Felt Emotions

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Abstract What does it mean "feeling" something? How body activation and its perception is crucial in emotional experience? How it impact on the cognitive components of human emotions and their "appraisal" function, or is affected by them? Which are the different mental paths of emotional experiences?

Keywords: Emotions, Feeling, Mind and Body, Cognitive Architecture, Appraisal

1. Premise and claims

Do we need "true" emotions – not just their simulated expression - in our artificial partners (agents or robots) for a meaningful social interaction? Do (cognitive) agents or robots need "true" emotions for their own preference and decision processes, social empathy or hostility, be sensible to moral norms and social duties? In any case, not "true" emotion without feeling something. No meaningful *model* of emotions can be provided without accounting for the fact that emotions are 'felt', modeling what this means, and how is integrated with the other representational and motivational components in the emotional "architecture".
This is what we will try to do in this paper. Our claims are the following:

- No real emotions without a 'body' (goals, beliefs, stimulus, reactions, actions, ... are not enough);
- No real 'body' without 'feeling', that is, without the body being felt, and sends sensorial signals about its current state;
- The bodies can autonomously, automatically, and primarily react to external stimuli, without a high level (belief-based) evaluation and forecast, and its 'reaction' (*motion*) is perceived and interpreted by the control system. Contrary to Ortony's et al. model [1] this is enough for simple emotions also in humans (like *fright* and *start* due to a loud noise, even before really realizing what it was).
- No human emotions without high-level cognition [2], but in the sense that the bodily response should be received, interpreted and attributed.
- There are <u>different routes</u> to the emotional process; bottom-up and top-down routes, and also their parallel use: while my body reacts to the stimulus (for example in *fright*) I continue to process it and evaluate it at a higher level, eventually converging or diverging with the implicit emotional evaluation ("danger!") and confirming it or blocking it ("What a stupid! It was just the wind!").
- Several of those paths are optional, while some of them are always there; in particular *the elicitation of a 'somatic' response and its ascription to the perceived/conceived event*.

2. Our Model of Emotions

2.1 Aspects of Emotions

Emotion forms a complex, **hybrid** subjective state (*state of mind*[3]).

[1] This research was part of the European Projects Mind RACES - EC's 6th Framework Programme: Cognitive Systems & of HUMAINE network.
[2] Not only in Ortony's sense: always high level cognitive evaluation and a top-down input to the body reaction.
[3] Also including the active representation of the body.

A constituent element of each complex emotion is the "mental state", an integrated structure of assumptions and goals which is closely linked to its functional nature, determines its intensional nature and classification, and accounts for its activation and motivation.

- **Intension** (what emotion is about- see below)
- **Hedonistic valence**: the general thesis is that *the emotions indicating failure* (actual or threatened) *to achieve a goal are subjectively negative, i.e. unpleasant*.
- **Constituent elements of the emotions**
  The basic constituent elements of the emotions are **beliefs, evaluations, goals**, **arousal** and **feeling** - i.e. somatic activation and its proprioception - the "tendency towards action" or **conative** component, and the **expressive** component.
- **Feeling.** By "feeling/to feel" in this context we do not intend the broad family of affects, moods, emotions, drives, … . We mean a crucial *component* of emotions (but not only of emotions):
  a) sensations from the body (proprioception/enteroception) and *about* body states and motions (like "feeling cold" "feeling pain" "feeling shiver");
  b) associated with, or ascribed to (see below: causal attribution), or interpreted as responses/reactions to a given perceived stimulus, or a given endogenous mental representation. In such a way the "feeling" acquires "*intension*", "*aboutness*", and become an emotional experience not just a strange event in our body.

(b)-feeling - which includes (a) - is a necessary component of a real (that is *experienced*) "emotion". An emotion contains (b) that contains (a).

