Affect Simulation with Primary and Secondary Emotions

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Abstract. In this paper the WASABI[1] Affect Simulation Architecture is introduced, in which a virtual human's cognitive reasoning capabilities are combined with simulated embodiment to achieve the simulation of primary and secondary emotions. In modeling primary emotions we follow the idea of "Core Affect" in combination with a continuous progression of bodily feeling in three-dimensional emotion space (PAD space), that is only subsequently categorized into discrete emotions. In humans, primary emotions are understood as onto-genetically earlier emotions, which directly influence facial expressions. Secondary emotions, in contrast, afford the ability to reason about current events in the light of experiences and expectations. By technically representing aspects of their connotative meaning in PAD space, we not only assure their mood-congruent elicitation, but also combine them with facial expressions, that are concurrently driven by the primary emotions. An empirical study showed that human players in the Skip-Bo scenario judge our virtual human MAX significantly older when secondary emotions are simulated in addition to primary ones.

1 Introduction and Motivation

Researchers in the field of Embodied Conversational Agents (ECAs) [8, 29] build anthropomorphic systems, which are employed in different interaction scenarios, that afford communicative abilities of different style and complexity. As these agents comprise an increasing number of sensors as well as actuators together with an increase in expressive capabilities, they need to be able to recognize and produce social cues in face-to-face communication.

One factor in social interaction is the ability to deal with the affective dimension appropriately. Therefore researchers in the growing field of "Affective Computing" [27] discuss ways to derive human affective states from all kinds of intrusive and non-intrusive sensors. With regard to the expressive capabilities of embodied agents the integration of emotional factors influencing bodily expressions is argued for. These bodily expressions include, e.g., facial expression, body posture, and voice inflection and all of them must be modulated in concert to synthesize coherent emotional behavior.

[1] [W]ASABI [A]ffect [S]imulation for [A]gents with [B]elievable [I]nteractivity

With the WASABI architecture we present our attempt to exploit different findings and conceptions of emotion psychology, neurobiology, and developmental psychology in a fully-implemented computational architecture. It is based on the simulation of an emotion dynamics in three-dimensional emotion space, which has proven beneficial to increase the lifelikeness and believability of our virtual human MAX in two different interaction scenarios [3]. With this emotion dynamics simulation, however, we are limited to a class of rather simple emotions, that are similar to Damasio's conception of primary emotions. In the WASABI architecture we use our agent's cognitive reasoning abilities to model the mood-congruent elicitation of secondary emotions as well.

In the following section the psychological as well as neurobiological background is described with respect to the distinction of primary as well as secondary emotions. Subsequently we give an overview of related work in the field of Affective Computing. The WASABI architecture is presented in Section 3. We explain how nine primary emotions together with three secondary emotions—namely the prospect-based emotions *hope*, *fears-confirmed*, and *relief*—were integrated in such a way that their mood-congruent elicitation can be guaranteed. We conclude by discussing results of a first empirical study on the effect of secondary emotion simulation in the Skip-Bo card game scenario.

2 Background and Related Work

We will first introduce the psychological and neurobiological background before an overview of related work in affective human-computer interaction is given.

2.1 Psychological and Neurobiological Background

According to [33] the "psychological construct" labeled emotion can be broken up into the component of cognitive appraisal, the physiological component of activation and arousal, the component of motor expression, the motivational component, and the component of subjective feeling state. We follow the distinction of a cognitive appraisal component and a physiological component in the computational simulation of affect.[2] We also account for the motivational component, because our agent's reasoning capabilities are modeled according to the belief-desire-intention approach to modeling rational behavior [30]. We further believe, that we first need to realize the dynamic interaction between a cognitive and a physiological component before we can tackle the question of how to computationally realize a subjective feeling state.

Recently, psychologists started to investigate "unconscious processes in emotions" [35] and Ortony at al. discuss levels of processing in "effective functioning" by introducing a distinction between "emotions" and "feelings" [26]. They understand feelings as "readouts of the brain's registration of bodily conditions and

[2] The motor expression component has been realized as well, but not in the scope of this paper (see [3] for details).

changes” whereas “emotions are interpreted feelings” [26, p. 174] and propose three different levels of information processing [26], which are compatible with Scherer’s three modes of representation [35].

