognitive processes are integrated with emotional input, important for the performance of executive functions (including attention, planning). Thus, the ventral system is seen as important for the rapid appraisal of emotional content and autonomic response regulation, while the dorsal system is important for the effortful regulation of the resulting affective states.

1.4.4 The Schachter-Singer Cognitive Arousal Theory

Schachter and Singer (1962) started with the assumption that physiological responses in emotion inform our brain that a state of heightened arousal exists. They induced artificial physiological arousal by injecting the subjects with adrenaline that activated the ANS. Their research concluded that once the bodily arousal was detected the cognitive processes take over by asserting the situation and label the arousal accordingly. This labeling of the arousal is what determines the emotions we feel.

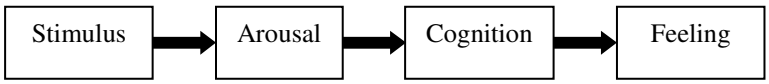

Figure 6. Schachter and Singer model of emotion

II. Reshuffling Emotions

2. 1 The mind-body problem and the affective processes

The classic mind-body dichotomy increased in its complexity by adding to it another problem, the mind-brain interaction and their possible/impossible interaction. It is not the purpose of this paper to compare the basic workings of the mind/brain or those of the mind un/related to the brain. Many researchers claim that the brain would not necessarily tell us anything about the workings of the mind, that science cannot study the mind. Others, on the other hand, admitting that the mind of each one of us is different, still there are certain properties of the mind common to us all. Frith (2007) does not see how brain studies could be conducted while completely ignoring the mind. Everything we know about the world around us, he points out, comes to us through the brain's connection with the physical world. Knowing where the brain has been damaged enables us to predict the content of the person's mind, even though there could be changes in the brain that would not necessarily show changes in the mind. Frith claims that there could not be changes in the mind (mental activity) without there also being changes in the brain, because "whatever happens in my mind is caused by, or at least depends upon, brain activity".

However, leaving aside this debate, we shall return to affective processes through which the mind (mental activity, subjective experiences included) seems to connect to the brain and the physiological processes of the body. We shall analyze affective states generated by certain external stimuli that are causing mental phenomena, ascribed to specific areas of the brain, that further produce particular behaviour.

At any step, the world offers us change and uncertainty that require constant adaptation and learning. Stability is safe; the unexpected is not always

welcome. In order to operate functionally at its latent potentiality, the organism needs certain stability. The salient world, constantly encountered, has a threshold beyond which it becomes disturbing, even though this threshold varies in different organisms. Feedback, homeostasis, autonomic and regulatory processes strive to reduce distortion, adjusting the organism to its optimal functionality. Scientific work in social and natural sciences, based on the supposition that unknowability of situations originates in lack of information, led to ever-increasing information seeking and processing. Their central goal has been avoidance of surprises. Unpredictability and surprise are fundamental aspects of the surrounding world and led researchers to the study of stability in chaotic dynamics of the complex systems.

No matter how fond we seem to be for changes in general, for the excitement of not knowing and the delight of uncertainty, stability, tacitly and continuously, is imposed on us by diverse internal processes. The organism lives its life effectively through various processes taking place between different subsystems of an organism enabling it thereby to deal effectively with the environment. As Arp (2008:13) argues, "this proper functioning, that yields internal homeostasis, takes place at levels in the hierarchy of the organism ranging from the coordinated activities in the cell, to cell performing coordinated processes in an organ, to organs performing coordinated processes in a subsystem, to subsystems performing coordinated activities in an organism". These somewhat steady maintenance processes make us what we are, delimitating us from other species: "rats have a richer olfactory life, eagles have keener eyes and dolphins may have thoughts that we barely fathom"[5]. At the same time, the moment the environment significantly changes, they automatically respond to the situation by preparing the organism to optimally deal with it and compensate for the change.

If this imposed stability is so important for the proper functioning of the organism, how does it cope with the salient surrounding? Why does it need stability? How important is it for the organism to live and function in a stable and safe environment?

Is there any genetic and physiologic need for stability? In a gene pool, the good genes aim at stability that would facilitate building efficient survival machine-bodies. Dawkins (1989: 86), taking into account Maynard Smith's *Evolutionary Stable Strategy (ESS)*, defines this strategy as "a gene pool that cannot be invaded by any new gene". The erratic mutations or immigration of new genes would be thus "penalized by natural selection", in trying to keep the

[5] Panksepp (1998), p. 4.

