

Modelling and reasoning on emotions: theories and clinical implications ^{*}

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Introduction

What are the objectives ?

⇒ give us knowledge on brain and on its functioning or give us the means to treat individual pathologies ?

Aim is to show that these two perspectives are not exclusive but interact.

1 Theories

The study of emotion is hampered by several conceptual problems. The major one is the relationships between emotional and cognitive functions has been and remains very controversial in the debate between biologically oriented (Zajonc, 1980) and cognitively oriented (Lazarus, 1982) theorists of emotions. The former maintain that emotion and cognition must be considered as two independent systems whereas the latter argue that there are not two systems, but that cognition plays an integral role in emotion. (for overviews see Schorr, 2001). Cognitivists stress the interaction existing in man between the two systems and the integral role that cognition plays in emotion.

Before to describe the different models of emotions, it is essential to define emotions, because there is a pervasive tendency to lump together a number of different affective phenomena by using terms such as emotion, affect, mood...

1.1 Definition: How to define precisely emotions ?

The exact nature of emotions remains controversial. Disagreements mainly stem from the fact that the sets of phenomena taken into account are very different. Some focus their attention on the simplest aspects of emotion as they appear in animals or in the early stages of the human development. Others are attracted by the complexity of emotional phenomena. Emotions have 2 dimensions; expressive and cognitive. Expressive dimension concerns the production of facial emotions or expression of internal states of the brain whereas the cognitive one is related to the comprehension of facial emotion expressions and intention to act. Furthermore, emotions are experiences; feelings are accompanying emergent actions like happiness or despair. According to Ekman (1984), emotions are reactions that last some seconds and must be distinguished on one side by very brief responses (such as the reflex reactions or basic survival-related appetitive behaviours) and, on the other side, by long-lasting affective schemata, such as affects or personality traits. Emotions associate physical sensations (modification of cardiac rhythm, muscles tonus,

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vigilance and sudation), mental representations (pleasant or dangerous situations based on conditioned, automatic and unconscious learning), and specific motor responses (tension of facial muscles, flight-flight reaction in case of dangerous situation). From a cognitive point of view, emotions are different from a simple state of the organism (behaviourists). It is a processus (i.e. a dynamic sequence of different variables) whose components are the following: cognitive evaluation of stimuli or situation, physiological activation, motor and facial expression, action draft or planning of behaviour, feelings (subjective states). In accordance with this point of view, function of emotion is adaptive because it allows an important flexibility of behaviour thanks to an elaborate treatment of complex informations (Scherer 1984). Examples of emotions: happiness, sadness, anger, fear, surprise and disgust but also despair, proud...

I will focus on fear in the second part of this presentation in the paragraph which is considered cognitive and behaviour therapy.

1.2 Psychological theories of emotion (Lazarus 1982, Scherer 1984)

This part provides an overview of major approaches to the conceptualization of emotions. It describes the theoretical models that have been proposed and their pertinence.

Major models of emotions

Componential cognitive models Most psychological theories postulate that subjective experience, peripheral physiological response patterns and motor expression are major component of the emotion construct. These three components have often been called the emotional response triad. Emotions are elicited by a cognitive (but not necessarily conscious or controlled) evaluation of the situation. This evaluation determines how the different components (physiological arousal, motor expression, conscious feelings, action tendencies, cognitive processing) are affected. All of these components may be important element of an emotional episode. The componential nature of emotions differs from the homologous component of the biological system. The general and specific differences between the two systems derive from the fact that their general topic is different and that their components have different characteristics (cf tableau 1).

