Automatic Recognition of the Unconscious Reactions from Physiological Signals

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Abstract. While the research in affective computing has been exclusively dealing with the recognition of explicit affective and cognitive states, carefully designed psychological and neuroimaging studies indicated that a considerable part of human experiences is tied to a deeper level of a psyche and not available for conscious awareness. Nevertheless, the unconscious processes of the mind greatly influence individuals' feelings and shape their behaviors. This paper presents an approach for automatic recognition of the unconscious experiences from physiological data. In our study we focused on primary or archetypal unconscious experiences. The subjects were stimulated with the film clips corresponding to 8 archetypal experiences. Their physiological signals including cardiovascular, electrodermal, respiratory activities, and skin temperature were monitored. The statistical analysis indicated that the induced experiences could be differentiated based on the physiological activations. Finally, a prediction model, which recognized the induced states with an accuracy of 79.5%, was constructed.

Keywords: Affective computing, archetypes, the collective unconscious.

1 Introduction

Since the beginning of the last decade affective computing has become a prominent research direction and attracted attention of researches who work on new generations of human-computer interfaces. Originally, Rosalind Picard defined affective computing as a computing that "relates to, arises from, or deliberately influences emotions" [1]. However, later affective computing gave an impulse to a more generic research area of physiological computing. The latter was introduced by Fairclough [2] and extended the scope of investigation from emotions to general psychological states of users. Physiological computing is seen as a novel mode of human-computer interaction (HCI) that enables development of computer systems, which are aware of the users' emotional and cognitive states and, thus, can dynamically adapt to their needs without the requirement of purposeful and overt communication from the users.

The research in physiological computing has built upon and confirmed many findings from psychophysiology, the field that extensively studies the physiological bases of psychological processes. In particular, it has become clear that responses of the autonomic nervous system have a good potential of being applied in computing

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applications because they are capable of predicting changes in psychological states of individuals and can be measured with relatively cheap, quick and unobtrusive methods [3]. The possible applications of physiological computing cover a range of domains and can be roughly divided into two branches: cognitive and affective. Cognitive physiological computing is directed at monitoring and improvement of the users' performance. For instance, in adaptive automation scenarios where an operator needs to control an aircraft or a vehicle, it is important to identify the states of boredom and low vigilance because they are likely to increase the risk of accidents [4, 5]. On the other hand, affective physiological computing is aimed at increase of pleasure in interaction with computer systems and is well suited for domains such as entertainment or computer-based learning [6]. Naturally, there is an overlap between these two branches of physiological computing [3] due to the fact that cognition and affect are interrelated in the human psyche.

One course of investigation in physiological computing involves study of the psychological states that have been identified in psychology but have not yet been considered with regard to HCI. It is of little surprise that research in psychology and neuroscience has collected more knowledge about human cognition, affect and behavior than any other disciplines. For this reason, physiological computing is largely based on original experiments in psychophysiology [2] and adoption of new insights from these fields seems rational. An emerging trend in psychological science over the past 30 years is understanding and acceptance of the fact that human experience is extensively tied to a deeper level of psyche, which is not directly available to conscious awareness and, thus, defined as the unconscious. Although it may sound controversial and surprising, often people are not very well aware of and not able to accurately report on their higher order cognitive processes [7]. The absence of introspective awareness about the unconscious mental processes does not mean that they have no influence or effect on behaviors, experiences and memories. On the contrary, carefully designed experiments with both healthy volunteers and brain-damaged patients have indicated that a large part of people's everyday behaviors is conducted without any conscious control [8]. As the phenomenon of the unconscious is still to be fully understood by the scientific community, there has not been developed an established definition for it yet. However, in order to avoid ambiguity and confusion, the unconscious processes have been operationally defined by Bargh "in terms of a lack of awareness of the influences or effects of a triggering stimulus and not of the triggering stimulus itself" [9]. This definition emphasizes the important distinction between *unconscious* and *subliminal* by resolving the common confusion about these two phenomena. People outside of psychological science often equate the unconscious with processing of stimuli, which are too weak or short to enter the conscious awareness and, therefore, are referred to as subliminal. In fact, the unconscious information processing is not necessarily associated with presentations of subliminal stimuli and runs continuously as a parallel background process in human mind [10].

Carl Jung, a Swiss psychiatrist, developed his concept of the unconscious in the beginning of the previous century. According to Jung, the unconscious consists of two components: the *personal unconscious* and the *collective unconscious*. The personal unconscious is a repository for all of one's feelings, memories, knowledge and