



Study of impact of stress and personalization of work place on cognitive performance of young.

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ABSTRACT

We tried to understand the impact of the stress on various cognitive characteristics of the humans. The people involved in the study were mostly students of the age group 21 years to 27 years. We have studied the behavior of 258 young people of which 168 were male and 90 were female volunteers over the period of 4 months. The volunteers were asked to perform various activities under certain predefined constraints. The focus of the activities was to evaluate the impact of the stress on the performance of the volunteers. Then same activities were repeated under the personalized favorable factors for each volunteer. The work resulted in some interesting finding presented in the paper.

Keywords: *cognitive, stress, humans*

INTRODUCTION

Cognition is a process or analysis involving the brain's logical power. Brain is the fundamental component of cognition of individuals, which controls cognitive operations like attention, memory, problem solving, decision making, behavior etc. We observed all cognitive traits which are influenced under various kinds of stress as well as favorable environment. Situations affecting cognitive traits of an individual are person specific and varied in nature. The external factors like surrounding, time and people around, impacts the performance to a great extent. It is observed that the person specific favorable surrounding has positive impact on performance and cognition. Interestingly the academic performance in both written and oral exam is negatively impacted by presence of knowledgeable person according to the volunteers, whereas the performance and cognition surprisingly improves after certain time with continuation of the same task. E.g. performance in the first 20 minutes of the exam and performance of the last 20 minutes of the exam is surprisingly different. We have further investigated the underlying factor for this difference, but these factors are beyond the scope of this paper. Further it is evident that there is no general solution to the cognitive decision, it is highly case and individual specific. Another important observation is personalization of the situation or rewards. Both invariably have shown to have the positive impact on both the performance and cognition.

Cognitively trained individuals are better in performance in case of emergencies and highly stressful situation [1]. In general, the cognitive factors that are affected due to stress are perception, attention, behavior, memory, decision making and response mechanism. The nature of response under stress depends upon the individual's differences, type of stress, time, pressure, external threat and other factor creating stress [2]. Sometime stress is important to reach the optimal level of arousal which improves the performance [3]. But stress at some point of time



will affect and degrade the performance even in the well skilled operator due to the gradual effect of increasing stress in cognition [4]. In this paper, aspect of cognition like attention, memory and behavior were studied under different stress condition and found to be degrading gradually under stress. The main factors which play major role in cognition are attention and memory.

OBJECTIVE OF THE STUDY

- Analyse the effect of stress and personalization on cognitive behavior
- Study the impact of stress and personalization on cognitive factors
- Evaluate the impact of stress on precision of cognitive decisions

MATERIAL

In various experiments, cases were identified which created the stressful situation like, strictly time bound short and long exam, computer simulations, animation for emotion management like music, happy and stressful situation, games. Jokes, movie clips, reading, cartoons clips, animations were used for creating the desired situations. Sometime certain beverages like tea, coffee and cold drinks (nonalcoholic) were also offered to volunteers to make them comfortable. Reading of the situations like reporting the failure in university exam to parents, exposure to sudden undesired events, handling unexpected situation with closed group of friends were also recorded. Authors also observed group behavior, individual behavior, cognitions decision in natural and created situation during the study. Software application was created for data recording and analysis using MS-Access 2010. MS-Access has good security feature to control unauthorized access to the data. The authors were having the passwords to access the database.

METHODOLOGY

Detail explanation of proposed study was given to the volunteers e.g. type of observations will be made, collection of the data, confidentiality regarding the collected data, type of activities during the study, etc. The consent is obtained from the volunteers. There was no minor (under the age 18 years) involved in our study. Each volunteer was asked to write their SWOT analysis, hobbies, interest, career plans, family background, close relationships, lifestyle, food habits, academic performance and their order of priority for money, family(all relations), time, career, job preferences, work location preference, house, car, health and anything other independently assuring them the confidentiality of the data.