According to Ortony and colleagues, lower-levels have to contribute in order to experience “hot” emotions such that “cold, rational anger” could be solely the product of the cognitive component “without the concomitant feeling components from lower levels.” [26, p. 197] A purely primitive feeling of fear, on the contrary, also lacks the necessary cognitive elaboration to become a full-blown emotion. These psychological considerations are compatible with LeDoux’s distinction of a low and a high road of fear elicitation in the brain [20] and Damasio’s assumption of bodily responses causing an “emotional body state” [9, p. 138] that is subsequently analyzed in the thought process.

Two classes of emotions Damasio’s neurobiological research on emotions suggests the distinction of at least two classes of emotions, namely, primary and secondary emotions [9].

The term “primary emotions” [9] refers to emotions which are supposed to be inate. They developed during phylogeny to support fast and reactive response behavior in case of immediate danger, i.e. basic behavioral response tendencies like “flight-or-fight” behaviors. In humans, however, the perception of the changed bodily state is combined with the object that initiated it resulting in a “feeling of the emotion” with respect to that particular object [9, p. 132]. Primary emotions are also understood as a prototypical emotion types which can already be ascribed to one year old children [10].

They are comparable to the concept of “Core Affect” [32, 14], which is based on the assumption that emotions cannot be identified by distinct categories from the start. “Core Affect” is represented in two-dimensional emotion space of Pleasure/Valence and Arousal, which is sometimes extended by a third dimension [37, 31, 17] labeled “Control/Dominance/Power” of connotative meaning. Furthermore, Wundt claims that any emotion can be characterized as a continuous progression in such three-dimensional emotion space [37]. The degree of Dominance not only describes the experienced “control” over the emotion or the situational context, but can also belong to an agent’s personality traits. The three-dimensional abstract emotion space is often referred to as PAD space.

Secondary emotions like “relief” or “hope” are assumed to arise from higher cognitive processes, based on an ability to evaluate preferences over outcomes and expectations. Accordingly, secondary emotions are acquired during ontogenesis through learning processes in the social context.

Damasio uses the adjective “secondary” to refer to “adult” emotions, which utilize the machinery of primary emotions by influencing the acquisition of “dispositional representations”, which are necessary for the elicitation of secondary emotions. These “acquired dispositional representations”, however, are believed to be different from the “innate dispositional representations” underlying primary emotions. Furthermore, secondary emotions influence bodily expressions through the same mechanisms as primary emotions.

2.2 Related Work

El-Nasr et al. [13] present FLAME as a formalization of the dynamics of 14 emotions based on fuzzy logic rules, that includes a mood value, which is continuously calculated as the average of all emotion intensities to provide a solution to the problem of conflicting emotions being activated at the same time. The idea of expectations is realized in FLAME by means of learning algorithms based on rewards and punishments. Although it was not integrated into the simulation of a virtual human, the mutual influence of emotion and mood is quite similar to the conception of emotion dynamics in the WASABI architecture.

Marsella and Gratch [23] focus with their "EMA" model of emotions on the dynamics of emotional appraisal. They also argue for a mood value as an addend in the calculation of otherwise equally activated emotional states following the idea of mood-congruent emotions. Their framework for modeling emotions is the first fully implemented, domain-independent architecture for emotional conversational agents.

Marinier and Laird [21] aim to combine the work of Gratch and Marsella [23] with the findings of Damasio [9]. In later publications [22], however, Damasio's work is less central and they follow the ideas of Scherer [34]. Their central idea of "appraisal frames" is based on the EMA model [23] and eleven of Scherer's sixteen appraisal dimensions are modeled for integration in the Soar cognitive architecture. They distinguish an "Active Appraisal Frame", which is the result of a momentary appraisal of a given event, from a "Perceived Appraisal Frame", which results from the combination of the actual mood and emotion frames. Thereby, they claim to account for Damasio's distinction between emotion and feeling—similarly to the conception underlying the WASABI architecture.

Although André et al. [1] start with the distinction of primary and secondary emotions, it is not taken up in their later publications, e.g. [16]. Gebhard [15], recently, uses the PAD space to derive a mood value from emotions resulting from OCC-based appraisal. Three-dimensional emotion spaces similar to PAD space are also used to drive the sociable robot "Kismet" [7] or the humanoid robot WE-4RII [19].

