Psychophysiological Assessment of Fatigue in Commercial Aviation Operations

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Introduction

The goal of this study is to improve understanding of crew work hours, workload, sleep, fatigue, and performance, and the relationships between these variables on actual flight deck performance. This study will provide objective measures of physiology and performance, which may benefit investigators in identifying fatigue levels of operators in commercial aviation and provide a way to better design strategies to limit crew fatigue. This research is supported by NASA Ames Research Center Psychophysiology Laboratory and EasyJet Airline Company, Ltd., Luton, UK.

Background

Pilot fatigue is a significant problem in modern aviation operations mainly for the unpredictable work hours, long duty periods, circadian disruptions, and insufficient sleep that are commonplace in both civilian and military flight operations. The National Transportation Safety Board has addressed “Human Fatigue” in aviation as one of its main priorities. It is the goal of this study to discover new countermeasures to overcome fatigue in pilots.

Methods

Twenty commercial pilots (18 men and 2 women, ranging between 22 and 46 years of age) from easyJet volunteered to participate in the study. All pilots flew the Flexible Roster Variation (FRV) schedule: 5 duty days on, 3 days off, 5 duty days on, 2 days off, 5 duty days on. Physiological data were collected on pilots during all 15 duty days throughout the experiment and sent to NASA Ames researchers for subsequent data processing and analyses. Measures recorded during the flights included heart rate, respiration rate, skin temperature, activity and posture acquired with a Zephyr Bioharness ambulatory monitor. Other data were recorded such as sleep log diaries, self-reports of mood states, sleepiness scales (Sanm-Perelli), and Performance Vigilance Task (PVT). Activity data were collected with an Actigraph watch which was worn continuously throughout all duty days and days off.

Physiological measures were processed with Datisp software which included customized functions for removal of motion artifacts (filtering), peak detection algorithms for ECG and respiration signals, and calculating means and standard deviations of each measure. These data were then graphed in Excel to examine relationships to specific crew activities such as phases of flight (take off, cruise, landing) and other metrics such as PVT, sleepiness (Sanm-Perelli), mood, and actigraphy. (See Figure 10 below)

Preliminary Results

Heart rate is measured in beats per minute and chest temperature is measured in degrees Fahrenheit, both are on the left vertical axis. Activity is measured in relative units on the right vertical axis. High activity when awake and low-activity while asleep.

Data Analysis

The three graphs above show heart rate (red), chest temperature (light blue), actigraphy (black), a normal 24-hour circadian cycle (dark blue), and actual flight times (green). Each graph represents 5 flight days for viewing similarities and differences in physiological responses over the entire flight roster (15 days). The circadian cycle is shown as a sine wave, the highest point of the sine wave is 12PM and the lowest point is 12AM.