# Recognizing bodily expression of affect in user tests

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**Abstract.** We describe our planned research in using affective feedback from body movement and posture to recognize affective states of users. Bodily expression of affect has received far less attention in research than facial expression. The aim of our research is to further investigate how affective states are communicated through bodily expression and to develop an evaluation method for assessing affective states of video gamers based on this knowledge. Current motion capture systems are often intrusive to the user and restricted to lab environments, which results in biasing user experience. We propose a non-intrusive recognition system for bodily expression of affect in a video game context, which can be deployed in the wild.

**Keywords:** affect, expression, recognition, user test, body, posture, movement

## 1 Introduction

With interactive devices becoming ever more ubiquitous, the field of human-computer interaction has seen a turn from investigating business environments and how to make task-related interaction more effective and efficient towards finding out how interaction can happen in a more joyous and satisfying way in all facets of everyday life. In use scenarios where task completion is not central anymore, but replaced by maybe more difficult to define criteria such as providing users with a good experience, we find ourselves in need of tools to assess these experiences.

A tricky part in evaluations is to capture how users feel during the interaction with an interactive application. Often they have difficulties expressing their feelings towards a new tool or application. Self-report methods, e.g. questionnaires, focus groups, “think aloud” walkthroughs; also rely on participants having good linguistic skills. This and the ability to provide objective feedback are desirable features when selecting participants in user-centered evaluation experiments, even more so when looking at usability issues known to have a strong subjective component. Emotions and the ability to keep track of them explicitly play a critical role in this context even if traditionally there have not been any specific instruments for gathering this type of feedback so that it could be used as a filter when interpreting feedback data.

In recent years, the field of affective computing has come up with a number of approaches that provide more objective data. Typically, these approaches detect one or several modes of affective feedback. Intentionally or not, we continuously express affect. This can happen verbally, through the tone of our voice and our choice of words, as well as non-verbally, through our facial expressions, posture, gestures, amongst others [1]. Also physiological data like heart rate or skin conductance have been used to infer the affective state of the user. As social beings, it comes natural to us to also read the affective states of the people around us. Automatically recognizing a person's affective state is still one of the big challenges in affective computing.

Of the non-verbal channels, facial expressions have received the most attention in research. We now have a good knowledge of how individual facial muscles work together to form an expression and how others perceive expressions. Less is known on how affect is communicated through postures and bodily movements.

## 2 Background

The research described here mainly touches on two research areas. One is user experience research, in particular methods for assessing the user experience. The other is non-verbal expression of affect, a sub-field of affective computing.

### 2.1 Assessing user experience

There is no consensus on the definition of user experience. Instead, it appears more useful to see it as an umbrella term for a variety of different needs [2] and a number of different sets of needs have been proposed [3, 4, 5, 6, 7].

McCarthy and Wright [3] argue that user experience should consider the emotional, intellectual, and sensual aspects of our interactions with technology. Technology is more than just a means to an end in that we do not just use technology; we live with it. They also see an interdependence between a technology and the experience that it co-shapes. An experience has no final state, there are continuously sense-making processes happening like anticipating, connecting, interpreting, reflecting, appropriating, and recounting.

Jordan [4] distinguishes a different set of needs, which he labels pleasures: Physical pleasure refers to the body and senses; social pleasure represents relationships with family, friends, co-workers, etc. Psychological pleasure refers to emotional and cognitive processes in the mind, e.g. doing something engaging. Ideological pleasure represents tastes and values. Jordan states that some of the pleasures are universal, while some are specific to culture and context.

As definitions of user experience and its constituents vary significantly, it is useful to look at how empirical studies of user experience interpret and operationalize it. In a recent review of such empirical studies, Bargas-Avila and Hornbæk [8] find that the most frequently investigated dimensions within user experience are emotions, enjoyment and aesthetics.

Methods for assessing the user experience can be first and foremost distinguished by whether they are based on subjective self-report of users or obtained from objective measurements of users engaging with an interactive application.

The subjective user experience can be obtained through verbal and non-verbal methods. In practice, most evaluations rely on verbal methods, such as post-experimental interviews and questionnaires. A more recent development are non-verbal methods. One example is the use of a slider [9] used as a physical manifestation of a Likert scale ranging from very positive to very negative. Users are instructed to continuously use it to express their emotional state during interaction. Another approach aims at improving affective feedback from children. As part of an evaluation children are asked to prepare drawings in which they express their experience [10]. Afterwards experts review the drawings.