ESS safe. If, at times, a new gene succeeds to invade the gene pool, there is a transitional period of instability, before a new evolutionary stable set becomes stable.

Seeing stability from a cultural perspective, Distin (2005) takes up Dawkins' idea of "memes", cultural replicators, and speaks about the evolutionary stable sets of memes. The genes, after providing theirs survival machines with brains capable of imitation, would have to compete for brain's limited capacity of paying attention in order to dominate over other memes. The success depends on the stability of the meme and its "penetrance in the cultural environment". Transmission of culture therefore depends on the development of cultural replicators, and for that to happen, stability is needed. At the same time, Distin (2005: 122) suggests that memetic replication is preceded by the emergence of stable behavioral patterns. It seems therefore reasonable to assume that in a stable gene pool there would be an evolutionary stable strategy consisting of stable behavioral patterns that would imprint on its members evolutionary stable sets of memes.

From another perspective, genetic instability, the hallmark of human cancer, is responsible for cellular changes that confer progressive transformation on cancerous cells. Huang et al (2006) proposed that tumor development is a result of expansion and progression on genetic alterations through the induction of genetic instability. Genetically unstable phenotype might increase mutation rate (Loeb, 1991) hence genetic instability might be necessary for cancer to develop.

Stability plays an important role in evolutionary theories and social theories of human societies. In human societies, reciprocal altruism is a ubiquitous, integral part of socio-economic behavior, and it is tempting to argue that we have evolved specialized cognitive mechanisms to facilitate its stability, including systematic detection and punishment of cheaters[6].

On religious accounts, Dawkins (1989: 193) wonders, "what is it about the idea of a god that gives it its stability and penetrance in the cultural environment? The survival value of the god meme in the meme pool results from its great psychological appeal. God exists, if only in the form of a meme with high survival value, or infective power, in the environment provided by human culture".

Blakeslee & Ramachandran (1998), following Freud's proposal of a defense mechanism, proposed an alternate theory about the evolution of self-

[6] Huber, L. et al, "Cooperation in Keas: Social and Cognitive Factors", in Itakura, S., Fujita, K. (eds.) *Origins of the Social Mind: Evolutionary and Developmental Views*, p. 105.

deception, suggesting that the real reason for the evolution of such mechanism (confabulation or Freudian defense mechanism) is to create a coherent belief system for the self. This allows the individual to act in such a manner that stability is imposed on his or her general schema (Sean et al., 2007). This view takes a priori that each of us need consistency, coherence, and continuity in our behavior and that in response to instances that do not fit our script, we tend to engage in self-deception behavior in order to preserve the autobiographical script and make the conflicting information "fit". (Blakeslee & Ramachandran, 1998) The human brain might thus be equipped with a mechanism that "imposes stability on one's script". As Blakeslee & Ramachandran (1998) and Schacter (2001) have pointed out, there are numerous instances in everyday life in which people use consistency biases to impose a sense of stability or logic on the perceived world in a self-deceptive manner. Blakeslee & Ramachandran (1998)[7] proposed that the left-hemisphere is primarily responsible for imposing consistency on one's script, while the right hemisphere is the "anomaly detector". This view is based on studies of anosognosic patients with damage on the right hemisphere. These patients will vehemently deny the paralysis of their felt arm.

Psychologically, conceptions of how to balance the relative stability of living systems against the diversity and change that characterizes evolution introduced notions of order and entropy in place of variation, selections and transmission. Equilibrium theory, contrary to Darwin's insistent gradualism, is characterized by long durations of stability of form interspersed by geologically brief periods of change. This aspect of punctuated equilibrium theory is now considered a real possibility.

Since Smith and Simpson (2004) claim that, there is no such thing as zero risk, no physical item that has zero failure risk and no human being that makes zero errors, it seems important to look into how an organism could cope with change, uncertainty, novelty and sometimes risk.

Gomot et al. (2006) hypothesize that the resistance to change in children with autism could be rooted in atypical processing of unexpected stimuli. In their fMRI analysis children with autism, during both deviance and "novelty detection" showed reduced activation of the left anterior cingulate cortex. This conforms evidence from ERP studies of atypical brain function related to automatic change detection in autism.

It appears that the organism, together with its components, is able to respond effectively to the salient environment if there is a degree of stability,

[7] Blakeslee & Ramachandran (1998), pp. 534-535.

which would allow its best possible functionality. Stability, thus, needed for a proper functioning, imposed even when it is not present (*see* Ramachandran's left hemisphere's "general" and Gazzaniga's left hemisphere's "interpreter") seems to play an important role in human life. Once the regularities in the environment and the sensorimotor representations seem to change, the organism has to find a way to cope with the uncertain stimulus.