Hierarchical psychological models There are two kinds of psychological models: "structural and developmental". The structural models maintain that emotions are hierarchically organized with discrete emotions at the basic (primary) level and very few emotional dimensions at a higher (secondary) level. The basic emotions of happiness, sadness, anger, fear, surprise and disgust can be viewed as the building blocks of the emotion system. The dimensions of valence (distinction between positive and negative emotions) and arousal occupy a higher order superordinate level. The developmental models consider three levels hierarchically organized from the lowest to highest. Each person possesses from birth a set of expressive-motor programs which forms the sensorimotor level of the model. It reflects at the level of action or interpersonal communication the basic interactive schemata of human species. The schematic level which is the second stage of emotional processing differs from the expressive-motor programs of the sensorimotor level because they are learned and different for each individual. It corresponds to the level of the true, spontaneous, felt emotions. The last one is the conceptual level which is based on mechanisms of conscious and declarative memory. It stores the abstract and propositional notion of what emotions are, of which situations provoke them and of how to deal appropriately with them according to the social rules. The developmental models of emotions consider the more basic emotions which appear during the earliest stages of child development. Complex emotions such as vanity, remorse or nostalgia need much more elaborated and flexible cognitive evaluations and differentiated response options.

1.3 Emotional as a biologically adaptive system (LeDoux 1986)

The two main characteristics of the emotional system are its componential nature and its hierarchical organization. I will separately consider investigations based on the componential nature

of emotions from neuropsychological models based on the hierarchical structure of emotions.

Componential model of emotions Emotions are consisting of several components such as psychological arousal, motor expression, conscious feelings, actions tendencies and cognitive processing which are subserved by different anatomical structures. For example, with regard to the motor expression, the most commonly accepted view consists in assuming that the hypothalamus is involved in the more elementary level (generation of the autonomic reaction). The componential model of emotions has prompted two main lines of neuropsychological research. The first has considered of studying the correlations between disorders affecting different components of the emotional processing system.

⇒ Research strategies were to show if emotional disturbances in brain damaged patients result from disruption of a central emotional processor or from the independent disruption of the various components of the emotional system. The second line of research has consisted of trying to clarify the relationships existing between specific components of emotions and well-defined structures of the brain. I will focus on this second line of research in the second part of this presentation in the paragraph which considers neuropsychological researches on emotion in Alzheimer's disease.

Hierarchical anatomical models *Longrightarrow* phylogenetic perspective According most authors, models assuming the hierarchical organization is based on the complexity of emotional computation performed by different brain structures with a control of the highest functional levels over the lowest ones.

Brains structures are subserving emotions may be based on complexity of operations performed at different levels. The highest brain structures inhibit, modulate and extend (rather than replace) the earliest functional systems. The most influential of these models has been proposed by Papez (1937) who tried to specify the role played by different cortical and subcortical structures in various aspects of emotional processing. Emotions were subserved by a well-defined anatomical circuit, which includes hippocampus, fornix, hypothalamus, anterior nuclei of the thalamus, cingulate cortex and their interconnections. (figure 1. circuit de Papez). According this model, sensory information coming from the external milieu may follow two different routes (a cortical and a subcortical route) to reach the hypothalamic structures where they receive their emotional significance. The first route originates in the cortical association areas, where the information undergoes complex perceptual and cognitive processing. The subcortical route might omit the stage of cortical processing, sending the raw and poorly processed data coming from the relay nuclei of the thalamus directly to the hypothalamus.

Much more recently, LeDoux and colleagues (1984) provided anatomical and experimental support to the Papez' dual route model. They are showing that the amygdala (and not the hypothalamus) is the structure where information coming from the outside world acquires emotional signification. Another example of complex hierarchical anatomical model was proposed by Gray and McNaughton (1996). Structures of different phylogenetic level might mobilize in situation of different complexity the same defensive fight-flight attitude, i.e. when the source of danger is very close and there is no time for analysis or when the situation involves more distant threats and there is some more time for analysis. Furthermore, the amygdala might mobilize defensive behaviour in light of potential (rather than actual) events.

1.4 Cognitive models: reviews

Emotions have been for a long time considered as useless manifestations, irrational and parasites (source of interferences). So, first cognitive models were tried to wash (sanitize) emotional dimension. These models indeed did not take into account the biological constraints provided by the anatomical organization of the brain or the fact that the adaptive systems subserved by this organ have undergone important reorganization during its phylogenetic history (Tucker et al., 2000). Emotions were undifferentiated.