2.2 Emotional Paths

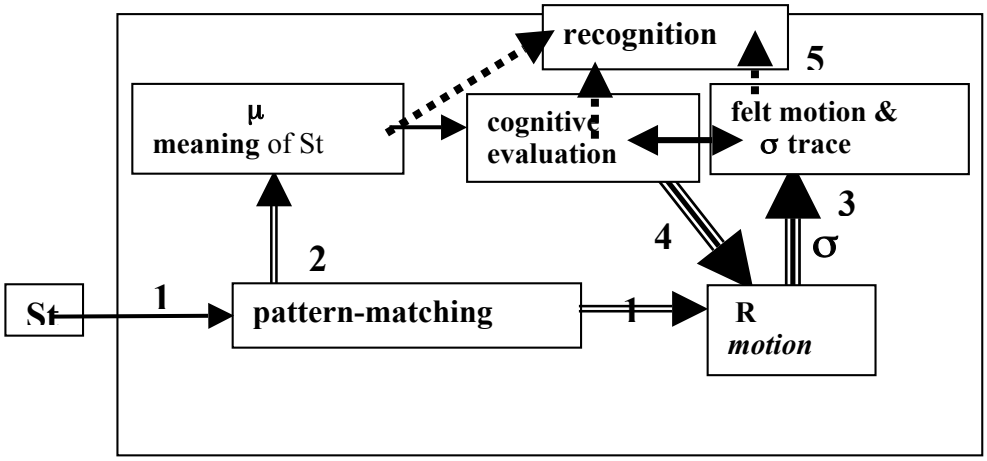

Fig.1 Emotional paths

It is very important not only identifying the links between the various *layers* (like in [1]), thus the *paths* of the possible processes, the flow of the emotional-information-processing, but to make explicit the *semantics* of those 'arrows' (this is a criticism to several other important models ex. [2] [3] [4] [5]), which is very rich and very diverse.

Let's sketch our coarse and incomplete but already complex model (Fig.1), in order to later disentangle different possible *emotional paths* (Figs. 2-3), and different 'functions' of the inter-layers links.

St is the *stimulus*, the perceived event (if any) eliciting the emotional reaction; **R** is the bodily *response* or related activation, i.e. the bodily 'motion'; **m** is the high level *interpretation* of St or an endogenous mental scenario; **σ** is the proprio-entero-ceptive *signal* to the control system

'informing' about the visceral-muscular reaction R, that is, *the felt sensations from and about the body motion*. Let's carefully consider those links.

The visceral route (from the 'sensitive' to the 'rational' soul):

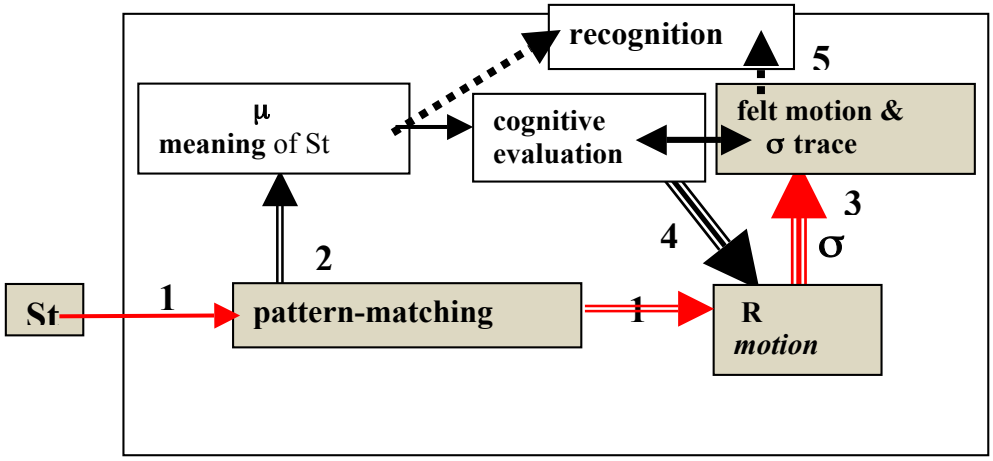

Fig.2 The visceral path

This path (1+1+3) characterizes what one could call the **'visceral route'**; that is, an emotional automatic (stimulus-response) somatic reaction **R** to a perceived event **St**, plus:

- the sensation/signal **σ** of this bodily motion,
- its *memorization* and *association* to the stimulus (formation of the 'somatic marker'), and
- the *implicit evaluation* of St in terms of the pleasant/unpleasant quality of **σ**.

In fact we assume that a positive or negative emotional response *does not presupposes an evaluation* of the event but **is** such an evaluation ([6] [7] [8]) This is similar to the "appraisal" of the stimulus postulated by many theories of emotions although in an ambiguous way; never clearly disentangling 'explicit cognitive evaluation' (beliefs, expectations, etc.) from implicit appraisal, positive or negative sensations and feelings about.

Moreover, the felt response can be *memorized* and *associated* with the stimulus. In such a way, also the he automatic activation from memory of this associated internal response (*evocation*) (in Damasio's terms, a "somatic marker"; [9]) *is* its appraisal.

