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ASSESSMENT OF COMPUTER GAME AS A PSYCHOLOGICAL STRESSOR

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Abstract : To simulate the effects of acute psychological stress, the effects of stressful computer game in young adult subjects were assessed by various physiological, psychological and biochemical parameters. The results showed a significant increase in the physiological and psychological markers of stress. It is concluded from these results that computer game can be used as an acute laboratory psychological stressor for future studies on physiological effects of stress.

Key words : stress psychological stressor computer game

INTRODUCTION

Environment provides man with certain internal contradictions and demands, which, as long as their intensity and frequency are within the normal limits of human tolerance, can stimulate his motivation and enhance his productivity. Because each of us is shaped by our own experience and our unique genetic make up, we are inherently different in how we respond to stress. “We don’t walk into trauma the same way and we don’t walk out of trauma the same way...”.

Stress, according to the health experts will cause more health problems than ever before, as it is characterized by change in the set point of Hypothalamo pituitary axis activity leading to stimulation of the autonomic nervous system resulting in immediate effects on the heart rate, blood pressure, temperature, respiratory rate and the plasma catecholamine levels, as well as delayed effects by release of corticosteroids. Stressors could be physical conditions such as heat or cold, ailments such as infection or inflammation, exercise etc. or psychological (stressful psychological environments such as working conditions and abusive relationships, performance stresses such as public speaking, mental arithmetic etc.).

The changes produced by physical stress such as effects of sub maximal and maximal exercise on the various physiological parameters are well studied but the impact of the various psychological stressors on human physiology are not studied in detail. The stressor commonly used in laboratories to elicit a psychological stress response is the Trier Social Stress Test (TSST). With

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an increasing interest and need to study stress physiology we need to look for more ways to give laboratory stress to the subjects with valid replication of the same in our day-to-day life.

In the same way that ‘you are what you eat' recent research suggests that also 'you are what you do and watch’. As computer games have increased in popularity, reports of players experiencing stress, fatigue and even game-related seizure activity have occasionally appeared (1, 2). While playing under the conditions of time deficits an increase of emotional stress is seen in children, accompanied by worsening of playing activity parameters (3). Given how the brain works it is logical - and increasingly proven - that if you subject yourself to miserable, negative experiences portrayed on television and computer games, then you feel unhappy or even depressed as a result. They produce stress, anxiety and actually adversely affect a person’s physical and mental health.

Significantly higher cortisol levels after playing the video game have been reported (4). Excessive computer and video game playing among children is now also being critically discussed from a pedagogic and public health point of view. A study by Erb et al (5) used computer game as stressor, to examine the influence of stress on intraocular pressure in healthy 15 non-smoking subjects, who were exposed to both bicycle ergometry physical stress and a computer-game psychological stress. It was demonstrated that mental stress in the form of computer game could lead to a rise in intraocular-pressure.

Thus studies showing the effect of computer game playing on the stress response of the body and the possibility of using computer game, as a stressor for studying stress physiology need to be explored.

The physiological parameters used to assess the levels of stress in the experimental stress tests are the cardiovascular responses (ranging from changes in heart rate to changes in autonomic tone), muscular activity (EMG), Galvanic Skin Response (skin conductivity) and Cortisol levels (6).

The present study aims at studying the effects of computer game in young adult subjects on their levels of stress by assessment of various physiological (Heart Rate, QT_C/QS2, EMG and GSR), psychological (acute stress questionnaire) and biochemical (cortisol estimation) parameters.

MATERIALS AND METHODS

Subjects

The study was conducted on 43 subjects (39 Males/4 Females); selected on voluntary basis from the staff and students of AIIMS (18–30 years). Informed written consent for participating in the study was taken from them. The subjects reported to be in good health and were not on any medication, which might affect the variables under study. In order to minimize the possible confounding factors, the subjects were asked to abstain from smoking, alcohol and caffeine containing beverages and to avoid

heavy physical or mental work from the evening before the experimental session. Ethical clearance for the study was taken from the ethics committee of All India Institute of Medical Sciences.