What happens when this stability begins to wave? As a possible answer to this question, we postulate that there must be a mechanism able to detect its absence and decide how to deal with the change. We shall call this the *Instability Detector Mechanism* (IDM) and try to look into its structure, behavior and interconnectivity. In this mechanism, we hypothesize that the emotion of surprise plays the role of the devise that sets out the re-stabilizing process, trying to reestablish the vanished balance. We shall consider surprise the instability detector as in the case of the fire alarm activated by a smoke detector. The reason for this assumption is that surprise (Lat. *sur* + *prendere* = over + take, to overtake) is a sudden reaction to an unexpected or a novel/uncertain situation/stimulus that seems to lie at the boundary between cognitive and emotional processes. A state that unexpectedly and suddenly overtakes us, pointing out towards something unknown, a novel situation, or could confuse us as an unexpected, unusual, unbelievable, or astonishing situation. In either case, it is short-lived and triggers different states, both cognitive and affective.

When the stability of the familiarity is shaken, when the personal world-view and beliefs are contradicted, when something incongruous and unaccountable is met, surprise seems to lead the person to a point of view from which the event, that triggered the unexpected, would somehow again make sense.

In affective studies, three dimensions of emotion have been addressed: (1) arousal (calm, excited); (2) valence (unpleasant, neuter, pleasant); and (3) potency or dominance (small, large). Arousal, the reaction intensity on coming upon an emotional charged stimulus, is associated with non-conscious, autonomic responses of the central nervous system. The hedonic valence categorizes the stimulus and is seen as appraisal evidence of affective states and is mostly connected with cognitive processes. Bradley and Lang (1994) speculate that the dominance dimension, which is relatively weak in accounting for variance in evaluative judgments of symbolic stimuli, is perhaps more potent in social interactions.

Pfaff (2006) considers that arousal processes, fundamental to all cognition and temperament, are at the base of emotional life. In his opinion, arousal precedes alertness, attention and orientation. At the very beginning of his book,

Pfaff asks the questions, “Why does and animal or a human being do something under one environmental condition and not another? Why does an animal or human being do anything at all?” He proposes that the answer to these questions could be found in the elementary arousal of the central nervous system (CNS), which he calls “the generalized arousal”. In the CNS, beneath all mental functions and particular emotional dispositions, “the generalized arousal” “throbs in the brainstem, activating or brains and behavior”.

The emotion of surprise has been addressed by many researchers by various approaches. Some researchers considered it as one of the “basic emotions” (Ekman and Friesen, 1978; Izard, 1991; Plutchik, 1980), on the basis of its unique manifestations. Russell (1991) classified surprise as an emotional state high in activation and neutral in valence, i.e. neither pleasant nor unpleasant. Appraisal theorists, looking at emotions as states stimulated by the organism’s evaluation and interpretation of events, have associated surprise with appraisals of unexpectedness, pleasantness, novelty, motive consistency and complexity (Smith and Ellsworth, 1985; Roseman, 1984; Reisenzein, 1999).

However, as far as our knowledge goes, none of these theorists has considered the emotions of surprise as itself being the initiator of other emotions and as the link between affective, cognitive and behavioral processes. A related idea (Mandler, 1990) was suggesting that surprise might precede emotions, as it could not be part of other valenced affective experiences. Ortony and Turner (1990), appraisal theorists, excluded surprise from the emotion’s list altogether, as, in their opinion, no affective state ought to lack valence. Kagan (2007: 98) says, “I noted that unexpected or unfamiliar events or feelings potentiate all emotional states”, but no more details are given in this respect. Kagan connects the increase of the heart rate with the feeling of unexpectedness.

What makes surprise different from other affective processes? In our understanding, the emotion of surprise seems to have various distinct features: it

- seems to act as a borderline phenomena (reaction or judgment);
- swings between cognitive processes and affective states;
- ridges cognitive processes and affective states;
- is the first displayed in infants in the first 6 months immediately leading to a bipolar state: a negative or distress state and a positive or satiated state;
- by itself has no ANS response tough emotional elicitors have autonomic biological adaptive character for other specific “basic” emotions;
- instantly activates the amygdala and the hippocampus;
- is essential for learning since has been shown that novelty improves memory
- is the briefest and immediately changing into basic emotions