The associated negative or positive emotion makes the situation bad or good, unpleasant or pleasant, and we dislike or we like it.

> "*Appraisal" consists of an automatic association (conscious or unconscious) of an internal affective response/state either pleasant or unpleasant, attractive or repulsive, etc., to the appraised stimulus or representation.*

It does not consists in a *judgment* of appropriateness or capability - possibly supported by additional justifications; on the contrary, it just consists in a subjective positive or negative experience/feeling associated with the stimulus or to the mental representation, usually previously conditioned to it in similar circumstances, and now retrieved. We consider these sub-symbolic, implicit forms of "evaluation" as evolutionary forerunners of cognitive evaluations.[4]

[4] We in fact distinguish between "appraisal" - that should be the *unconscious* or *automatic*, implicit, an *intuitive* orientation towards what is good an what is bad for the organism- and "evaluation": the cognitive judgments relative to what is good or bad for p (and why). We define an evaluation of an entity *x* as *a belief of an evaluating agent e about*

The top-down route (from 'rational' to 'sensitive' soul)
The path in Fig. 3 (1+2+4+3(+5)) characterizes what one could call the **'cognitive-appraisal based route'**; that is an emotional reaction to the evaluation of a perceived event St, plus the sensation **s** of this bodily motion, its memorization and association to the stimulus (formation of the 'somatic marker'), and implicit evaluation of St/**m** in terms of the pleasant/unpleasant quality of s. Consider that "Cognitive Evaluation" is a really simplified module: we put together two well-known kinds of appraisal: the evaluation of the event ("What happened? How to attribute it? Which predictions?") and the **'coping' evaluation**: how to deal with that event.

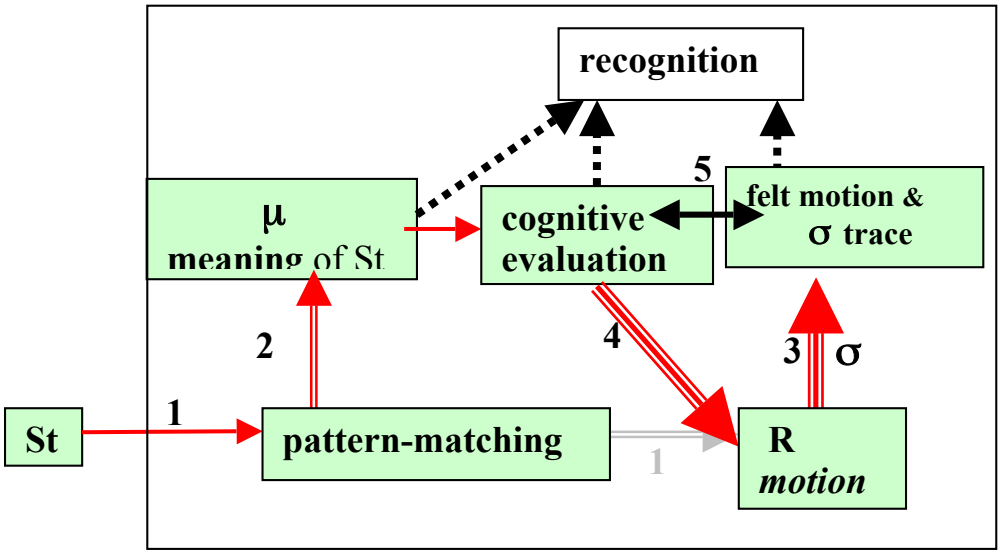

Fig. 3 Cognitive evaluation and body reaction

As we said the emotional reaction can just be due to a though or internally generated scenario or prospect (*imagination*), not to an external stimulus: route 1-1, 1-2 may not be there at all.
Let's now provide the 'semantics' of the arrows in Figs. 1-3.

3. Semantics

Arrow 3 (*James' arrow*; the bottom-up one) is the most important passage in order to make what happens to and in our body, its *reaction* (to a stimulus (*Arrow 1*) or to a thought (*Arrow 4*)) a real 'emotion'. This represents in fact several things:
3i) *Feeling*; the 'perception' of what is happening: sensation.
To feel consists in this path:
a) The run time *monitoring* of the internal (body) environment and of its dynamics (in response to external or internal stimuli) in order the brain and also the mind (beliefs, decisions, etc.) respond to it. Our control and government system (both as brain and as mind) is not only for dealing with the external environment chances, but also for managing internal events in an adaptive way. We both have a 'Foreign-office' and a 'Ministry of Interior'. Actions on and in the internal environment are usually not 'intentional' actions. More frequently they are unconditioned or conditioned responses, or proto-intentional actions.

