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Toward an Expressive Virtual Coach: Fitness Movements in Emotional and Motivational Contexts

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Abstract
Virtual coach applications are being developed in edutainment and health domains. There are several parameters that need to be considered when designing a motivating coach. According to the literature, the more motivating human coaches are the more effective they are. We believe that personalization of coaches' movements makes them more encouraging. In this paper we describe an experiment that we conducted to collect both expressive and motivating fitness movements. We describe some results and their potential impact for the design and evaluation of virtual coaches.

Author Keywords
Coach; virtual; emotion; motivation; movements

ACM Classification Keywords
H.5. Information interfaces and presentation (e.g., HCI): Miscellaneous. J.4. Social and behavioral sciences: Psychology.

Introduction
Sports interactive applications are flourishing. The rapid growth of affordable sensing technologies for the edutainment industry has enabled the development of

physically engaging games –so called exergames. Exergames are used to persuade seniors to increase their physical activity [1], integrating physical education courses and helping combat obesity. Virtual trainers are sports oriented applications (e.g., Tai-chi, biking, fitness) which use physical training to improve health. They can propose a personal plan; provide performance feedback and motivational supports [8]. Energy expenditure, recognized as a measure of physical exercise, is also associated with user enjoyment in the case of exergames and health benefits. Enjoyment is a major factor that supports motivation to play exergames. Moreover, emotionally demonstrative coaches have an effect on motivation [6]. Several research questions remain to be addressed: What is the impact of an expressive or motivated virtual trainer on users? Are its full-body expressive movements sufficient to motivate users?

The multidisciplinary study described in this paper aims at providing insights on virtual coaching applications and sports motivation in human computer interactions. In this paper, we emphasize the role of the affective experience and motivational support for the design of a virtual fitness trainer. After a short review of virtual coach applications and studies in HCI, we present existing databases enabling the analysis of motivation and emotions in movement. Considering the limitations of the state of the art, we describe a protocol that we have defined and applied to capture motivational and emotional variations in fitness movements. We draw conclusions about the analyses of the collected data for the design of a virtual coach that should adapt its movements to the user to modulate his experience.

We hypothesize the existence of movement variations following the natural emotional and motivational context. The long-term goal of our application will be a virtual coach able to generate a movement sequence with these different contexts. The user will follow the movements and the rhythm provided by the virtual coach. One main challenge is to modulate the affective and motivational experience of the user through the movements of the coach.

The next step will be to verify our hypothesis, which is that expressive coaches improve users' motivation and encourage fitness activities. As a future direction, the work presented here will allow the design of an application able to display credible full-body coaching movements that respond in real-time to the precise movements of the user.

Background

Previous work on Virtual Trainers

The term "virtual trainer" encompasses a wide variety of applications. However, systems for full-body movement training and evaluation are scarce. Virtual PAT was one of the first systems to provide video based movement tracking to enable the TV coach to provide appropriate feedback [2]. Recent work such as MotionMA [11] focuses on guiding users in movement training. Besides the direct movement feedbacks, the trainer proposed by [10] enables the design of a personalized program. None of these systems do consider enjoyment, affect or motivation. Indeed, most studies focus on the user's emotional or motivational responses neglecting the expressiveness of the virtual trainer or its motivational state. In addition to the coaches' appearance and their feedback, one recent study focused on motivational aspects of virtual

Figure 1: Participant performing choreography.

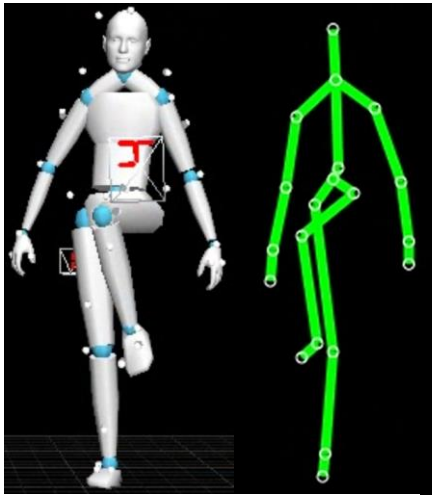

Figure 2: Different motion capture devices.

coaching: [4] show how parasocial interaction is related to intrinsic motivation.

Databases

Several studies deal with the impact of emotion on movements collected by motion capture systems [7]. Some of these studies focus on daily activity like walking, drinking or knocking on a door [5] performed by actors in scripted scenario. Other studies also consider free dance movements [3]. No studies consider movement features in fitness choreography during non-scripted elicitation of emotions. Moreover, to our knowledge, there is no database or study that analyzes the influence of motivation on fitness movements collected via motion capture.

Using a multidisciplinary approach (psychology, sports sciences, computer science), we designed an experimental protocol that provides data on fitness movements with multi-level precision sensors in emotional and motivational contexts. Motion capture and common sensors (accelerometers, depth-cameras, and video cameras) are combined. The precision of these different devices is compared to inform the relevance and usefulness of the collected data for the recognition and synthesis module of a virtual coach application.

Protocol

Thirty three French sports sciences students (11 female; M_{age} = 21.3, SD = 1.7) volunteered to participate in the study. The average of their reported duration of weekly training was 6.4 hours (SD = 3.4). Upon arrival, participants were given a consent form, the description of research aims (i.e., to create a virtual coach) and a description of the procedure that they were to follow (i.e., to repeat a previously learned choreography four times; see Figure 1). The general instruction was to perform the choreography in the "best way." This instruction was repeated before each condition. A neutral condition started the experiment. Then positive and negative valence conditions were counterbalanced across participants. The positive valence condition consisted of performing the choreography after having received a reward and watching a 1:30 minute mash-up of funny videos. The negative valence condition consisted of performing the choreography after the experimenter explained that the video of the participant's performance would be displayed in real-time at a remote lecture hall in front of hundreds of students. Finally, in the motivation condition the participant had to imagine herself as a fitness trainer who had to motivate her audience. This last condition was less spontaneous than the other conditions and aimed at collecting acted data for comparison. Between conditions participants completed several self-report questionnaires (e.g., differential emotion state; DES, [9]), and performed a distraction task (i.e., memory words).

The experiment room was equipped with 10 infrared cameras (S250e Optitrack system, frequency: 120 Hz, resolution: 832*832), one Kinect (30 Hz, resolution 200*300), and one webcam (30 Hz, resolution 1280*720); see Figure 2. All data collected from these devices were post-synchronized. Participants wore a 36 marker motion-capture suit and a QSensor device to record electro-dermal activity and X, Y, Z acceleration of the right wrist (see Figure 1*).*

This protocol of emotion and motivation elicitation was validated since different physiological response and emotional perception were obtained between conditions

Figure 3: Unidirectional interaction between fitness virtual coach and user.

[12]. For example, electrodermal activity was stronger (i.e., increase of arousal) for positive, negative and motivation condition compared to the neutral; DES report for the happiness scale revealed a significant increase between the negative and positive conditions.

Future directions

A virtual fitness coach system requires modules that enable recognition and synthesis of credible movements' (i.e., intra-individual variations of the movement). The ecological protocol presented here is designed with this purpose in mind.

However, analyzed interactions between real coaches and real users are needed to allow bidirectional interaction between the user and the virtual coach. The current protocol presented here does not enable the study such interaction variables (see Figure 3). A second protocol enabling the collection of dyadic interactions will be proposed studying both synchronization and motor responses of users and coaches.

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