- does not require leaning and memory unlike all other basic emotions

- its intentional object is not dependent on cognition, rather on non-cognition

- always occurs with organism perceiving itself as being surprised (a meta-perceptual status)

In surprise, through appraisal, the organism is deciding whether the novel stimulus is unpleasant, pleasant or neutral. These lead to the "basic emotions"

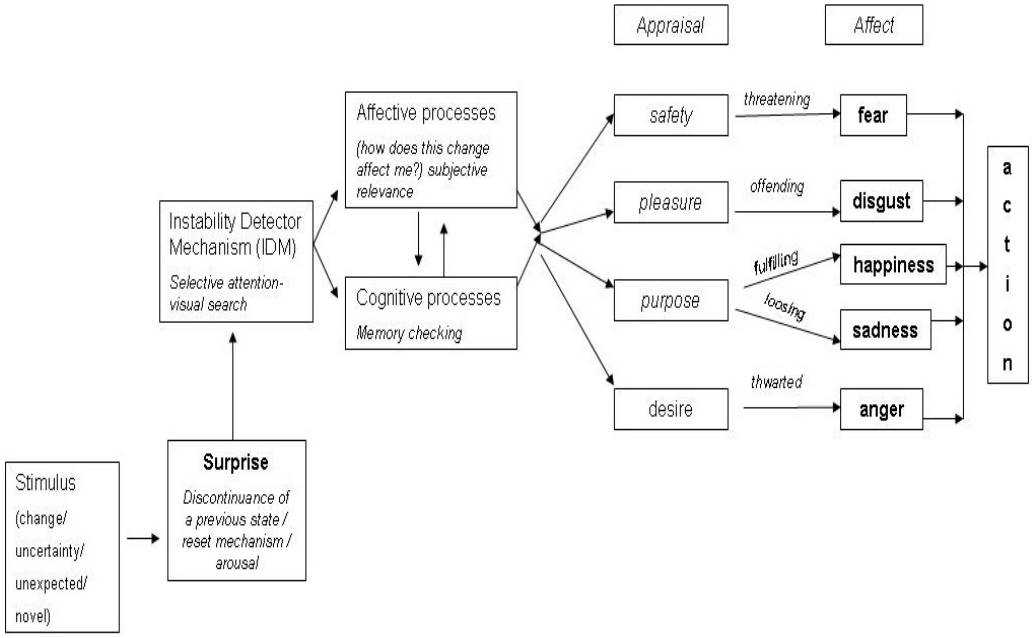

Figure 7. Proposed mechanism of affective processes mechanism that rise from the perception of change/unexpected/novel stimuli

In our premises, the emotion of surprise connects the emotional arousal with the cognitive appraisal. Thus, we presume that physiological arousal (low or high intensity) is the basis of qualitative distinctions (valence) among various emotional experiences. In this respect the arousal, responsible for the initiation and the intensity of emotional experiences, would initiate appraisals, responsible for the qualitative (valence) distinction between different emotional states. (Bradley & Lang, 2007)

While analyzing the brainstem arousal systems, we looked into the arousal systems of the brainstem, how they prolong or heighten waking response to particular stimuli or conditions. It was shown that the noradrenaline (NA)

neurotransmitter, responsible for arousal and focusing of attention, gives rise to diffuse innervation of the entire brain. The locus coeruleus (LC) neurons, utilizing the NA, first provide innervation to the subcortical relay stations in the thalamus, hypothalamus and the basal forebrain. These subcortical components have the capacity to influence the cortex directly while recruiting the subcortical relays of the brainstem arousal. The stimulation of the LC elicits cortical activation that would lead to the appraisal processes. On the other hand, acording to Panksepp (1998), there is an innate emotional SEEKING system ingrained within the mammalian brain. Positive expectancy and anticipatory states emerge through its interaction with higher brain mechanisms such as the frontal cortex and hippocampus that generate plans by mediating higher-order temporal and spatial information processing. If the outcome of this interaction is unexpected or unanticipated then a "cognitive or expectancy reset" mechanism involving the cognitive dissonance would yield the subjective emotion of surprise.

We propose that when a stimulus/event interrupts the habitual perceptual experience, produced whenever the mental representation of the stimulus is changed, altering habituation into dishabituation/sensitization, it arouses the experience of surprise, producing thus affective behavior in human mind. The perception of a novel stimulus takes place when the subject is confronted with something out of ordinary, something that does not fit into his/her knowledge base. If the stimulus is not the same, as in the habitual situation, the subject allocates attentional resources to the environmental change and the stimulus environment is changed or updated.

