FEEL-COG: **The Role of Affect in the Development of Cognition**

Extended Abstract

A Unified Model of Cognition, Emotion and Action

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The *Unified Model* suggests that cognitive processes that steer and organize adaptive behavior evolve in what is commonly known as *affective space*. The theoretical framework of the model is that of Bertalanffy's "general system theory" (Bertalanffy, L. v. 1972) with self-organizing properties (Carver & Scheier, 2002), Piaget's genetic epistemology (Piaget, 1950) and Prieto's semiological explanation of how praxis (action) shapes cognition (Prieto,1975).

"General system theory" views living systems as open systems capable of interacting with environment They are not seen as *equilibrium states* but as states in steady dynamic re-equilibration. This enables them to be regulatory, goal-seeking and have teleological behaviour. Their functioning necessarily entails the construction of knowledge.

Piaget's epistemology explains the progressive emergence of knowledge structures as a consequence of the interaction with environment via two main processes : *assimilation* into pre-existing behavioural schemes (sensori-motor, conceptual) and accommodation (adaptation of the schemes). Adaptation is then seen equilibrium between the two actions. Successful adaptation is felt as an affectively positive state (enjoyment), while unsuccessful accommodation can be felt as a negative affective state. Affective states then becomes part of schemes. Affective schemes remain unconscious when not matched with accommodation.

Prieto's semiological epistemology provides a powerful model of the construction knowledge that enables the system to be regulatory. The starting point is *praxis* - defined as a deliberate action aiming at changing the internal or internal environment or preventing their spontaneous change. Praxis determines which environmental characteristics are relevant for the action to be regulatory. It determines the utility of the knowledge and its affective value (often called interest or motivation). Affective aspects of cognition (interest, pleasurable experience, success, failure) are thus considered to be initiators, modulators, or terminators of adaptive actions.

Adaptive Behaviour and Autonomous Agents

Adaptive behaviour of complex self-organizing systems is guided by a limited number of interacting control parameters.

Both early cybernetic models of self-organising adaptive systems (Cellerier 1968) and modern architectures of autonomous agents (Orlando A. G. Canamero, L., te Boekhorst R. Tyrell T. (1993) ; agree that for a system to be adaptive, it should perform at least five tasks :

1. Sense the internal and external environment, interpret and store the sensory information
2. Use the perceptual inputs and memory to decide (action selection and arbitration).
3. Regulate the internal resources (in humans: neuroendocrine, somatic and autonomic adjustments).
4. Transform the chosen action into patterns of overt behaviour including communication
5. Evaluate the outcome (perception, information processing, and memory).

The proposed *Unified model* suggests that the control parameters steering the execution of the five tasks can be described in terms of three dimensions usually attributed to emotions: valence, arousal and

potency. In Feith and Thayer's (2001) model of emotion, valence and arousal are described as the dynamic systems' control parameters. We believe that these control parameters *per se* are inherent to cognitive processes subserving the organism's interaction with the environment and that it is only under certain conditions (explained below) that valence, arousal and potency come to be considered as dimensions of emotions. We agree with George Mandler who argues "against any theories of emotion that are independent of or different from a more general analysis of human processing systems" (Mandler 1975).

Valence as Control Parameter

We consider the attribution of valence as inherent to tasks 1 and 5 in which the subject assimilates internal and/or external stimuli into the existing knowledge structures (sensori-motor and conceptual schemes). Each piece of knowledge is attributed a value related to the actual or potential hedonic valence of the stimulus and its beneficial or detrimental character regarding the subject's interests. Valence tagging is considered inherent to the subject's adaptive behaviour which aims at maintaining or achieving positively valenced states and/or avoiding negatively valenced states. Baddeley (2007) proposed the existence of a hedonic detection system.The target states can concern any or all of the three dimensions of Self, namely: *Intrapersonal Self* (personal interests, including own body), *Interpersonal Self* - relational and social interests (Trevarthen 1993; Hobson 1993), and *Transpersonal Self* (meta-cognitions, more global trans-societal interests). For overview see Brewer, M. B., & Gardner, W. (1996).