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x's usefulness with regard to a goal p. Evaluations are a special kind of *beliefs*, characterized by a strict relationship with action, by virtue of their link with *goals*. Evaluations not only imply goals, but also can *generate* them [5] [6].

b) However, 'feeling' does not necessarily and always implies an *actual bodily activation*. This can be just the *origin* of the 'sensation'. Feeling can simply be the retrieval of a memory trace of a previously felt body-experience associated (conditioned) with a given situation, mental representation or action: *evocation* of σ (*somatic* marker).

3ii) ***Attribution***; the mental attribution of the bodily reaction and sensation to a given event or mental content as the cause and releaser of it. [5] Without such a causal attribution or perceived link (between mental content and felt bodily reaction) (*arrow 5*) it seems that we do not experience real 'emotions' but just bodily alterations. The signals from the body must be interpreted and associated with a significant event (Schacter-Singer).

3iii) ***Recognition***; arrow 3 contributes to the complete bottom-up process that ends with the possible 'categorization' of the perceived state as a given 'emotion' on the basis of different visceral, postural, expressive sensations, of the St, and/or the associated specific thought contents. [6] Human beings feel *specific* emotions also thanks to their cultural categories and their learning to 'recognize/categorize' them by cognitively discriminating one from the other on the basis of content, context, and sensations. Thus to feel a specific emotion also means to be aware of it, to recognize what is happening to you. People can be confuse about their perceived emotions; they can feel depressed when they are just tired; but subjectively speaking they are depressed since they interpret their sensations in such a way and with some pertinent related content. As any other recognition / categorization process this is a 'constructive' activity.

The link emotions-feeling seems to mean that emotions are useful for **evaluating** and acting with priorities in the external world but on the basis of and in relation to the value of the events for our body, its internal life, and its long term ***interests*** (more than actual goals – [4]) like 'integrity'. Our body seems some sort of physical 'memory' of adaptive functions and successful or unsuccessful experiences. The body reacts with an alarm when the event threats or concerns some primary adaptive function of the animal. If that 'goal' is achieved or close to the achievement the feeling is pleasant (happiness, joy, satisfaction, etc.), if it is damaged or treated the feeling is unpleasant (ex. boredom, anxiety, fear, guilt, shame, ..)

Arrow 4 (the top-down) represents three different things:

4i) The **top-down somatic activation due to a mental content** (a mental imagery, a though, an inference and prediction, a memory, an evaluation, etc.)

The body reacts not to an external stimulus (that can be completely lacking) but to its mental interpretation and evaluation, or to an endogenously produced mental representation. In the last case there is no route on *arrow 2* and **m** (the endogenous mental representation) is the starting point.

In Ortony, Norman and Rivelle model (like in all the strongly 'cognitive appraisal' based models) arrow 4 is the necessary path for having a true human emotion: a bodily reaction to a stimulus is not enough; it should be elicited by a mental evaluation of it. We do agree that a mere 'visceral' bottom line path is not enough for a full emotion, but we disagree about the necessity of *arrow 4*; for us also *arrow 1 + arrow 3* is enough: a reactive bodily response to something just due to a primitive 'pattern recognition', or 'releaser' without any complex mental evaluation or interpretation or thinking, but this reaction is 'felt', attributed, and recognized at the central cognitive level. This happens for example in *frights*, *starts* of fear, strong *disorientation,* and is enough for a true emotion.

4ii) The **feedback** or **loop** on the body of a previous bottom-up flow (Arrow 3), i.e. of the subjective 'interpretation' of a felt bodily response.[7] *Arrows 3 and 4* can determine **a recursive loop**: this also holds in visceral emotion but requires this level of cognitive appraisal of the somatic input (thanks to *arrow 5*) (what in RET and Cognitive therapy they call the 'secondary evaluation/reaction'. This is for example the very well known case of panic crises due to the subject's interpretation of heart acceleration and his reaction to this interpretation and worries, and again and again (cit.). Figure 4.

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[5] This kind of 'belief' is important in human emotion also for accounting for Schacter's emotional or non-emotional quality of bodily modifications.