The subject's attentional resources would try to answer the question, "What is this X to my Y?", where X stands for the target (novel stimulus) while Y is replaced by the subject's essential requirements, such as safety, purpose, progress, or pleasure, when they are threatened, fulfilled or lost, opposed and offended respectively. In each of these cases, a different affective state follows, as the case of the question, "What is this snake to my safety?" would lead to the experience of fear.

Figure 8 illustrates different appraisals to the subject's essential requirements aroused by the novel stimulus through the evaluation of the relevance it could bear to the subject. Different affective states are generated as response to the novel stimulus properties, which could be seen in terms of intensity and safety. The affective response is seen as bearing functional properties, at the psycho-physiological level as well as at the motor level, generating specific behaviour.

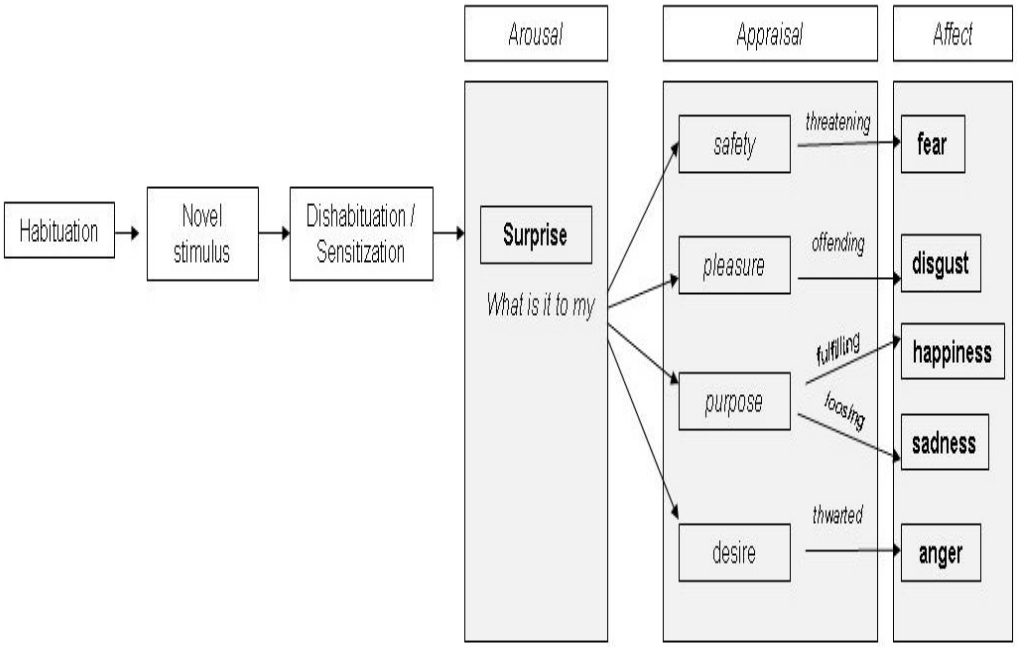

Figure 8. Affective processes initiated by novel stimuli "breaking up" the organism's habitual "slumber"

The ventral (or "what") visual stream picks up the relevant information of the novel stimulus. Blakeslee and Ramachandran (1998) briefly state that the "what" pathway, compared with the "how" pathway, the dorsal stream, is conscious and suggest that the difference is made by being linked to the amygdala and other limbic structures. The amygdala monitors the perceptual representations and "serves the organism's basic goals", determining "whether or not to respond emotionally to something and what responses are appropriate". The insular cortex, driven by sensory input and viscera, provides the amygdala with supplementary information, a "gut reaction" to something.

In our opinion, the "basic evolutionary goals" could be seen as safety, pleasure, purpose and desire. The meaning or significance of the change in a situation, presumed as connected with the perception of a novel stimulus/event, is "picked up" by the amygdala, which initiates emotional experiences according to the way it affects the organism.

Conclusion

We proposed that the emotion of surprise connects neuropsychological and physiological arousal processes with the cognitive appraisal processes. Thus, we have shown that neuropsychological and physiological arousal is the basis of qualitative distinctions (valence) among various emotional experiences. In this respect, the arousal, responsible for the initiation and the intensity of emotional experiences, generates appraisals, responsible for the hedonic quantitative (valence) distinction between different emotional states. Looking at affective processes in this perspective seems to eliminate the dichotomy of mind and body. The emotion of surprise has been considered the initiator of other emotions and the link between affective, cognitive and behavioral processes.

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