Affective neuroscience research suggests that primitive motivational subsystems based in subcortical neural structures provide an evaluative outcome necessary to initiate an approach or withdrawal response (Davidson, 1992a, 1992b) subserve the attribution of valence (Lane et al., 1997; Lane & Zei 2002, Lang, 1995)

Potency as Control Parameter

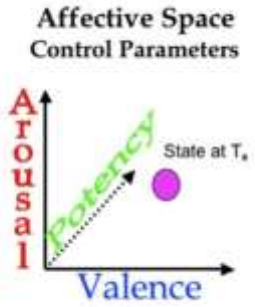
Attribution of a *potency tag* is inherent to task 2 of an adaptive system: action selection, arbitration, decision making and an estimate of the subject's coping potential. The latter refers to the estimated relation between available power and the power needed to cope with the situation. It is the decision to initiate action that generates the sense of agency and the construction of Self. Decision making implies choice. From the cybernetic point of view, it is only if the machine has the possibility of reacting in different ways (see Bertalanffy's equifinality principle) that its behavior can be regulatory (Ashby, 1961). Prieto (1991) offers an original explanation of how decision making and choice are related to the construction of the Self. He argues that in an instrumental act, the subject's body is the initiator of the action and it is the feeling that one can be a cause of action that generates the sense of agency and allows one to acquire self-identity.To quote Gallagher "*This is the feeling of identity, of being the perspectival origin of one's own experience, which is a basic component of the experienced differentiation of self from non-self.*" (Gallagher, 2005 p. 201).

Activation/Arousal as control parameter

Activation / Arousal tag is inherent to tasks 3 and 4 of the cybernetic model. It denotes the afferent-feedback based percept of internal body tone. This percept can be defined as a cognitive composite of feedback information from cardiovascular targets, gut, lungs, muscles, and electrocortical arousal. The *activation-tag* carries the information about the amount of energy mobilization involved in autonomic, motoric, and physiological changes required to handle the stimulus and/or its consequences. It can be seen as **s**chema activation before it is overt energy engagement. Piaget considers bodily energy management to be an affective dimension of behaviour involving the attribution of a *yield value* related to the actual or required investment of energy.

In summary, adaptive action involves the construction and usage of knowledge of the environment, of the internal milieu, of the self as acting subject, and of one's own action. We consider valence, arousal

and potency as the parameters that define the dimensions of the control space of adaptive interaction with environment.



Emotions as Specific Configurations of the Control Space

A relentless change in the configuration of the control parameters assures a dynamic equilibrium of the system. The amplitude of each parameter's change as well as its speed of change create configurations that can be subjectively felt or externally recognised as motivational or emotional states. We suggest the following criterion for distinguishing between emotional and non-emotional responses:
If the amplitude and/or the speed of change of any or all control parameters falls out of their normal range of variation, the state becomes cognitively dominant. In other words when the control-parameter-readouts fall outside their regular range of oscillations, the state is likely to be felt and conceptualized as emotional. The detection of such deviations is rooted in the fundamental physiological principle of set-point detection. We share Douglas Watt's view that " When internal physiological states are outside a desirable range, both visceral sensations and action dispositions are activated.

But phenomenal states of rage, separation distress, fear must have similar mechanisms, that these are *'not OK'* departures from ideal organismic baselines, activating defensive responses. These are central and not peripheral aspects of affect." (Watt, D. F. 2001). The deviation from a *set-point* is implicit in Russel's dimensional model of emotion, where the centre of the circumplex represents a neutral point on bipolar dimensions (valence and arousal), and "each emotion label can be thought of as a vector originating from centre of the circle with its length representing intensity (extremity or saturation)" (Russel 1989). Once triggered, an emotional response can then involve a resetting of procedural priorities and the regulation of the speed of task execution. It goes without saying that the sensitivity thresholds and ceiling values will vary from one person to the other depending on genetic, physiological, contextual and social factors.

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