Procedure

Each subject attended individually an introductory session before entering into the study in which they were acquainted with the laboratory setting and the recording procedure to be used. Then they were asked to play computer games and the game that gave them a subjective feeling of maximum stress was chosen as a stressor for that subject as also confirmed by simultaneous recording of GSR and heart rate.

Every subject was studied in the experimental session in the afternoon, for about 1 hour. The subject was seated comfortably, electrodes for measurement of ECG, EMG, and GSR were placed, they were asked to fill the stress rating scales and first blood sample was taken. The subject then played the computer game chosen for them in the introductory session and the following recordings were done.

Physiological Stress Parameters (ECG, EMG and GSR) : These recordings were done using Biopac Student Lab PRO® Software version 3.6.7 and MP30 Hardware from BIOPAC Systems, Inc. which has inbuilt system for all the processes involved in recording from signal acquisition to data display.

ECG (0.5–35 Hz) was continuously measured using Lead-2, sample rate at 200/sec, gain X 2000. The heart rate was calculated from the R-waves using mean value of beats per min for artifact free 300 sec graph for each stage of recording.

Phonocardiography (20–100 Hz) was done at sampling rate 200/sec and gain X 2000. This was done along with ECG to measure QTc/QS2 ratio. The bell of the stethoscope was placed on the precordium and kept in place with the help of a strap tied round chest. It was ensured that the strap was neither too tight to suffocate the subject or too loose to cause movement artifact.

QT_C/QS2 is the ratio of electrical systole to the total electromechanical systole that has been used as an index of sympathetic discharge to the heart (7). QTc is corrected QT, correction applied to ensure that the changes in QT are inherent and not due to changes in heart rate or R-R interval of ECG and measured from the beginning of ventricular depolarization (beginning of Q wave) up to the end of repolarization (end of T wave). QS2 is measured from Q wave to second heart sound. Both the QT and the QS2 intervals were determined from ten cardiac cycles (8).

EMG (30–500 Hz) was recorded from the temporalis and the masseter muscles, at sampling rate 200 Hz, gain X 2500. The basal electrical activity or the tone of EMG increases with sympathetic activity or stress. The electrodes used were disposable Ag-AgCI surface electrodes with 10 mm contact area. The muscles were identified on palpation by making subject contract these muscles by clenching his teeth. The electrode for ground was placed on the skin overlying the spine of C7 vertebra. The raw data was first rectified and then integrated.

GSR (0–35 Hz) Galvanic Skin Response is a relatively reliable index for a person's internal "state". It reflects sweat gland activity and changes in the sympathetic nervous system. The activity of the sweat glands in response to sympathetic nervous stimulation (increased sympathetic activation) increases resulting in an increased conductance, which can be recorded and measured. Two Ag/AgCI electrodes were tied round the index and middle finger of left hand. Absolute values of GSR at each point in time through out the experiment were recorded and the change under various states i.e. pre and post stress was calculated.

Biochemical stress parameters

5-ml blood sample was drawn in the beginning and the end of the session for cortisol assays in 20 subjects. Plasma was immediately separated from the whole blood by centrifugation and stored at –20°C until the biochemical assays were performed. Cortisol was determined using commercial ELISA kits (DRG International Inc., USA). The inter assay and the intra assay coefficients of variation were below 5.4% and 2.8% respectively.

Psychological stress parameters

Acute stress questionnaire was used to assess the mental and emotional stress (9). It has 20 items to be scored from 1 to 5 and indicates how you feel in the present situation. The minimum score possible was 20 and the maximum was 100.

Stressor

Computer game: The stressor used in this study was either a computer game or an arithmetic calculation. The computer games used were either "Tetris" in which the subject was required to build complete rows of blocks using the different shapes, sizes and orientation of sets of those blocks presented on the computer screen, or from software called "Blackhawk Striker Launch" in which a fighter helicopter has to fight enemy aircrafts in air and enemy tanks on land. The game becomes very stressful when too many shells and enemies with little space to move surround the helicopter. The other game "Starship Eleven" has a spaceship, which has to be moved against many hurdles. The navigation of the ship is a work of precision and failure causing repeated crashes gives a lot of stress to the player.