Objective measurements include data from observations of the users' behavior, physiological data, facial and bodily expressions, and voice. Behavior can be assessed by e.g. measuring the performance of the user in terms of speed required for task-solving, measuring how often and with how much force the user clicks the mouse or punches keys, or by measuring the eye gaze of the user. In particular eye gaze is a popular measure for getting an idea which of the items on screen catch the attention of the user. Physiological data from measuring heart rate, skin conductance, and others allows inferences on arousal states of users and whether their valence is positive or negative. Often several measures are combined and data fusion algorithms are applied to get a more stable assessment of users' affective states. Yet to date, such objective measurements are not used widely in practice.

### 2.2 Bodily expression of affect

When we look into research on non-verbal expression of affect, the vast majority of studies focus on facial expressions. We now have a fair understanding of how individual facial muscles contribute to an expression [11] and how expressions are perceived in terms of affect [12]. De Gelder [13] estimates that over 95 per cent of studies have used faces as stimuli for the assessment of emotional states. The remaining 5 per cent are split between human voice, other auditory signals, and the smallest number has looked into the body as a source for human communication of affect.

De Gelder then asks why researchers have not shown more interest in the body. It is by no means a new area of research and dates at least back to James' study of expression of body posture from 1932 [14]. One difficulty that arises from using the body as stimulus to study the expression of emotions is the fact that the human body is complex. The complexity stems from a big number of joints and all possible rotations around these joints that result in a large number of degrees of freedom. It can be argued that the complexity of the body is the reason why there exist no formal models for body postures as there are for facial expressions (e.g., the facial action coding system [15]).

Yet, studies into bodily expression of affect have shown that changes in affective states can be observed in changes in posture [16]. It has also been put forward that facial expressions can be deliberately manipulated for deceptive purposes. Bodily expressions are thought of providing a more honest image of a person's affective state, as we are not as aware of our bodily display as of our facial expressions. Also, the relationship between affective state and posture appears to be bidirectional. Riskind and Gotay [17] present evidence that the sheer posture of a person has influence on the mental state. In their study, subjects put in a hunched and threatened posture report greater stress than subjects put in a relaxed posture.

In our own research, we investigated the movements of video-gamers playing Nintendo Wii Sports games [18]. We found movement patterns, which correspond to the strategies players used, based on their motivation for playing in the first place. Interviews revealed that some gamers are aware of changes in the way they move, depending on their current mood while playing.

Bianchi-Berthouze [19] investigated which types of body movements can be observed in the context of video games. In her model she distinguishes task-related movements (i.e. task-control, task-facilitating, and otherwise task-related), expression of affect, and gesturing for social interaction.

An issue within research on non-verbal expression of affect lies in the differences in methodology used in studies. This starts with the choice of emotion model. Calvo and D'Mello [20] note that even as researchers in affective computing try to remain agnostic to the different theories that have been put forward in emotion research their output is "rife with theoretical assumptions that impact their effectiveness." Some studies use Ekman's [21] model of basic emotions [22, 23] or a variation of it in that they either apply more [16, 24, 25] or fewer [26, 27] emotion labels. Other studies use dimensional models of affect or a component process model of emotion [28].

Most studies present observers with static body postures in form of images. As mentioned earlier, the human body is complex. A practical consequence of the complexity is that studies employ various techniques to limit the complexity and operate with small subsets of all physically possible postures. Postures can be chosen without a specific emotion in mind [14], participants can be asked to describe everyday situations [24] or to spontaneously perform postures after inducing emotional states [22], or participants' self-report can be measured [25]. Other studies use prototypical postures, depicting clearly defined emotions, either performed by actors [26, 27] or defined manually [23].

Also the type of stimulus is of importance. The DANVAS-POS set [29] shows people in various sitting and standing postures, with their faces painted over with a black marker so that facial expressions cannot be seen. James [14] used photographs of a mannequin. Most of the more recent studies use computer-generated stimuli, which comes with the big advantage that parameters such as visual appearance, posture, viewpoint, detail, and lighting, can be controlled.

Knowing how the different approaches influence outcomes (e.g., the agreement rates of observers on the emotion depicted in an image) could help us in assessing individual approaches and compare the outcomes. In one of our own studies [30], we investigated how the type of stimulus influences agreement rates and found that agreement rates varied for different levels of realism of the stimulus (a mannequin vs. a virtual human). Even if consolidation is not a central aim of the research presented here, outlining the variations in methodology raises awareness to be cautious when making decisions concerning the underlying emotion model, type of stimulus, and experiment design in general.