The information collected was analyzed with the help of statistician to prepare the person specific observation and evaluation plan along with demographic information of the volunteers. Separate observation sheets were created for each volunteer. The gender specific analysis is not reported in study.

Considering the important fact that all volunteers studying in different colleges and streams, each volunteer was kept under the observation for at least 60 days considering the exam period in between, so that we can make analysis and recording for pre exam, during exam and post exam period.



OBSERVATIONS

Following observations were made during the study,

Stress performance behavior

Student performance was analyzed under the different stressful situations the observations made are as given below.

Identification of Cognitive Factors Affected by Stress

Cognitive development, language development, on infant temperament, behavioral, emotional functioning, physical development, behavioral, anxiety, depression, schizophrenia and other mental illness, like attention deficient and hyper reactivity disorder, delayed language development and lower intellectual functioning.

As per the studies in human and the experimental animal models, suggest that the psychological stressors during the pregnancy have an influence in the physical, behavioral and cognitive development of the offspring. In human studies it is found that prenatal maternal anxiety and prenatal exposure to the life-threatening event is associated with a severe obstetric complication like especially preterm birth. Offspring's from these mothers are withdrawn, anxious and depressed. From a study it is found that offspring from the mother who have suffered some personal loss like death of husband when she was pregnant, had delivered the offspring suffering from schizophrenia and other mental illness. In several human studies it is found that mother suffering from anxiety (Crandon 1979a, 1979b, Field et al. 1985, Grimm 1961) during their pregnancy, gave birth to children with attention deficient and hyper reactivity disorder. In other study of anxiety in pregnant women experienced at 12 -22 weeks of pregnancy besides controlling all the potential confounding factors, significantly predicted more severe attention problems in their child after birth at 18 and 32 months of age. Chronic stress cause by daily hassles, state or trait anxiety during pregnancy also leads to delayed language development and lower intellectual functioning respectively. The findings from the Project Ice Storms strongly suggest the stressor and other stressful event during pregnancy irrespective of maternal personality factor, have a negative impact on the cognitive development, language development, on infant temperament, behavioral, emotional functioning as well as in physical development of the children those who exposed in utero. So, the effects of prenatal maternal stress on cognitive development may be due to an effect on brain development in fetus.

Maternal psychology and fetal factors during pregnancy affect growth of developing fetus and fetal programming with an indelible impression on adult organ function, including function of brain and nervous system. This is a known fact that there is no direct neural connection between mother and the fetus but maternal psychological functioning is translated into physiological effects under maternal distress such as alteration in behavior due to substance abuse, reduction in the blood flow between mother and fetus making fetus deprived of oxygen and nutrient and maternal release of stress hormones which is then transported across placenta to the fetus. Other maternal problem like anxiety is also associated with the reduced blood flow to fetus, which implicit assumption that prenatal stress and emotion affects child development even after birth because of the negative effects on the development of the nervous system before birth. It is also found that mother's perception of experiencing mild stress in everyday life was inversely related to their fetus movements and heart rate were in synchrony indicating developing neural



integration. In other study emotional intensity, perception of stress, and feeling during pregnancy were positively related to the activity level of their fetus, thus indication that the fetus responds to changes in sensory environment of the uterus that occur when maternal heart rate, blood pressure and other internal function are abruptly altered. This factor of sensory perception is accepted from the fact that hearing is the first perceptual system of development prenatally and fetus can perceive sounds that emanate from both within and outside the uterus.

higher maternal anxiety in the mid pregnancy was associated with better motor and mental development of the children. This association remained even after controlling statistically for other possible contributing factors, including level of maternal education and both anxiety and stress after giving birth. Thus, it can be said that neuro hormones like glucocorticoids produced during the stress response which play a role in the maturation of body organ during fetal development and fetal programming