3 The WASABI Architecture

The WASABI architecture conceptualized here builds upon previous work on the simulation of emotion dynamics for the virtual human MAX [2] that has proven to support the agent's believability in two different interaction scenarios [3, 6]. It was, however, limited to the simulation of primary emotions.

Accordingly, the WASABI architecture [5] combines bodily emotion dynamics with cognitive appraisal in order to simulate infant-like primary emotions as well as cognitively elaborated, more adult secondary emotions. In the following a suitable specification of the different concepts *emotion* and *mood* is derived from the theoretical background presented above.

Emotions are understood as current states with a specific quality and intensity, which are the outcome of complex neurophysiological processes for communication. The processes include neural activity of the brain as well as physiological responses of the body. One gets aware of one's emotions in two cases: (1) if their awareness likelihood w exceeds a certain threshold (cf. Section 3.3) or (2) if one concentrates on the underlying processes by means of introspection.

Emotions can be classified into primary and secondary ones, but every emotion has either positive or negative valence of a certain value and compared to mood an emotion lasts significantly less long. The differences between primary and secondary emotions are conceptualized as follows:

- Secondary emotions are based on more complex data structures than primary ones. Accordingly, only some general aspects of secondary emotions (such as their valence components) are represented in PAD space.
- The appraisal of secondary emotions depends much more on the situational and social context than that of primary emotions. Thus, secondary emotions are more dependent on the agent's cognitive reasoning abilities.
- The releasers of secondary emotions might be learned based on the history of primary emotions in connection with memories of events, agents and objects.
- The agent's facial expressions of primary emotions (cf. Figure 1) may accompany secondary emotions.
- Secondary emotions also modulate the agent's simulated embodiment.

Mood is understood as a background state with a much simpler affective quality than emotions. It is assumed that bodily responses influence the development of mood over time and that a mood is a diffuse valenced state, i.e. the experiencing individual is likely to be unable to give a clear reason for his or her current mood. Emotions have a fortifying or alleviating effect on an individual's mood, which, in turn, influences the elicitation of emotions [24]. A mood's duration is in general longer than that of emotions.

3.1 Nine Primary Emotions

Primary emotions (PE) are inborn affective states, which are triggered by reflexes in case of potentially harmful stimuli. They result in fast, reactive behavioral responses and, thus, are quite similar to the concept of proto-affect proposed by [26]. According to developmental psychology, young children express their (primary) emotions directly, because they did not yet internalize this process as in the case of adults [18].

In our previous realization of emotion dynamics [2] this direct expression of primary emotions is achieved by implementing five of Ekman's six "basic emotions". In addition, the emotions "bored", "annoyed", and "depressed" as well as the non-emotional state "concentrated" are simulated. Each of the primary emotions is located in PAD space according to Table 1, for which the coordinates are derived from some of the values given in [31, p. 286ff]. The seven facial

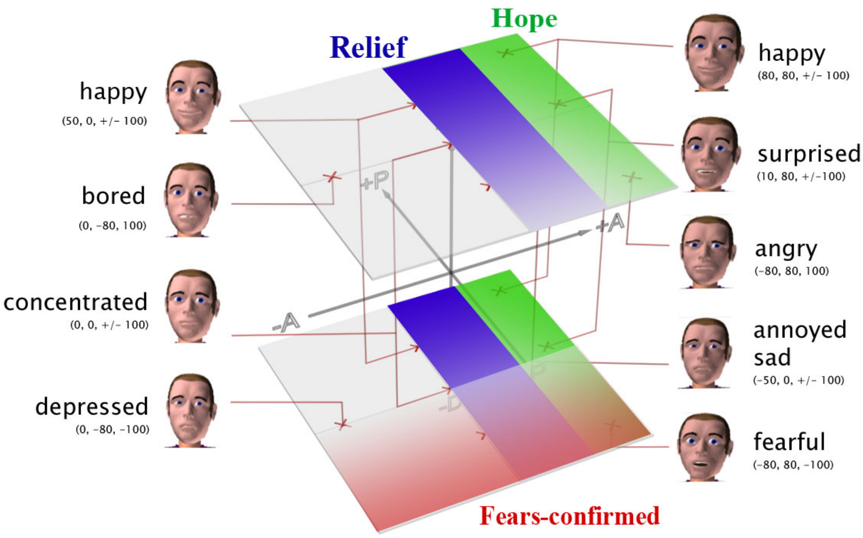


Fig. 1. The nine primary emotions of Table 1 as points together with the three secondary emotions of Table 2 as weighted areas in PAD space

expressions of MAX corresponding to the eight primary emotions and the neutral state "concentrated" (cf. Table 1) are shown in Figure 1. In case of high pleasure Ekman's set of "basic emotions" [12] only contains one obviously positive emotion, namely happiness. Thus, in the presented implementation [5] this primary emotion covers the whole area of positive pleasure regardless of arousal or dominance as it is located in PAD space four times altogether.

