Evidence from U.S. and Russian space missions indicates that flight crew personnel experience operational stressors that adversely affect physiological and psychological well-being, and performance capability [1,2]. In order to provide timely countermeasures for stressor-induced impairments in flight crew personnel objective and unobtrusive measures to determine the presence of elevated stress levels are required. It is well established that human emotion and distress are universally expressed via neural control of facial muscles. The goal is to develop and test an optically based computer recognition algorithm of the face to reliably detect the presence of stress during performance demands. This project specifically addresses critical path questions aimed at ways to objectively and unobtrusively identify emotional distress to behavioral stressors during long-duration space flight.

A total of 60 healthy adults (male and female; 22-45 years) are being studied in a laboratory screening session and two testing sessions. During each testing session subjects complete a battery of neurobehavioural tasks, with differing performance demands. Subjects’ facial expressions, salivary cortisol levels, heart rate variability, neurobehavioural performance and subjective ratings of stress and mood are assessed throughout. Algorithm development is being achieved using video footage of facial expressions from the early testing sessions. The developed computer recognition algorithms are then being prospectively tested for accuracy in predicting both the presence and absence of stress reactions during exposure to behavioural stressors. In between neurobehavioral testing periods, subjects are administered various questionnaires to investigate intrinsic aspects of personality, affect and stress.

Analyses test the hypothesis that a computer recognition algorithm of the face can be developed to reliably detect the presence of high stress (and of low stress) during performance. Further, in exploratory and heuristic analyses, we are evaluating the effects of behavioral stressors on physiological responses (cortisol secretion, heart rate), on psychological responses (self-reported stress and mood), and on neurobehavioral performance responses; and exploring the extent to which the magnitude of the stress response as assessed by these measures relates to the accuracy of the computer recognition algorithm of the face. Exploratory analyses also investigate whether a relationship exists between intrinsic factors (aspects of personality, affect and stress perception) and stress response as indicated by physiological and psychological markers, and by facial expression.

Over the past year significant advances in programming and enhancement of the computer recognition algorithm have been accomplished. We have developed a technique that provides robust 3-dimensional (3D) tracking of stressor-induced changes in facial expression. In this approach, numerous low-level, well known computer vision algorithms are initially used to extract 2-dimensional (2D) information (tracking single points, edges, shading and optical flow), from video-recordings of the face. Our newly developed statistical technique, referred to as cue integration, uses principles of Affine and Gaussian mathematics to combine the information from these low-level algorithms using a maximum likelihood estimator to perform optimal data fusion. The integrated information is used to construct a deformable model, or 3D surface representation of the face [3]. Therefore, our technique allows the translation of 2D video footage to a form that can be used for tracking the 3D orientation and translation of the face, as well as parameters that describe the movement of eyebrows, mouth, etc. Validation of this computer recognition algorithm will provide a critically needed method for detecting the development of stress responses in astronauts, and it will form a key component in the prevention and countermeasure strategies for stress.


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