[6] See our claim about this kind of 'belief' in human emotion in order to account for cultural differences, individual competence, and for more or less sophisticated and discriminative emotional systems (their might be culture with one, two or three species of hostile disposition and feelings, while Italian culture distinguishes between at least 15 different hostility affects).

[7] Probably it would be better to have two arrows 4. One for the (positive or negative) feedback loop from path 3; one for the impact on the body after 2.

4iii) There might be another meaning of this arrow, and more precisely of its *loop function*. The evaluation of the bodily activation (motion) and stimulus **s** and the reaction to it might be not that of fostering body motion, but – on the contrary – its inhibition: the attempt to remain cold and quite, and maintaining the 'self-control'.

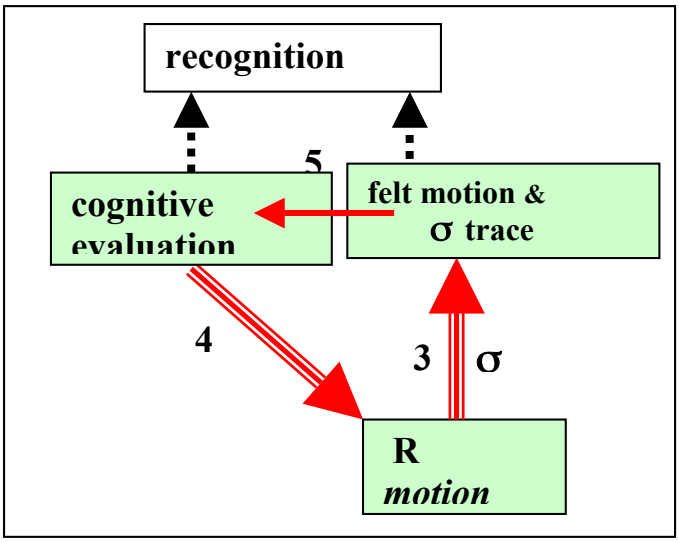

Fig. 4 A possible vicious circle

4. To feel with an unaffected body

As we said 'feeling' does not necessarily and always implies *an actual bodily activation*. It is possible to 'feel' something also in absence of a current specific signal/sensation from the body about some bodily reaction to an event or a thought. In this case a given thought or mental representation **m**, or a given stimulus, just activates the *central trace* of a previously associated (conditioned) affective/somatic response ('somatic marker') **s;** that is, they *evocate* previously memorized sensory experiences. We call this kind of feeling: "evocation-based feeling"; while the other involving actual sensations and signals from the body is called "bodily-activation-based feeling". The main merit of the (not so clear) Damasio's notion is precisely the clarification of the fact that a 'somatic' marking, that is the activation of the 'somatic marker' does not require the activation of the body, a current somatic signal; the activation of the *central memory trace* of that somatic response is enough. The other merit is the idea that one can have classical conditioning mechanisms not just on mere stimuli and responses, but upon mental scenarios and high-level representations used for/in reasoning and decision making.
This is very important for our model. It allows us to claim that:

- Always, when a subject says "I feel that" "I feel so…" she is really feeling something, that is she has some sensation, some 'somatic' signal, but not necessarily from her activated body; what she senses is the recalling of previous sensations and affective reactions: they are 'evoked', 'imagined', 'simulated' sensations.

We believe that for a good and general theory of 'feeling' this should be generalized also to cases like "I (do not) feel safe", "It is just a sensation. I do not feel confident", "I feel able to …", "I feel that everything is going worst", etc., that mainly are "evocation-based feelings" due to the unconscious re-evocation of previous affective or sensory-motor experiences.

5. On James' arrow again: implementing "affectus" and how feeling *affects* a reason-based mind

Let us now focus other very important meanings of James' arrow (arrow 3): its 'informative', epistemic-value function and its 'motivational' (conative-value) function.
For us this is the most important aspect of the notion of "affectus" (Spinoza), that is, how body "affects" mind. There are –it is true – several important impacts of bodily motion and signals on cognitive processes in strict sense: how mood affects memory retrieval; how attention is modified by emotional reactions; how emotional states favor some heuristics or others, or a given framing; how they can cut -or expand- decision time, or shortcut at all any decision process. However, in our view, "affectus" is the most significant "intrusion" of the perceived bodily activation within the intimate architecture of a reason-based (not necessarily 'rational') mind, by introducing a radically heterogeneous criterion within that symbolic "computation". The felt sensation from the body affects both the epistemic and the motivational-decisional aspects of cognitive processing [10].