3.2 Three Secondary Emotions

According to Damasio, the elicitation of secondary emotions involves a "thought process", in which the actual stimulus is evaluated against previously acquired experiences and online generated expectations.

The "prospect-based emotions" cluster of the OCC-model of emotions [25] is considered here to belong to the class of secondary emotions, because their appraisal process includes the evaluation of events against experiences and expectations. This OCC-cluster consists of six emotions, of which *hope*, *fears-confirmed*, and *relief* are simulated in the WASABI architecture.

Hope Ortony et al. describe *hope* as resulting from the appraisal of a prospective event [25]. If the potential event is considered desirable for oneself, one is likely to be "pleased about the prospect of a desirable event" [25, p. 110]. The calculation of this emotion's awareness likelihood, however, is rather independent from these cognitive processes.

PE final		Facial expr. (Ekman)	PAD values	base intensity i_{pe}
1.	angry	anger (*anger*)	(80, 80, 100)	0.75
2.	annoyed	sad (*sadness*)	(-50, 0, 100)	0.75
3.	bored	bored (*none*)	(0, -80, 100)	0.75
4.	concentrated	neutral (*none*)	(0, 0, ±100)	0.75
5.	depressed	sad (*sadness*)	(0, -80, -100)	0.75
6.	fearful	fear (*fear*)	(-80, 80, 100)	0.25
7.	happy	happy (*happiness*)	(80, 80, ±100) (50, 0, ±100)	0.75
8.	sad	sad (*sadness*)	(-50, 0, -100)	0.75
9.	surprised	surprised (*surprise*)	(10, 80, ±100)	0.0

Table 1. Primary emotions in PAD space: The five "basic emotions" of [11] are assigned to the corresponding facial expressions modeled in [2] whenever such a mapping is possible (cp. Figure 1) and additionally an individual base intensity i_{pe} is set for each primary emotion (see also Section 3.3)

The previous analysis provides the rationale for modeling *hope* in the following way:

- Pleasure: The awareness likelihood of *hope* increases the more pleasurable the agent feels.
- Arousal: With respect to an agent's arousal, *hope* is more likely elicited the higher the agent's arousal value.
- Dominance: The awareness likelihood of *hope* is modeled to be independent of the agent's general level of dominance.

To realize this distribution of awareness likelihood in case of hope, two areas are introduced in Figure 1, one in the high dominance plane and the other in the low dominance plane. In Table 2 the exact values of the four corners of each of the two areas together with the respective base intensity in each corner is given for *hope*.

Fears-confirmed According to Ortony et al., *fears-confirmed* is elicited when being "displeased about the confirmation of the prospect of an undesirable event." [25, p. 110] With respect to its representation in PAD space the similarity to the primary emotion *fearful* is taken into account and the following decisions are taken:

- Pleasure: The awareness likelihood of *fears-confirmed* increases the less pleasurable the agent feels.
- Arousal: *fears-confirmed* is considered to be independent from the agent's arousal value.
- Dominance: *fears-confirmed* can only be perceived by the agent, when he feels submissive as in the case of *fearful*.

This distribution of awareness likelihood is realized in PAD space (cf. Figure 1) by introducing an area in the low dominance plane (cf. Table 2 for the exact coordinates and intensities).