## 3 Research Aims and Approach

The main hypothesis of this research is that **affect can be recognized from static body posture and body movement for assessing the user experience.**

A first step in proving the hypothesis is to build a recognition system that fulfills the following requirement: First, it must provide accurate information on posture and movements of the user. In the past, motion capture suits were used for this. These were either suits based on sensors placed on an exoskeleton or camera-based systems with visual markers that are placed on the user. Having worked with an exoskeleton type suit in a previous study investigating motivation and movement patterns of video gamers playing Nintendo Wii games [18], we have first hand experience on how intrusive exoskeleton suits are. Wearing such a suit heavily influences the affective experience of a user, which is certainly a thing one wants to avoid in a study on measuring affect. But also camera-based systems (e.g., Vicon) come with a disadvantage in that they are carefully calibrated into a room and moving them to a different location is labor-intensive. As a result, the use of camera-based system is limited to a lab environment. This is certainly a disadvantage when studying user experience and many researchers advocate the evaluation of systems that are meant to be used in everyday life should also be evaluated there and not in an (to the user alien) lab environment [31, 32]. We can conclude from this our requirements two and three: The recognition system has to be non-intrusive in order not to influence the user experience and it should be mobile and able to operate in a number of different settings.

The system we are currently building is based on the recently introduced Microsoft Kinect movement sensor. The Kinect sensor is a camera-based movement sensor, emitting an infrared grid and aggregating the reflected light into a skeleton representation of the body. It is fairly robust in terms of ability to function in changing (indoor) environments and totally non-intrusive for the user. As it is an optical system users do not have to wear specific clothes.

With this system we want to build a database of affective movements and postures. Most studies to date have only looked at static postures. With our recognition system we are able to also look at movements. As other studies have done before, we start with acted displays of affect. Exaggerated as they are, they facilitate recognition at an early stage. As the system matures we plan to move to more subtle displays of affect, which stem from test participants not instructed to display anything in particular, but simply asked to engage in a movement-based or active video game such as Nintendo Wii games, XBOX games including a Kinect sensor, or others. We believe that active video games allow us to observe a bigger variety of movements than in sedentary use scenarios.

A special focus of attention is to observe the interaction between two and possible more gamers. In her model on movement types, Bianchi-Berthouze [19] stresses that affect expression facilitates social interaction. The Kinect sensor and its analytical software are able to track several people at a time. This gives us the opportunity to study in detail what kind of affective expressions we can observe and how they influence and regulate the social interaction of gamers in various scenarios (e.g., collaborative vs. opposed).

## 4 Contribution and Relevance

The research presented in this paper envisages two main contributions:

The first contribution is the **investigation of human expression of affect through the body**. While it is established that we express our affective states through posture and the way we move, the knowledge of how affect is communicated, perceived and interpreted is limited. Also, consolidating the results of existing studies is difficult as the studies often differ heavily in methodology and investigate different scenarios, e.g. dance or rehabilitation. The research presented here contributes specifically a deeper investigation on how users of active video games express affect through the body. We also aim at shedding more light on what types of movements we can observe and how in multi-gamer scenarios the bodily expression of affect influences the interaction between gamers

The second contribution is to present **a new method for assessing the affective user experience**, again in the context of active video games. A robust version of the system described earlier could assist researchers as well as practitioners in evaluations of interactive products. Fusing readings from bodily expression of affect with readings from other modes, such as facial expressions, voice, or others will result in more robust multi-modal affect recognition systems.

The immediate application of the research described here lie in the evaluation of active video games. A next step could be to integrate affect recognition based on a number of channels including posture and movement directly into such games. A game able to sense the emotion of its users could then adapt gameplay, e.g. become easier when detecting frustration of more difficult when detecting boredom. This could ensure a continuous positive user experience.

The envisaged outcome of the research presented here appears also relevant for other domains. Also in the area of embodied conversational agents and social robots, it appears beneficial if the agent or robot receives information on the affective state of its human interlocutor in order to adapt it. In human-human interaction we continuously do so and providing agents and robots with this capability would make them more realistic, i.e. more human-like. Also in the area of physical rehabilitation, a system that can recognize and analyze posture and movement could assist therapists in identifying problematic areas and aid in monitoring therapy. In educational scenarios, detecting boredom, frustration or fear can be valuable for ensuring continued motivation of students.

## 5 Conclusions

We described our planned research in using affective feedback from body movement and posture to recognize affective states of video gamers. The recognition system we propose is non-intrusive and can be deployed in various environments allowing us to study the user “in the wild”.

We outlined a number of issues both in user experience research as well as affective computing. As this is work-in-progress at an early stage we certainly raise more questions than we can currently answer.

Yet, we believe that the work we present here can help us to get a deeper understanding of how affect is expressed through the body and to study social aspects of non-verbal communication of affect in multi-gamer scenarios. We are also positive that our work can result in a new tool to assess emotions in the evaluation of games and interactive products in general.

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