5.1 The felt certainty of beliefs

The first point is known in the literature as *ex-consequentia-reasoning, affect as information* [11]. The idea is that the perceived bodily activation is used as evidence on which a belief *about the world* (the event) (not about the body or the mind) is based. For example we believe that a given situation is 'dangerous' just because we feel fear; or we believe that a person is sexy and perceive her/him as exciting (just) because we are sexually excited. Let us consider the classical example of the emotion of fear providing bases and evidence for the idea that there is some danger around. Arrows 3 is altering the normal cognitive process that ground beliefs and their credibility. The *credibility* of a given belief and its assumption depends on other beliefs that support it, and of its sources: (i) direct perception of the fact ("I saw it"); (ii) social communication ("They say that …"); (iii) inference and reasoning ("I conclude that…").

- *The many the different converging sources and supports, the stronger the belief (its 'certainty' or credibility);*
- *The more reliable/trusted the source the more credible the belief.*

These are the two principles founding beliefs formation and their strength. Now Arrow 3 affects this process and introduces a completely heterogeneous and independent principle:

- *The more intense the felt sensation (the motion) the greater the subjective certainty of the belief.* We have both possible schemes (Figure 5):

  - A belief, based on usual 'evidences' and 'sources' (direct perception, inference, communication) ("It is frozen! There is danger! I should be careful") activating an emotional response of fear or worry; and then a feedback of the felt motion (bodily response to this idea) on the belief 'credibility' and 'evidence' (low part of Figure 5); but also:
  - A belief just follower of and derived from a mere affective experience (motion) and *implicit appraisal* just automatically aroused by some low level stimulus (Figure 5 but also the path depicted in Figure 2).

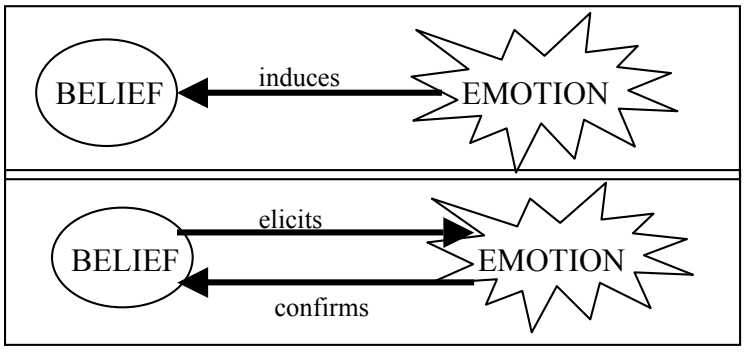

Fig. 5 Affect as Information

The wisdom of the body and Pascal's heart. This is a "non-rational" principle, more precisely a not "reason-based" principle for believing. One cannot justify (except in fact *post hoc* and in a self-deceptive way), cannot account for or support this belief. This – obviously - does not mean that it is necessarily non adaptive or advantageous; or that there are no other implicit and unknown "reasons" for believing so. As Pascal claimed "The heart has its own *reasons* that Reason cannot understand". That is, our implicit embodied "memory" of previous events and their value might provide a correct, automatic, unconscious, primary "evaluation" of the new event; even when we are not able to retrieve those previous affective experience that shape our current (not arguable) reaction [12]. This affective *pre*judice can be non adaptive when the association has been arbitrary, or the analogy is not well grounded and just superficial, when the response is too generalized, when the learning has been based on very few strong experiences, etc.

A new kind of "implicit beliefs": when "feeling that…" implicitly is "believing that..".

There is a family of implicit beliefs (in the sense of 'potential') that are *feeling-based*; actually consists in a feeling state (a mood about..), which can be also interpreted at a declarative symbolic level and can bring to an explicit belief.

As we saw, a given mood-about, feeling, can either confirm and support a given belief (eliciting it) or also can *produce* its related belief. In this case, when the feeling is active we might say that the related belief is already *implicit*; it is presupposed or entailed by that feeling but is not explicitly formulated – like in Figure 5, or not activated, although preexisting; only the feeling is active. For example, a sense [8] of impotence, of not being able; or a feeling of non-safety or threat, can *anticipate* its explicit beliefs and hold before and without its formulation. This phenomenon in some sense is analogous to the other theory of *implicit/potential* beliefs. When X believes/knows that p, and in fact p implies q, X implicitly and potentially also believes/knows that q; but not actually. For example, X cannot detect possible contradictions with other beliefs. This is because psychologically speaking we do not know all the logical consequences of what we know; we have to actually *derive* them, to 'write' them in some memory or data-base for effectively believing them

Analogously, a feeling "that p", a mood "about" something, implies the belief that p, although this might just be a 'candidate' belief, not so strong and certain to be *accepted* a belief:
(Feel-that X p) ➔ (Bel X p)[9]

Obviously the reverse relation is not true: (Bel X p) NOT implies (Feel X p).