Area	(PAD values), intensity
HOPE	
high dominance	(100, 0, 100), 0.6; (100, 100, 100), 1.0; (-100, 100, 100), 0.5; (-100, 0, 100), 0.1
low dominance	(100, 0, -100), 0.6; (100, 100, -100), 1.0; (-100, 100, -100), 0.5; (-100, 0, -100), 0.1
FEARS-CONFIRMED	
low dominance	(-100, 100, -100), 1.0; (0, 100, -100), 0.0; (0, -100, -100), 0.0; (-100, -100, -100), 1.0
RELIEF	
high dominance	(100, 0, 100), 1.0; (100, 50, 100), 1.0; (-100, 50, 100), 0.2; (-100, 0, 100), 0.2
low dominance	(100, 0, -100), 1.0; (100, 50, -100), 1.0; (-100, 50, -100), 0.2; (-100, 0, -100), 0.2

Table 2. The parameters of the secondary emotions *hope*, *fears-confirmed*, and *relief* for representation in PAD space

Relief The secondary emotion *relief* is described as being experienced whenever one is "pleased about the disconfirmation of the prospect of an undesirable event." [25, p. 110] Taking the similarity with Gehm and Scherer's "content" cluster into account [17], *relief* is represented in PAD space according to the following considerations:

– Pleasure: *relief* is more likely to become aware the more pleasurable the agent feels.
– Arousal: Only in case of relatively low arousal levels the agent is assumed to get aware of the emotion *relief*.
– Dominance: The awareness likelihood of *relief* is considered to be independent from the agent's state of dominance.

The awareness likelihood is represented in Figure 1 by two areas, one located in the high dominance plane and the other in the low dominance plane (cf. Table 2).

3.3 Emotion Dynamics and Awareness Likelihood

The implementation of emotion dynamics is based on the assumption that an organisms natural, homeostatic state is characterized by emotional balance, which accompanies an agent's normal level of cognitive processing [36]. Whenever an emotionally relevant internal or external stimulus is detected, however, its valence component serves as an emotional impulse, which disturbs the homeostasis causing certain levels of pleasure and arousal in the emotion module. Furthermore, a dynamic process is started by which these values are continuously driven back to the state of balance (see [3] for details).

The two valences are mathematically mapped into PAD space (cf. Figure 1) and combined with the actual level of Dominance, which is derived from the situational context in the cognition of the architecture. This process results in a course of a reference point in PAD space representing the continuously changing, bodily feeling state from which the awareness likelihood of primary and secondary emotions is derived with an update rate of 25Hz (see also [4, 6]).

Awareness likelihood of primary emotions The awareness likelihood of any of the nine primary emotions *pe* (cf. Table 1) increases the smaller the distance between the actual PAD values and the primary emotion's PAD values (i.e. d_{pe} in Equation 1). When d_{pe} falls below Φ_{pe} units for a particular primary emotion *pe*, the calculation of its awareness likelihood w_{pe} is started according to Equation 1 until d_{pe} falls below Δ_{pe} units in which case the likelihood is w_{pe} equals the primary emotion's base intensity i_{pe}.

$$w_{pe} = (1 - \frac{d_{pe} - \Delta_{pe}}{\Phi_{pe} - \Delta_{pe}}) \cdot i_{pe}, \qquad with \qquad \Phi_{pe} > \Delta_{pe} \;\; \forall pe \in \{pe_1, \ldots, pe_9\} \qquad (1)$$

In Equation 1, Φ_{pe} can be interpreted as the activation threshold and Δ_{pe} as the saturation threshold, which can be adjusted for every primary emotion $pe_n \in \{pe_1, \ldots, pe_9\}$ independently[3]. By setting a primary emotion's base intensity i_{pe} to 0.0 (as in the case of *surprised*, cf. Table 1) it needs to be *triggered* by the cognition before it might gain a non-zero awareness likelihood w_{pe}.

In case of primary emotions that are represented in PAD space more than once (i.e. concentrated, happy, and surprised; cf. Table 1) the representation with the minimum distance to the reference point is considered in Equation 1 for calculation of its awareness likelihood.

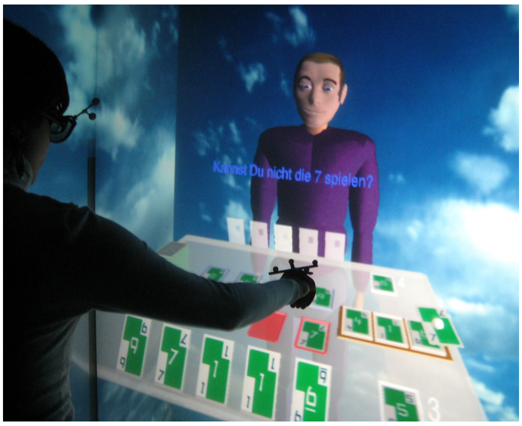
Awareness likelihood of secondary emotions With representing the three secondary emotions in PAD space their mood-congruent elicitation can be assured, because the actual PAD values are also relevant for calculating every secondary emotion's awareness likelihood. In contrast to most primary emotions, all secondary emotion's *base intensities* are set to zero by default (cp. the case of *surprised* above).