Arithmetic calculation: The arithmetic calculation given was based on sequential subtraction of a fixed digit from a higher order digit verbally. The subjects were required to subtract a fixed digit e.g. 7 from 100 and thus go backwards towards 1/0. The subject was further put under stress by pointing out mistakes in their calculations and made to repeat the same again.

Statistical Analysis

The level of stress as measured by various physiological and biochemical parameters were assessed using two tailed, paired t test. The value of $P<0.05$ was considered significant.

RESULTS

The age of subjects, number of years of education and handedness did not differ significantly. Results of the variables using the paired t test revealed a significant change in the two states (i.e. post stress versus pre stress). Summaries of the results of the present study are presented in Table I.

The mean GSR pre stress was 1.80 ± 1.40 µ mho and post stress was 2.63 ± 2.02 µ mho, with a significant increase with stress (P<0.001).

Mean Heart rate pre stress was 81.51 ± 10.57 and increase to post stress was 84.68 ± 11.14, which was significant (P<0.001). Thus a 4% increase in the heart rate was seen with computer game as a stressor. There was a significant increase (P<0.001) in the QT_C/QS2 value i.e. the sympathetic tone in these subjects increased after playing the computer game.

TABLE I: Mean pre and post stress values of various stress parameters.

	Pre-stress	*Post-stress*
GSR (µ mho)	1.80±1.40	2.63±2.02***
EMG (mV-sec)	3.02±1.06	4.11±2.77*
HR (beats/min)	81.51±10.57	84.68±11.14***
QT_C/QS2	1.07±.09	1.16±.07***
AcQ	25.70±7.01	28.40±8.04***
CORT (ng/ml)	152.9±49.25	130.05±41.28*

***P<0.001, *P<0.01

GSR : Galvanic Skin Response
EMG : Electromyographic activity
HR : Heart Rate
AcQ : Acute Stress Questionnaire scores
CORT : Cotisol levels

Name Age Date

Stress Questionnaire

This questionnaire is purely a simple indicator of the amount of stress that you are currently experiencing within your particular lifestyle. It is not a substitute for seeking professional medical advice or diagnosis. To determine your level of stress, just select one answer for each question. To make the feedback meaningful, try and answer all the questions as honestly as possible.

1 ---------- 2 ---------- 3 ---------- 4 ---------- 5
almost never rarely sometimes quite often must of the times

	1	2	3	4	5
1. Do you get on well with your co-workers?					
2. Do you let others know how you are feeling?					
3. Do you suffer with constipation or diarrhea?					
4. Do you get jealous of others?					
5. How often do you catch colds?					
6. Do you crave sweet things to eat?					
7. How often do you suffer with headaches?					
8. When you have been ill does it take you long time to get over it?					
9. Are you quick to anger?					
10. Do you feel that you are under too much pressure?					
11. Do you feel refreshed at the beginning of the day?					
12. How often do you feel lonely?					
13. Do you drink alcohol?					
14. Does your heart pound?					
15. Do you suffer with difficulty in sleeping?					
16. When conflict arises do you overreact?					
17. Do you have difficulty in concentrating?					
18. Do you have allergy flare ups?					
19. Do you sweet excessively?					
20. Are you happy?					

EMG was done in 35 subjects and a significant increase was seen ($P<0.01$) from 3.02 ± 1.06 mV-sec to 4.11 ± 2.77 mV-sec. The rest of the data from eight subjects was discarded due to poor recording or interference.

The cortisol levels were estimated in 20 subjects. A significant decrease ($P<0.01$) was seen in cortisol levels from pre stress 152.9 ± 49.25 ng/ml to post stress 130.05 ± 41.28 ng/ml.

Mean scores on the Acute Stress Questionnaires before stress was 25.70 ± 7.01 whereas the scores post stress was 28.40 ± 8.04, which was significantly higher ($P<0.001$) and correlated positively with the changes in the physiological and biochemical parameters.