Effect of stress throughout the life span on the brain has an impact on the cognition and behavior of an individual. Stress hormones produced during any time period in a life may be during pregnancy period, infancy, childhood, adolescence or aging has an impact on the brain structures involve in the cognition and mental health. Effect of stress on the brain of an individual's is a function of time and duration of the stress hormones exposure, and also depends on the interaction between gene effects and previous exposure to environmental adversity in life span and also during the prenatal condition which leads to the development of different disorders in an individual's exposed to stress . All these factors affect the brain structure, behavior and cognition of an individual's programming because when an environmental factor that acts during a sensitive development period affects the structure and function of tissue, leading to effects that persist throughout life. It is evident from the studies in humans that during early childhood and old age brain is very sensitive to the stress as at this period the brain undergoes many important changes and this is how exposure to early life stress can lead to cognitive deficits in adulthood indicating that effects of stress at different stage of life interact and influence the cognitive, behavior and other mental health related problems. Thus, regulation of gene expression play role in the cognitive function and mental disorder. Human studies have revealed that prenatal maternal stress, depression and anxiety and exogenous glucocorticoids during pregnancy is associated with increased basal HPA axis activity in the offspring at different ages including 6 months, 5 years and 10 years. Thus, leading to disturbance in neurological, cognitive and behavioral problem like unsocial behavior and drug abuse, attention deficient hyper reactivity disorder, sleep disturbance as well as psychiatric disorder like depression, mood and anxiety. Besides the prenatal maternal stress, parents – child interaction and mother psychological state post-natal also influence HPA axis activity of child in 1st year of development as infants are labile and sensitive to their environment at this developing stage. Human studies have also suggested that adolescence period is also very sensitive to stress induced -HPA axis activity due to the change in the sex steroid level during this period as steroids also influence HPA axis activity. Thus, during this period of growth, elevated level of both stress hormones and sex steroid affects the brain structure, function and brain damage due to production of neuro toxin in response to the elevated level of stress hormones respectively. Repetitive stress response and stress experience leads to unconstructive repetitive thinking (URT) such as rumination, worry, preservative cognition and cognitive interference ,which ultimately leads to recurrent thinking about the problems which amplify, extend and reactivate emotional and physiological components which act as stressor and continue the stress response even after the cessation of the stressor. This URT thus act as psychological mediator leading to short- and long-term negative consequences for cognitive function.



According to the Selye's stress is highly individual's experience and does not depend on the particular events, rather stress depends on the specific psychological determinant that triggers stress response. This stress response is the nonspecific determinant and condition that put strain on the organism. But this unspecific determinant of stress is not agreed by other researchers as we know that these stress determinants are psychological in nature and stress is induced by the interpretation of these determinants and events. **Mason** described the three psychological determinants of stress to be determinants that would induce stress response in any individual when exposed to them that a determinant should be 1. Novel, unpredictable and the individual must have the feelings that he/she does not have control over the situation. Thus, determinants of stress are highly specific, potentially predictable and measurable. According to the meta-analysis for the determinant of stress which is presence of social evaluation threat which are novel, unpredictable, uncontrollable like public speaking task which is relative to the stressor of the events or situation that will elicit a stress response only on certain proportion of an individual's depending upon cognitive interpretation and cognitive analysis of the situation on which physiological response will depend.

Other theory of stress explains the 'secretion of stress hormones in response to stressor' which can easily cross the blood-brain barrier and access the brain thus influencing the learning and memory by affecting the region associated with these cognitive abilities. While short-term novel stress can be helpful for the individual resulting in new learning and acquired behavioral strategies for coping like certain type of fear-related memories. Though repeated stress can cause cognitive impairment as well as structural changes in the hippocampus due to the excessive release of stress hormones like glucocorticoid hormones. Optimal level of glucocorticoid hormones is necessary for the optimal state of cognitive efficiency which increases or decreases level of hormones leading to impaired cognitive efficiency. Human study has confirmed the impact of glucocorticoids on cognitive function leading to impaired declarative memory function supporting the view that glucocorticoids affect hippocampal-dependent cognitive function. Besides the impact of external and internal stressor, emotion and stress also share a common platform. An experience is often related to particular emotion e.g.: fear, surprise, joy and other which can cause stressful situation. Thus, these emotions create a conscious response either physical (increase in heart rate, perspiration etc.) or interpretation of the situation in terms of behavioral change, anxiety, etc.

