Psychophysiological Data Collection in an Organizational Setting: Studying Interaction Between the Manager and Subordinate During Performance Review Discussion

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ABSTRACT

In this paper we present a method for collecting synchronized psychophysiological signals and video stream in a real work-life setting, during performance review discussion between the manager and subordinate. A split screen video showing the both discussants is prepared, including the visualized psychophysiological signals. The video is used in coaching sessions organized to the managers. The goal of the coaching sessions is to train the managers to better perceive their own and the discussing partner's emotional state and thus improve their interaction skills. The described method can be used also in the study of emotions during dyadic interaction in other contexts.

Author Keywords

Psychophysiology, emotions, social interaction, management, visualization.

INTRODUCTION

Hogan and Kaiser [5] argue that leadership is perhaps the single most important issue in the human sciences because good or bad leadership can have huge effects in the performance and well-being of organizations. Leadership has been studied from various different aspects, emotional intelligence being one of them [see, for example 8]. Various studies have shown that skills and attributes that are related to emotional intelligence have an important role in effective leadership [e.g. 4, 10]. We have studied the role of emotional intelligence in effective leadership in a 2-year project, and as a part of the project we have created a method to provide the managers feedback on their interaction with the subordinates during a performance review discussion. The psychophysiological activity of the both discussing partners is visualized in real time in the video of the discussion. The idea behind this is to make visible the emotional responses of the discussants so that by reviewing the video material the manager could increase his or her understanding of his or her own emotional reactions and also those of the discussing partner. We hypothesize that this leads to increased emotional and interaction skills.

Psychophysiology and Emotions

In psychological research emotions can be seen as biologically based action dispositions that have an important role in the determination of human behavior [e.g., 6]. Emotions can be considered to be constituted of three separate but related reactive systems: (a) expressive and evaluative language, (b) physiological response, and (c) behavioral response [6]. According to the dimensional theory of emotion, all emotions can be placed in a two-dimensional space, defined by valence and arousal [e.g., 6]. The valence dimension varies from unpleasant to pleasant and the arousal dimension defines the level of bodily activation related to the current emotional experience and ranges from calm to excited state.

The psychophysiological method uses physiological signals, such as facial electromyography (EMG), electrodermal activity (EDA), and electrocardiography (ECG) for investigating different psychological processes

[3]. By measuring bodily activities, inferences about emotions, attention, and motivation can be made. Facial EMG has often been used to study the hedonic valence [e.g., 2]. Increases in the activation of the cheek (zygomaticus major) muscle area have been associated with positive emotions, whereas increases in the activation of the brow (corrugator supercilii) muscle region have been associated with negative emotions [11]. Periocular (orbicularis oculi) muscle area activity appears to be particularly high during positive-valenced high-arousal emotions [see for example, 9]. For the measurement of arousal, electrodermal activity (EDA) is an important index. EDA has been shown to correlate with self-reported emotional arousal in studies where affective pictures have been used as stimuli [e.g., 7].

METHODS

Subjects and the Setting

We have until preparing this paper recorded 112 discussions from 40 managers. The subjects were from five different organizations (two public, three commercial) and the mean age of the managers was 44 years and for subordinates 45 years. The discussions were held at conference rooms of each participating company and the structure of the discussions was decided freely by the manager and the subordinates. The topic, however, was fixed to be a performance review discussion. In some organizations this type of discussions were held annually, whereas in other (more sale oriented) organizations it was almost a monthly custom.

After the placement of the electrodes a 5 minute baseline was recorded before the actual discussion could start. The discussions lasted between 40 minutes to 2 hours, with an average of about one hour and each manager had a discussion with two subordinates, with at least 30 min break in between the sessions. The discussing partners were seated by a table and a stand for two web-cameras was placed in between them for the recording of facial gestures.

Psychophysiological Recordings

The physiological signals were recorded from participants with two Varioport-B portable recording systems (Becker Meditec, Karlsruhe, Germany). Facial EMG activity was recorded from the left corrugator supercilii, zygomaticus major, and orbicularis oculi muscle regions, using surface Ag/AgCl electrodes with a contact area of 4 mm diameter (Becker Meditec, Karlsruhe, Germany). Electrodes were filled with Synapse conductive electrode cream (Med-Tek/Synapse, Arcadia, CA). The raw EMG signal was sampled at 1024 Hz, amplified, and frequencies below 57 Hz and above 390 Hz were filtered out, using the analog filter built in the Varioport device. Electrodermal activity (EDA) was recorded with Varioport 16-bit digital skin conductance an amplifier (input range = 0–70 μS) that applied a constant 0.5 V across Ag/AgCl electrodes with a contact area of 4 mm diameter (Becker Meditec), sampling at 32 Hz. Electrodes were filled with TD-246 skin conductance electrode paste (Med Assoc. Inc.) and attached to the middle phalanges of the ring and little fingers of the subject's left hand after hands were washed with soap and water. Electrocardiogram (ECG) was recorded with three electrodes, one placed on the neck over the vertebra; second placed on the left side of the ribcage over the second lowest rib; and the third placed over the uppermost part of the center line of the rib cage.