Accordingly, every secondary emotion has first to be triggered by a cognitive process, before it gains the potential to get aware to the agent. Furthermore, a secondary emotion's *lifetime* parameter (set to 10.0 by default) together with its *decay function* (set to linear by default) are used to decrease its intensity over time until its *base intensity* of zero is reached again.

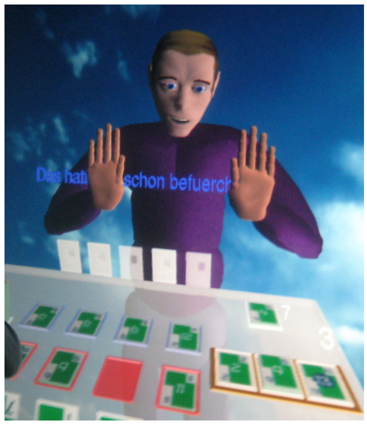
In the Skip-Bo card game scenario [6], for example, Max might believe that the opponent may play a card hindering him to fulfill one of his goals and the expectation of an undesirable event is generated. Later, upon perceiving and interpreting the opponent's actions, Max might realize that the opponent fulfilled the expectation by playing that undesired card. In result the secondary emotion *fears-confirmed* is triggered and, at the same time, a negative emotional impulse is sent to the emotion dynamics. If the corresponding PAD values fall into the *fears-confirmed* region (cf. Figure 1), Max will get aware that his *fears*

[3] The nine primary emotions are indexed according to Table 1.

are *confirmed* with a likelihood that results from linear interpolation between the current intensities in the four corners of the *fears-confirmed* area at the location given by the actual PAD values. Currently, each non-zero likelihood of a secondary emotion lets MAX produce an appropriate verbal expression (cf. Figure 2(a) and Figure 2(b)).



(a) MAX expresses his *hope* that the human player will play the card with the number seven next by saying “Kannst Du nicht die 7 spielen?” (Can’t you play the seven?)



(b) MAX realizes that his *fears* just got *confirmed* and utters “Das hatte ich schon befrchtet!” (I was already afraid of that!)

Fig. 2. MAX expressing his *hope* and realizing that his *fears* got *confirmed*

3.4 Connecting Cognition and Embodiment

In Figure 3 the conceptual distinction of an agent’s simulated embodiment and its cognition is presented and the different modules and components of the WASABI architecture are assigned to the corresponding layers.

To the left of Figure 3 the virtual human MAX perceives some (internal or external) stimulus. *Non-conscious appraisal* is realized by directly sending a small positive *emotional impulse* to the *Emotion dynamics* component of the WASABI architecture. This establishes the “low road” [20] of primary emotion elicitation. For example, the presence of visitors in the museum [2] is interpreted as *intrinsically pleasant* following the ideas of Scherer [34].

Another path resulting in *emotional impulses* begins with *conscious appraisal* of the perceived stimulus (cf. Figure 3, top left). This process resides in the *Cognition*, because it is based on the evaluation of goal-conduciveness of an event [34] and can be considered the “high road” of emotion elicitation [20]. Therefore, MAX exploits his BDI-based cognitive reasoning abilities to update his *memory* and generate *expectations*. These deliberative processes not only