2 Clinical implications

Neuropsychology of emotion can be considered to be a very young and fresh field of inquiry. The first series of studies conducted in this area have been almost exclusively devoted to the problem of hemispheric asymmetries in representation and control of emotions (Borod 1993). The right hemisphere is more implicated than the left one in the processing of emotional information. More recently, the focus of attention has been directed to a much boarder array of problems approached either with traditional neuropsychological and neurophysiological methods or with functional neuroimaging techniques.

In neuropsychology research (organic diseases) The Alzheimer's disease (AD) is a good model to study alteration of emotional disturbances because it involves the amygdala (limbic system) which plays an important role both in emotion as demonstrated repeatedly in various lesions and functional neuroimaging studies (references). Amygdala is active during encoding of emotional stimuli and the magnitude of amygdala activation during encoding correlates with retrieval of emotional information (Canli and al., 2000; Cahill and al., 1996).

In the context of the present intervention, I'll focus my attention on the relationships between emotion and memory disturbance in AD. Specifically, does the disease affect the modulation of memory by emotion? Normal controls associate emotional items with additional semantic information or with autobiographical experiences when they learn new information. Furthermore, emotion may serve as a retrieval cue. A person may initially remember how they felt about an event, and that cue may then allow them to generate additional features about the event. Before everything, it is essential to recall in few words in what memory impairment consists in the Alzheimer's disease. The disease results in significant atrophy of medial temporal lobe that leads the dramatic memory deficit. At the early stage, impairment concerns mainly episodic memory which is characterized by an inability to learn new information or to recall previously learned information. The decline of cognitive functioning is gradual since it involves other cognitive impairment such as aphasia, apraxia, agnosia and executive disturbance as the disease progresses.

Emotional implication on recall was studied by means of theoretical model of cognitive neuropsychology of memory (Tulving et al. XXX). This model postulates that memory can be considered in terms of dissociable systems, distinct processes, and neuroanatomical structures (See figure 1). Within long-term memory systems, episodic memory is typically severely impaired in early-stage Alzheimer's. Semantic memory is less likely to be significantly affected, although impairments may be observed in some individuals. Procedural memory is preserved, as are some aspects of priming. Memory can also be considered in terms of the processes of encoding, storage and retrieval.

Some studies (Hamann et al., 2000; Kazui et al., 2000; Kensinger et al., 2002) showed that recall of patients with Alzheimer's disease is typically better for emotional (negative and positive pictures, words or sentences) than for neutral stimuli. In these studies, recall tests consisting of two short stories were administered to patients with AD and normal subjects. The two stories were identical except for one passage in each story; one was emotionally charged (arousing story) and the other (neutral story) was not. Memory is also better for neutral stimuli embedded in an emotional context (references). AD patients demonstrated also impairments in emotionally mediated implicit memory (affective priming for positive stimuli, Padovan et al., 2002). Other studies did not show such deficits. In contrast, they demonstrated intact enhancement effect of emotion on positive pictures, negative stories, films or real-life event. Differences across studies are related to the heterogeneity of patient populations (disease severity), difference in the stimuli or the extent of amygdala atrophy (Morris et al., 1999).

According to Kazui et al (2000), emotional arousal improve episodic memory in patients with AD and give a clue to management of people with dementia. Rehabilitation of emotional deficits is based on aspects of emotional communication such as prosody or consists in developing some procedures which selected cues of interpersonal communication.

In cognitive and behaviour therapy (functional disorders) Cognitive-behavioural therapy is a very often used psychotherapy for anxiety disorder. It is considered to be first-line treatment of panic disorder. This latter can be depicted as a profound blast of anxious affect. The emotional component is fear. The physical symptoms of anxiety are multiple: shortness of breath, rapid heart rate, dizziness, tingling, sweating. Most of the people consider the physical symptoms to be the most distressing part of the anxiety experience. When anxious, one's automatic thoughts and mental images tend to be catastrophic, that is there is an exaggeration of the dangerousness of the situation and a simultaneous underestimation of one's control over the danger (cognitive symptoms).