Video Recordings

Conversations were recorded from a distance with two standard DV-cameras attached on tripods and separately with two web-cameras (Logitech Quickcam 9000 Pro) attached to a stand that was placed between the discussing partners. A custom Python program utilizing OpenCV library was used to record the signal from the web-cameras to a standard Windows XP laptop. Resulting videos were converted (720x576 / 640x480, 25 fps, 5Mbps / 192Kbps / 48Hz VBR) with a H.264 codec for final use. Audio was recorded from the internal microphones of the web-cameras and also from the DV-camera using a "shotgun"-pattern microphone attached to the camera directed to manager.

Synchronization Issues

Synchronization between the audiovisual recording system and the Varioport data-acquisition devices was handled using a custom Python program communicating via Bluetooth with both Varioports´ marker channels, sending a digital marker when a video recording was started and stopped. Synchronization was also assessed by manually inserting markers before and after the discussion into the two Varioport devices using a digital Y-cable with the button presses clearly visible on the video recordings. This method allows the comparing of the psychophysical data samples to the video/audio frames and scaling the latter to match the internal clock of the recording devices. Our recording/synchronization program allows for an arbitrary rate of sent digital markers to Varioport devices, thus allowing a very fine-grained synchronization for the recordings.

Analyses of the Psychophysiological Signals

Data were analyzed using Matlab (v.7.7.0) software with Anslab Professional (v.2.4) toolbox. ECG signals was analyzed using 400 Hz sampling rate and a band of 0.5-40Hz. R-peaks were detected algorithmically. Artefactual values (+/- 3 standard deviations from physiologically realistic mean calculated with values in the range of 400-1300ms) were removed and missing values were interpolated. Heart rate signal (bpm) was obtained and smoothed. EMG signals were filtered (high pass: 28Hz, low pass: 15Hz and notch: 50Hz .The signal was rectified and smoothed using a 50ms moving average. The processed signals were saved with 4Hz sampling rate (10 Hz for EMG). EDA signal was decomposed to phasic driver and tonic components using Ledalab (V3.2.3) Matlab program [1] and saved with a sampling rate of 10 Hz.

Visualization of the Psychophysiological Data on the Video

Videos of the participants were edited and psychophysiological data were combined with them using Avisynth (V2.5) frameserving scripting program (Figure 1) Video tracks were arranged as a split screen in the top half of the resulting video. Psychophysiological visualization signals were derived with a sampling rate of 1Hz. Heartrate (bpm) and electrodermal activity were visualized as continuous graphs at the bottom half of the screen. EMG and EDA were visualized using a "smileyface" emoticon superposed on the corresponding videos. Orbicularis oculi and Corrugator supercilii EMG activity was represented as different degrees of smile and frown. EDA was represented as different degrees of blushing and sweatdrops appearing next to the face. The degrees of activity were determined using data clustering methods in Matlab. The resulting video was encoded to various formats (H.264 and WMV) using Adobe Premiere Pro CS4.

CONCLUSIONS AND FUTURE DIRECTIONS

The method we describe here can be also used in other contexts, where it is important to collect continuous, synchronized, psychophysiological signals and video from two interacting partners. It is also possible to increase the number of the observed persons. Our current set-up enables mobile in vivo data collecting, easy adding of more cameras and psychophysiological recording devices, accurate wireless synchronization between recording devices and an automated, reproducible way of editing and compiling video material. In future recordings we plan to use Noldus FaceReader or equivalent application to automatically detect emotional reactions from the face. We will thus test if the automatic detection of facial expression could be used instead of facial EMG electrodes in detecting the emotional valence. The facial EMG electrodes are most obtrusive for the subjects of all the used devices and a compensatory method would be needed for a more ecologically valid setting.

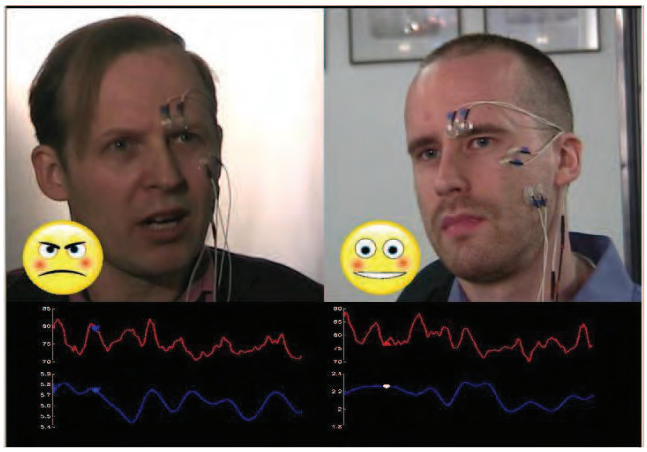

Figure 1. Picture showing the final visualization of data, provided to the managers to be used during the coaching sessions. On the left side is manager's data and on the right side the subordinate's data. The emoticons visualize facial EMG and EDA activity. The graphs below show heart rate and EDA activity, respectively, for the whole discussion.

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