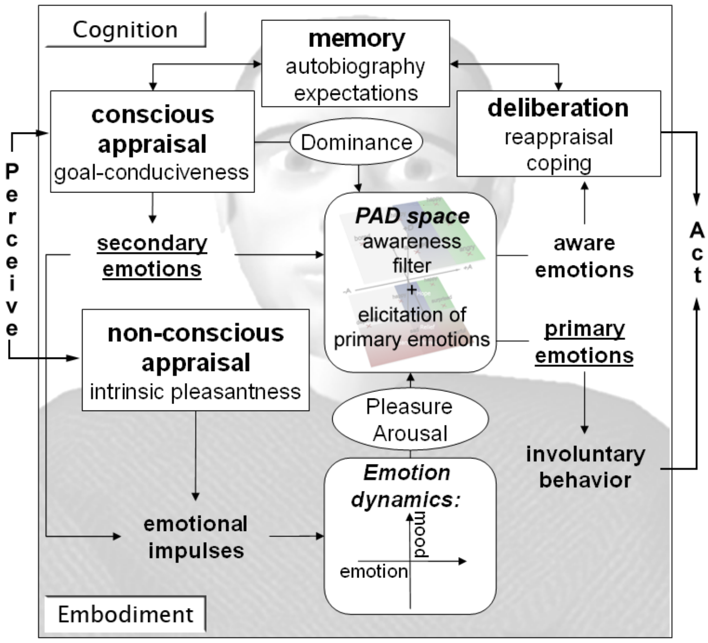


Fig. 3. The conceptual distinction of cognition and embodiment in the WASABI architecture

enable MAX to derive his subjective level of *Dominance* from the situational and social context, but also propose cognitively plausible *secondary emotions*.

These *secondary emotions* are, however, first *filtered* in *PAD space*, before MAX might get *aware* of them (cf. Figure 3, middle). Independent of this "awareness filter", every cognitively plausible *secondary emotion* influences the *Emotion dynamics* component of the WASABI architecture, thereby modulating MAX's *Pleasure* and *Arousal* values, i.e. his simulated *Embodiment*. This influence is achieved by interpreting the valence component of any *secondary emotion* as an *emotional impulse* (cf. Figure 3, left). This way, *secondary emotions* "utilize the machinery of primary emotions" [9], because they might result in the elicitation of mood-congruent *primary emotions*, which—in the WASABI architecture—drive MAX's facial expressions *involuntarily*. Furthermore, as the *Pleasure* and *Arousal* values are incessantly modulating MAX's *involuntary behaviors* (i.e. breathing and eye blinking) as well, even "unaware" *secondary emotions* have an effect on MAX's bodily state and involuntary behavior.

In combination with the actual level of *Dominance*, *primary emotions* are elicited by means of a distance metric in *PAD space*. As mentioned before, these primary emotions are directly driving MAX's facial expressions. Although this automatism might be considered unnatural for an adult, it has proven applicable and believable in the situational contexts in which MAX was integrated so far.

After the awareness filter has been applied, the resulting set of *aware emotions* consists of primary and secondary emotions together with their respective awareness likelihoods. They are finally subject to further deliberation and reappraisal resulting in different coping behaviors. In the card game scenario the direct vocal and facial expression of negative emotions is sufficient to let the human players play in accordance with the rules.

4 Discussion and Conclusion

We presented the WASABI architecture for mood-congruent simulation of primary and secondary emotions as it is integrated in, and makes use of, the overall cognitive architecture of our Virtual Human MAX. The simulation and direct expression of primary emotions is based on the idea to capture an agent's bodily feeling state as a continuous progression in three-dimensional emotion space (i.e. PAD space), which is only subsequently translated into weighted, primary emotions. Secondary emotions, in contrast, are understood as onto-genetically later types of emotions, which require higher cognitive reasoning abilities and a certain sense of time, in that an agent has to be able to take experiences and expectations into account to generate prospect-based emotions. To also assure mood-congruency of secondary emotions, we roughly capture aspects of their connotative meanings in PAD space as well by introducing weighted areas. Furthermore, to account for the decisive influence of cognitive processes in the elicitation of secondary emotions, they can only gain a certain awareness likelihood in PAD space of the embodiment, after having been triggered by cognitive processes.

Although our approach has not yet been subject to an extended evaluation, some empirical evidence on the effect of secondary emotion simulation could already be gathered. A total of 23 participants played Skip-Bo either against MAX only simulating and expressing primary emotions (similar to the negative empathic condition in [28], n=11) or against MAX additionally simulating and verbally expressing secondary emotions (cf. Figure 2, n=12). As a result, MAX with primary and secondary emotions "in concert" was judged significantly older (mean value 27,5 years, standard deviation 7.5) than MAX with simulated primary emotions alone (mean value 19,8 years, standard deviation 7.7)[4].

In summary, we believe that the WASABI architecture is a helpful model to understand how the dynamic interplay of a human's body and mind together with his past experiences and future expectations sometimes turns "cold" cognitions into "hot" affective states.

[4] A two-tailed t-test assuming unequal variances results in $p = 0.025$. No significant effect of the participants' gender could be found.

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