On posture as a modality for expressing and recognizing emotions

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Abstract. The aim of this paper is to promote posture as an important tool for controlling and monitoring the interaction between user and technology. This form of bodily expression of affects presents two facets of interest to our community: (a) It is a powerful modality of communication. As evidence, we summarize some of our previous studies showing how systems can be trained to accurately recognize emotions, even across different cultural backgrounds; (b) Body postures have been shown to have a powerful regulatory role on emotions. This opens the door to the development of systems that, by involving the body of its users, can induce specific affective states and therefore improve user engagement. To support our discussion, we briefly review a very preliminary study showing how incorporating full-body movements in the control of a game results in users reporting a higher sense of engagement. We hypothesize that involving more degrees of freedom in the control of the game facilitated the expression of associated affective states (e.g., excitement) which in turn resulted in the participant experiencing those states more fully.

1 Introduction

The biological processes underlying the generation of emotions involve various sub-systems of the human organism – in particular, the autonomic, endocrine and nervous systems whose activity results in measurable quantities (e.g., galvanic skin response). It therefore comes as no surprise that many studies in the field of affective computing have used biophysical sensors to measure affective states [1, 2]. Given the strong connections between central nervous system and motor apparatus, physical responses should also be expected. Following the work of Ekman and Friesen [3], many studies have focused on the recognition (and synthesis) of affective states from facial expressions. However, because the face is involved in various functions and many of the famously recognized facial expressions only represent a very small subset of the possible expressions, the validity of facial expressions as a modality for recognizing affective states should be questioned (see [4] for example). In this paper, we would like to suggest that posture should be considered a necessary complement to facial expressions. Despite recent studies in cognitive neuroscience suggesting that at least some of the brain correlates of facial perception are involved in the appraisal of body configurations (e.g., [5]), there has been surprisingly little in the HCI literature in terms of grounding the recognition of affective states into body postures (see [6–9] for some exceptions). Furthermore, the finding that body postures are often selected over facial expressions when both modalities are available and incongruent [10] contrasts sharply with the fact that almost all studies on the recognition of affective states from non-verbal communication use each modality in isolation, and that the few studies that do combine both have a disproportionate importance of the head over the body (e.g., [11]).

2 Body posture as a communicative modality

With the 7-38-55 rule, Mehrabian and Friar [12] stressed how important the non-verbal component (38% for voice tone and 55% for facial expression) of communication was in communicating affect when compared to the purely verbal component (7%). Interestingly, they did not consider the role of posture in the communication. This reflects the fact that face was initially thought to be the most important communication channel for identifying affective states as precise categories whereas posture was thought to convey information only at the level of affective dimensions. In recent years, this idea has been questioned by psychology studies showing posture to be a very good indicator for certain categories of emotions (e.g., anger, boredom, interest, excitement, affection), see [8, 13, 14] and [15](cited in [16]) for examples. Whilst these studies have been used rather effectively to enable artificial systems to express affective behavior through posture (e.g., Sony's AIBO [17]), posture still has no equivalent to the Facial Action Coding System (FACS) [3], most existing studies (see [6, 18] for example) using coarse-grained posture descriptors (e.g. leaning forward, slumping back).

Our previous work (see [7, 19, 20] for example) has set to establish the groundwork for a FACS-like formal model. We proposed a general description of posture based on angles and distances between body joints and used it to create an affective posture recognition system that maps the set of postural descriptors into affective categories using an associative neural network. While the postures used in the study involved only 4 emotion categories (happiness, sadness, anger and fear), the system can learn new categories interactively through an unsupervised learning mechanism.

Using 102 postures extracted from natural human motion capture data, the system showed a 71% classification success rate [7]. The classification rate was obtained by comparing the systems classification and the classification of 42 independent observers. Fearful postures showed the lowest inter-observer agreement, being often confused with angry or happy. However, adding a measure of the direction of the movement to the postural descriptor allowed for a significant improvement (up 8% to 79%) in its recognition rate [21]. Interestingly, Coulson [8] made a similar observation in a parallel study in which he looked at how 6 joint rotations (head bend, chest bend, abdomen twist, shoulder forward/backward, shoulder swing, and elbow bend) could help recognizing 6 emotions (angry, fear, happy, sad, surprised and disgust). He suggested that the low recognition of some emotions such as fear showed the need for features describing motion, i.e., direction, velocity, and amplitude.

In [22], we tested the informational content of the posture descriptors by applying mixed discriminant analysis (MDA) and looking at whether the features could account for different levels (high, low) of three affective dimensions: arousal, valence and action tendency (a dimension proposed by Fridja [23]). The results showed a 1% error on arousal, 20% on valence and 25% on action tendency. Using the same basic representation, our other studies showed how affective appraisal of body postures revealed significant effects on both culture [24] and gender [25]. This set of low-level feature descriptors does also bring a mechanistic explanation to recent findings in neuroscience suggesting that the face fusiform area (FFA) – the brain area responsible for facial processing – was involved in processing postural expressions of affect even when facial cues were removed [5]. Indeed, our statistical analysis showed that features related to head configuration (e.g., inclination and rotation of the head) are very important in discriminating between emotions [19] and in particular in discriminating between nuances of a particular emotion (e.g., upset versus angry, or fear versus surprise) [20].

This body of work thus suggests that posture could be used, if not as an alternative to facial expressions, at least in conjunction with facial expressions to provide for finer grain appraisals and increased discriminatory power in the case of ambiguous or incongruent information. But this is not the only contribution of posture to our study of emotion in human-machine interaction.