The main goal of this therapy is to identify and change underlying inappropriate thoughts and patterns that underlie and perpetuate the course of the panic attacks. Very often a vicious cycle of dysfunctional thoughts (catastrophic fears), anticipatory anxiety and agoraphobic avoidance causes a chronic condition (see figure 2).

The model of LeDoux's concerns fear only (doesn't concern other emotions). Fear conditioning and anxious reactions are emerged from the thalamus and the amygdala. These structures form a circuit that is involved in case of immediate survival responses (flight or fight). The connection between the thalamus and the amygdala is the most direct and therefore the fastest. In parallel, another pathway exists. The circuit involved the prefrontal cortex in addition to the thalamus and the amygdala. The cortex prefrontal is involved for more complex conditioning when individual must process an entire sentence than a single tone as a stimulus. Individual takes more time for cognition to shift from reaction to action. The prefrontal cortex seems to be essential for this transition. In this context, individual can be seen as an emotional actor who copes with a cognitive planning of voluntary action rather a just reactor to an involuntarily elicited emotion reaction. The medial prefrontal cortex while is not required for conditioning plays an important role in the extinction of anxiety which is induced in clinical practice by exposure of fear cues and cognitive restructuring.

Treatment of patients suffering panic disorder involves two kinds of techniques; exposure to fear cues (behaviour therapy) and cognitive restructuring (cognitive therapy). The central component of the treatment of panic disorder involves exposure to fear cues. The powerful means of reducing anxiety problems is believed to counter avoidance. Avoidance reduces anxiety in short term, but it makes for more anxiety in the long term as avoidance increases over the time. In few words, exposure involves placing someone in the avoided situation, despite the anxiety, until the anxiety decreases completely. In order to conduct exposure, the therapist works with the patient to identify a hierarchy of fear-evoking situations. The person gradually exposes herself to what has been avoided, starting with a level that evokes a minimum of anxiety, and increase the level of exposure as each level is successfully extinguished. Relaxation exercises and decatastrophising techniques are simultaneously used. This method of exposing is called systematic desensitization.

Cognitive restructuring is used to identify and counter fear of bodily sensations. Patients that suffering from panic disorder overestimate the probability of a negative consequence and have catastrophic thinking about meaning of such sensations. They were encouraged to consider the evidence and think of alternative possible outcomes following the experience of bodily cues. Part of this process involves identifying the origin of feared sensations and/or any misinformations about the meaning of the sensations.

The model of LeDoux provides a theoretical framework for cognitive-behavioural therapy as it establishes a relationship between emotion and cognitive factors. This author believes that anxiety disorder is a result of fear system breaking loose of the cortical controls that keep primitive impulses in check. His prominent hypothesis is that some humans may be super-prepared for various stimuli and consequently increase the likelihood of developing of anxiety disorders. Bodily feedback also is important in this theoretical model. Somatic responses have an impact on the conscious awareness of emotion. This is particularly evident in patients suffering

of panic disorder. This model set up behavioural therapeutic actions on emotional component on the circuit that is the more direct and cognitive therapeutic actions on the second pathway that is more rational.

3 Conclusion

Theoretical models allow a better understanding of functional mechanism of deficits in individual pathologies. They produce in the field of cognitive neuropsychology important results mainly in the comprehension of implication of emotional deficit on memory. This comprehension of cerebral functioning leads in clinical practice profound changes in the evaluation of patients and produces new orientations in the rehabilitation (Van der Linden 1996). Across the studies, clinical neuropsychologists progressively changed their point of view from a muscular conception of the brain to strategic interventions that are more theoretical and methodological elaborated. Working memory (Baddeley) \implies take place into the LeDoux model to explain his theory of (to be completed this night).