minutes prior to centrifugation and immediately after centrifugation. Rats in saline group were injected with the same volume of saline. Six hours after exposure, rats were decapitated. One hemisphere was preserved in liquid nitrogen for RNA extraction and the other was processed for apoptosis detection. **RESULTS:** Changes in mRNA expression of bcl-2 and p53 and apoptotic cells were observed in rat brain six hours after repeated +Gz exposures. bFGF and danshen were able block the changes of bcl-2 and p53 expression and inhibit apoptotic cell death. **DISCUSSION:** The data suggest that apoptosis and changes in bcl-2 and p53 expression in the rat brain can be induced by repeated +Gz exposures. Apoptosis is, therefore, one of the molecular mechanisms of brain damage induced by repeated +Gz exposures. bFGF and danshen were of the equal potency in preventing brain injury induced by repeated +Gz exposures.

Learning Objectives:
1   Effect of bFGF and danshen on brain trauma of rats exposed to repeated, high, positive acceleration

[90] ASSESSMENT OF INDUCED BLOOD POOLING IN THE ANIMAL MODEL PLACED IN DIFFERENT POSTURES USING TITLT-TABLE

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The gravity induced loss of consciousness (G-LOC) is due to mainly blood pooling in the lower body segments of the aircraft pilot. The purpose of this study was to design and develop modified instruments to assess blood pooling in the laboratory. The principles of the modified instruments were based on electrical field plethys-mography (EFP) and electrical impedance plethysmography (EIP). EFP comprises a circuit consisting of an integrated chip (IC) of 20 KHz oscillator coupled through a transformer to a modified Kelvin´s bridge. The excitation of imposed voltage was kept constant at 90 Volts. The potential difference was measured by balancing the bridge and observing the result on a cathode ray oscilloscope (CRO) through an amplifier. EIP also consists of a circuit integrated chip (IC) of 20 KHz oscillator coupled through a transformer to a modified Kelvin´s bridge. However, excitation was taken at a constant current of 3 mA and frequency of 20 KHz. Impedance was measured by balancing the bridge and observing the result on digital display through an amplifier. It was necessary to test the developed instruments on an animal model before using the devices on a human model in the laboratory. Blood pooling was induced in a monkey using venous occlusion plethys-mography. In this procedure, the cuffs were placed on right thigh, abdomen, and left arm of the monkey and inflated to 120 mmHg, 60 mmHg, and 60 mmHg, respectively. Further, the table on which the monkey was placed was tilted at different positions between 45 degree and 80 degree from the horizontal keeping the head up and legs down. The EFP and EIP instruments recorded blood volume and its changes in the leg-segment. The maximum measured values of impedances during physiologically normal and induced blood pooling conditions are 60 ohms and 34 ohms respectively. Results also confirm that blood pooling vanished after the release of air from all cuffs. EIP was found more suitable and recommended over EFP to study the blood pooling in the human model.

Learning Objectives:
1   Modeling to study blood pooling of an aircraft pilot
2   Development of countermeasure to avoid G-LOC
3   To increase G tollerance of an aircraft pilot

Monday, May 4   **2:30PM**
San Diego/San Jose Ballrooms

POSTER: Training, Performance, & Operations

[91] INFLUENCE OF SPATIAL ABILITY ON PRIMARY AND SECONDARY SPACE TELEROBOTICS OPERATOR PERFORMANCE

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INTRODUCTION: Telerobotic arms have been invaluable tools during space missions. Operators work in pairs; the primary operator controls the arm, while the secondary operator assists with situational awareness. Individual ability to manipulate the arm and integrate camera views is believed to correlate with 3 subcomponents of spatial intelligence: spatial visualization, mental rotation, and perspective taking (PT). **HYPOTHESES:** Subjects with higher spatial ability scores would perform tasks faster, with a more efficient path and more fluid movements. They would also be better at identifying potential problems and would perform better under a high (< 90°) disparity condition between the camera- and control-frames. **METHODS:** Two experiments were conducted; the first on primary operator performance, and the other on secondary. In Experiment 1, 19 naïve subjects were trained to manipulate a 6 degree of freedom simulated arm using a pair of hand controllers. The virtual environment was modeled after a NASA training tool and the 18 trials were performed under both low and high disparity. In Experiment 2, 20 subjects (11 naïve) were trained to manipulate the arm during 6 trials and observe an additional 32 trials for problems. **RESULTS:** Both experiments found a main effect of PT score on choosing the most efficient path and on maintaining safe clearance from obstacles without a direct view. A significant cross-effect, PT score * Disparity, was also found. In Experiment 2, PT scores distinguished the way subjects divided their gaze between the screens and how quickly and accurately they could detect problems. **DISCUSSION:** We confirmed our hypotheses that spatial ability scores contribute to telerobotics performance, which degrades under a high disparity condition. Subjects with high PT scores were better able to divide their gaze between screens instead of fixating on a single view. The results of these studies could be used to customize early astronaut robotics training. This research was supported by NSBRI through NASA Cooperative Agreement NCC 9-58.

Learning Objectives:
1   The audience will learn how spatial ability affects space telerobotics performance.

[92] HUMAN PERFORMANCE INVESTIGATION USING FITTS´ LAW WITH FRACTAL OBJECTS

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INTRODUCTION: One of the most popular models of human motor response is Fitts´ Law, which has been studied extensively. There is also now strong evidence to suggest that the micro movements of human motor control may be viewed as fractal or scale-free objects. Fitts´ law presents a powerful paradigm to link information theory models with optimal flow properties and fractal objects. By using the Fitts´ Law as a platform, a better understanding of the origin of fractal objects and its relationship to optimality and information theory may be achieved for human motor movements and performance. **METHODS:** A presentation of a theoretical development of Fitts´ Law relating information theoretic models to human motor response is provided. Computer simulations of scale-free micro movements of the motor actions are then summed. The typical semi-log plot of performance (acquisition time) versus bits of difficulty is then determined from the synthesized fractal objects. The correlation of the synthesized data with a straight line on this log-normal plot provides concurrence with Fitts´ Law if the correlation coefficient is high. **RESULTS:** Fitts´ Law is a ubiquitous construct for a variety of human and animal data related to motor response. Typical correlations could be 85-95% which is well known from the literature. The computer simulations adjust the fractal dimension of the micro movements until the correlations approach 85-95% on the log normal plot. The fractal dimension of the micro movements is then compared to the data in the literature to suggest that for human motor movements that Fitts´ law also provides certain optimality properties in human motor movement.