Psychophysiological candidates for biocybernetic control of adaptive automation

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Abstract

Biocybernetic control is defined as the use of psychophysiology as a real-time input to a computerised system. This paper is concerned with the biocybernetic control of adaptive automation, e.g. the use of psychophysiology to regulate provision of system automation. The goal of the current study was to identify measures of psychophysiology which were sensitive to task characteristics, specifically task demand and time-on-task. Thirty participants performed the Multi Attribute Task Battery (MATB) under conditions of high and low task demand over a period of sixty-four minutes. Several channels of psychophysiological activity were recorded during performance of the MATB, e.g. EEG, ECG, EOG, respiration rate. The results indicated that power in the theta and alpha bandwidths, heart rate, vagal tone and eyeblink duration were sensitive to task demand, whereas alpha power, 0.1 Hz sinus arrhythmia and eyeblink duration were sensitive to time-on-task. The consequences of these findings for the selection of candidates for biocybernetic control are discussed.

Introduction

Biocybernetic control describes the use of real-time psychophysiology as an input to a computing system. This type of biological/machine control loop is represented by simple biofeedback systems wherein ongoing psychophysiological activity is relayed to the individual via visual or auditory feedback. Psychophysiological data may also be used in more complex ways: to relay information about the emotional status of the user to the computer system (Picard, 1997) and to characterise those psychophysiological states of functional impairment (Fairclough, 2001). The goal of biocybernetic control is to extend the adaptive repertoire of the computing system: to adjust system interface/functionality in order to optimise human-computer interaction and minimise the risk of error.

The purpose of automation is to perform those functions which are beyond human capability, too taxing for the human operator, or merely a source of hindrance for the operator (Wickens, 1992). The level and loci of automation within a human-computer interaction may vary enormously from total system automation to partial automation for selected tasks (Parasuraman, Sheridan, & Wickens, 2000). However, there are several disadvantages associated with automation, including: deskilling,