3 Body posture as a regulator of emotions

Another line of work suggests another important role of body posture. And that is that changes in posture can induce changes in affective states or have a feedback role affecting motivation and emotion. A study by Riskind and Gotay [26], for example, revealed how "subjects who had been temporarily placed in a slumped, depressed physical posture later appeared to develop helplessness more readily, as assessed by their lack of persistence in a standard learned helplessness task, than did subjects who had been placed in an expansive, upright posture." Furthermore, it was shown that posture had also an effect on verbally reported self-perceptions. This is not surprising, as others have reported similar regulatory properties with other forms of non-verbal expressions of affects. Richards and Gross [27], for example, showed that simply keeping a stiff upper lip during an emotional event had effect on the memory of the event, and generally, exacted a cognitive toll as great as intentional cognitive avoidance.

As a result, the field of pain management, for example, is becoming increasingly interested in the relation between pain and emotion [28], as various studies suggest that problems in regulating and expressing emotions are linked to increased pain and distress. Although pain, as such, is not an emotion, it is associated with a set of negative emotions (in particular, frustration) that will express at the postural level. Here, the affective states involved relate to the autonomic component of the emotion, of course, but they also have a communicative intent as well. Indeed, it has been observed that pain behavior often increases in amplitude in the presence of solicitous others and/or health professionals.

With respect to human-machine interaction, this opens the door to the development of systems that, by involving the body of its users, can induce specific affective states and therefore improve user engagement.

4 Posture, interactive devices, and immersion in HCI

The two previous sections have depicted the two facets of postures. These two facets make posture a very important modality for human-machine interaction. We may be able to use postures to explore novel issues, in particular, engagement or immersion.

To illustrate this idea, we briefly describe two experiments we performed to investigate (a) the relationship between postural behavior and immersion and (b) the importance of full-body control of the task in improving user experience.

4.1 Experiment 1: Posture and immersion

This experiment involves two different types of desktop computer games. The first game was a very low-immersive game in which the user simply had to click on a randomly appearing target. The second game was a first person shooter game, Half-Life, whose format makes it a likely precursor of immersion [29]. The primary modality of input was the keyboard with some additional commands involving the mouse. Twenty participants were randomly assigned to one or the other game, and were interrupted after 10 minutes of play to fill an immersion questionaire [30]. The sessions were videotaped to provide a view of the subject in the saggital plane where most of the motion was expected to take place.

Major changes in body postures were used to discriminate between levels of immersion and/or affective states. The “clicking” group, who returned very low immersion scores (47.6±16.64 in a scale of 160) was characterized by many shifts in the sitting position, alternating between a very relaxed position (e.g., arm stretched behind the head and body leaned back) or a very attentive one, with a forward leaning body and still head. The “shooting” group, which returned significantly higher immersion scores (68.11±11.95), revealed a different pattern of changes in body posture. Participants showed very few changes in posture, with those that showed more game-unrelated changes scoring lower in the immersion questionnaire. Interestingly, some players also displayed head motion that were related to the game, e.g., moving the head as if following the main character in its digital environment.

These results are preliminary and require further analysis, however, they suggest that higher immersion is accompanied by a reduction of un-necessary postural activity, perhaps because of increased attentional load.

4.2 Experiment 2: Influence of device on engagement

In this experiment, fourteen participants were asked to play a music game, Guitar Hero for PlayStation, using two different shapes of controlling devices. While playing a song, the system instructs the player to press a specific sequence of color-coded buttons. The timeliness of each input contributes to the score of the player. In the “pad” condition of the experiment, the player was given a standard PlayStation DualShock controller, which only involved button pressing. In the “guitar” condition, however, the player was given a guitar-shaped controller that involved not only five fret buttons but also a strut bar and a whammy bar. An extra command required tilting the guitar controller upward, thus involving full-body movement.

Each player was asked to fill an engagement questionnaire, a revised version of the Gaming Engagement Questionnaire (GEQ) of Chen et al. [31], after playing 20 minutes in each condition. The order in which each participant played each condition was counterbalanced over the sample of participants. When using the guitar-shaped device, players returned higher engagement scores on the questionnaire ($t=-3.659$, $p<.001$), while displaying a number of body postures and movements that would, at least qualitatively, correlate with higher engagement. Other movements appeared task-related such as keeping the beat using head and body.

Although immersion and engagement cannot be compared, experiments 1 and 2 showed interesting differences in terms of posture. Participants in experiment 2 were more readily using body language to express their affective state. Typical postures included dropping the arms to show disappointment, or leaning back and bringing the arms up when surprised. These differences are interesting because they put in question our argument earlier that the decrease in task-unrelated movements was due to a higher attentional load during immersion. This second experiment therefore suggests that the standing position itself, as well as the increased degrees of freedom offered by the device, enabled the participants to experience their affective states more fully, which resulted in higher engagement scores.

5 Conclusion

We would like to suggest that involving the body in the control of technology facilitates users’ expression of their feelings, which in turn makes them have an improved experience, i.e., being engaged. While a full-body interface involves technological difficulties due to the increased number of degrees of freedom, recent progress in sensing devices, signal processing and pattern recognition, make it possible to deal with these issues in real-time, and as our current studies suggest, incorporating posture as a communication channel might augment the sense of presence and increase user engagement

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