5.2 The felt importance of goals

A very similar revolution is introduced by the felt bodily reaction or activation in the goal reasons-based processing. The *value* or *importance* of a goal, its motivating force, is normally derived from the means-end relations and reasoning: that is, from some consideration of plausible pros and cons.

- Given (in a given moment for a given person) the subjective value of the final aims or motives of the person, and of his active goals;

[8] Dictionary defines one meaning od "sense" as: *a feeling derived from multiple or subtle sense impressions.*

[9] The feeling that p implies the belief in two sense: either (Feel X p) Contains (Bel X p), like for example a "fear" mental state contains a prediction; or like the idea of "to kill" contains the idea of "to die"; or (Feel X p) potentially produces (Bel X p)

- given what she believes and takes into account about the possible effects and means-end relations of actions and sub-goals;
- the value of a given action A or sub-goal SG *is the sum of the values of all the foreseen positive consequences (realized aims) less the values of all the compromised and renounced aims (costs).*

This 'calculation' is based on *reasons* (beliefs about effects) and is arguable and questionable ("Did you consider this possible danger?"). Now, Arrow 3 as "affectus" again subverts this schema, introducing a completely heterogeneous and independent principle of goal value:

- *The more intense the felt sensation (the motion) the greater the subjective value of the goal, its priority.*

In the theory of 'felt needs' for example we explained in such a way why *needs are particularly "pushing" motives (*compared with 'desires' 'intentions' 'wishes' etc.) [13].

- First, they are conceived as necessary for the aim, not as useful but optional;
- Second, they are conceived (framed) in negative terms, in terms of losses rather than gains (if you don't have... you lose, you will not..) and we know that the avoidance of damages is more influencing than the perspective of gains (*prospect theory*);
- Third, they are related to some pain or disturbance, to a negative felt bodily sensation **s**, which must be stopped or avoided;
- Fourth, mental representation with sensory motors components have a stronger impact than very abstract, merely conceptual representations [14].

- *The stronger the pain (and the persuasion/belief that it depends on the lack of O and will stop taking O) the stronger the goal of having O.*

This goal is like an "impulse" since is sensation and affect driven. This is in fact general for the goals activated by an emotion, that we call "impulses":

- *The stronger the bodily-sensation (feeling) the stronger (important, cohercive, urgent) the impulse.*

Also in this case a non-rational mechanism replaces or alters the reason-based one. Feeling – through James' arrow – affects mind and replaces belief-value calculation (*credibility*) and goal-value calculation (*importance*).

6. Final Remarks

Those are some of the main functions of emotions. Without modeling the feeling component, that is the felt somatic response and activation, we cannot really understand and model emotions. This case is also instructive for understanding *what does it means to 'reincorporate' mind*. It does not means to eliminate cognitive 'mental representations' like *goals* (intentions, desires, projects, …) or *beliefs* (assumptions, evaluations, expectations, …); it means to understand the specific links between them and the body, in terms of both

- 'grounding' conceptual representations in sensory-motor intelligence (the "embodiment" approach in Cognitive Science), and
- relating cognitive processing (like believing, preferring) with the 'experience' of the body and of its reactions and felt internal states.

We have to "embody" mental representations and processes, but also to "mentalize" the body. If we want to build "real" emotions in artificial creatures (not just their imitation and depiction) we have to work on this kind of "architecture", by integrating body and mind, cognition and sensations.

We didn't answered in this paper to our initial questions: *Do we need "true" emotions – not just their simulated expression - in our artificial partners (agents or robots) for a meaningful social interaction? Do (cognitive) agents or robots need "true" emotions for their own preference and decision processes, social empathy or hostility, being sensible to moral norms and social duties?* However, this in fact was not our aim.

Our claim was that: if one *would* intend to model real emotional process she should (also) take into account, modeling, and reproduce the somatic processes of "feeling" something: "true" emotion are "felt".

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