DISCUSSION

The primary finding of this study was that computer games are not just a passive pleasure activity but associated with a definite stress response as shown by the increased physiological stress parameters. The increased mean scores on the stress questionnaire also support the use of computer games as a psychological stressor in the laboratory setting.

Forty-one out of the forty three subjects in this study showed computer game related significant increase in the various stress parameters, that are consistent with previous reports of stress induced impairments in the young adult age group. It has been shown that the energy cost of the game approximates mild-intensity exercise (10, 11). Changes in HR (12) and GSR (3) in young healthy adults in laboratory setting as previously seen are also replicated in our study.

An increase in the sympathetic discharge using computerized arithmetic and Atari games as stressors indicated by increase in the gastrointestinal transit time and glycemic control has been shown (13). In our study a significant increase in the sympathetic discharge i.e. the QT_C/QS2 values is seen.

In our study the levels of cortisol, contrary to previous reports, have reduced in response to the stressor. The stress response occurs in two stages: a short latency component, the fight or flight response, with stimulation of the autonomic nervous system resulting in immediate effects on the heart rate, blood pressure, temperature, respiratory rate and the plasma catecholamine levels (14, 15) and a slower acting response by release of corticosteroids. Cortisol has a much longer latency of release than norepinephrine (minutes instead of seconds), and it takes hours for the adaptive effects to emerge. Peak cortisol levels are attained 10–15 minutes after the disturbance of homeostasis and the levels remain elevated for 30–90 min as a function of the nature of stress and coping ability of the individual (16, 17).

Plasma catecholamines have been shown to be elevated by acute stressors such as hypotension, hypoxia etc. by increasing the discharge of Locus Coeruleus, the main source of norepinephrine afferents to the rest of the brain. Such changes in the firing rates of LC occur within seconds of the administration of stress (18, 19, 20). The degree of increase reflects the intensity of

the stressful stimuli (21, 22). On the other hand, activation of the HPA axis, via increased CRF in the hypothalamus leads to increased ACTH from anterior pituitary, which hence triggers the glucocorticoid secretion from the adrenal cortex. The Cortisol hence released, binds with its receptors i.e. GR and MR receptors to bring about its effects (23).

Even though these systems are studied in isolation, interactions between the two are well known to exist, during stress the adrenal medulla is exposed to high levels of corticosteroids leading to increased conversion of norepinephrine to epinephrine, conversely, the monoamines regulate the HPA axis in the brain by activation of PVN of hypothalamus and thus increased release of CRF (24). Hence while norepinephrine activity is immediately increased in response to threatening stimuli, cortisol modulates the long-term neuronal changes associated with stress.

These complex interrelationships between the two systems reveal the subtleties of the stress response. Also, in both the systems the level of the available monoamines influence the response such that more the available monoamines, greater the stress response.

The decreased levels of serum cortisol in our study post stress were also seen in a previous study by Skosnik et al in 2000 (25), by using computer game play for 15 min as a stressor. These results indicate that either the stressor was mild to only produce the sympathetic activation or the latency of cortisol release was too long to be observed. Further also the individual coping abilities may be responsible for an early reversal of the stress reactivity of the body though other physiological changes due to the activation of the sympatheto-medullary axis continued to be present during this period.

Therefore, it seems worthwhile to study each of the possibilities by probably a more frequent blood sampling and estimation of levels of norepinephrine during the testing procedure in the future investigations.

Computer games did not produce stress in two subjects probably because these subjects were too used to these games and were using preformed strategies during the play. In these subjects increased stress levels were obtained using arithmetic calculation. However, it would be worthwhile to use different type of computer games to see if changing the principle strategy used in the game leads to increase in the levels of stress.

Today we need to answer the questions pertaining to the stressful effects of all the modernization and increased influence of technologies in our life. Time and again it has been demonstrated that the age-old ways of life were much more healthy. Finally, the study clearly demonstrates the activation of a stress response in these subjects and thus, this can be used as a psychological stressor in the laboratory setting. The changes in the various physiological parameters have been highly consistent and also correlated by psychological assessment.

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