Research in cognitive psychology emphasizes on the acute and chronic stress which affects performance of individuals. There are many studies confirming the effect of stress on cognition, performance and health. Theoretical account of effects of stress in psychology involves the optimal level of stress or arousal for performance in any task. It is evident from the fact that stress under emergency situation causes the operator to lose his attention and focus leading to the degradation in the retrospective (long-term memory) and prospective (short-term) memory dependent on the retrieval in due course of time tends to shrink as stress level increases which is the major reason for the performance error and failure in emergency situation. Stress introduces the disruption of balance between cognition and environment thus affecting the cognitive activity of common sense, rational thinking, analytical thinking thus influencing judgment and decision-making ability. Generally, stress effect on cognition and human performance under multiple factors like motivation, attention, memory, environment, arousal level, consciousness, awareness, and intuitive factors. These all are the main contributing factors which influence cognition which may have positive or negative consequences depending upon the type of stress and stressors (endogenous and exogenous). Till now no theory completely elucidates the underlying process of stress.



Effect of stress on accuracy of cognitive decisions

Emergency situation, Time pressure, Emotion, Risk, Lack of attention, Loss of memory, Decision making, Gambling, Psychology, Desires, Risk, Choice, Environmental constraint, Exogenous and Endogenous Factors.

Often emergencies are time dependent which demands the correct decision at correct moment. Thus, emergencies are stressful which put psychological pressure on individuals. Emergency situations are not only time dependent but constantly demanding in terms of correct decision on changing the situation. The same decision cannot be always right for the other situation. Thus, decision mostly is affected as per the need of the situation under the stress condition. Decision demanding situation often creates stress in emergencies but the stress subsides as the emergencies pass.

Decision making is a cognitive process which involves the process of making a choice or course of action by a person. The decision-making process requires critical thinking, experience, attention, working memory and reasoning. Components of Decision making are attention and memory, reasoning, past experiences, psychology etc.

Decision making is an outcome of process assessment and judgment which is based on the option, choice or alternative which an individual wants to make. Making a choice and taking decision is involving cognition which underlies the fact of desires one has. Individual differences in values will define what constitutes an accurate or high-quality decision (that is, whether or not an individual is happy/satisfied with the decision made). It is also likely that we adjust our 'quality standards' as a function of task demands (such as time pressure, complexity of the decision). The cognitive skill and their limitations are also influential in constraining choices so that choice making in reality varies from what may be seen as ideal and logical. It is evident that humans are bounded by constraints like environmental constraint and constraint of their mind like limited memory. These constraints have an impact on individual and they shape people's behaviour. Research in this field is based on the approach that cognitive aspect of decision making includes emotion and 'ease of justification' for a decision. In the process of decision-making emotion and other goals or desired outcomes also play an important role because decision is influenced by the emotions for the highly valued things and desire for the potential outcome. Framing of a problem includes both information about the decision problem and the context of the decision problem (for example, time constraints, emotional aspects etc.). Individual differences in the way information is perceived, organized and interpreted, and differences in context, mean that the decision or choice made about the same decision problem will vary between individuals and across different contexts (Kahneman and Tversky, 1984; Shoemaker and Russo, 2001).

Cognitive psychologists have studied decision making capacity and hence deduced that, decision making process involves many areas of cognition like perceptual process (Link, 1992) to memory recognition (Ratcliff, 1978) and categorization (Nosofsky & Pal-meri, 1997). Time pressure and the choice of making a decision or not making it, is related to the probability of risk associated with that decision. It means that if time pressure increases, the frequency of making a choice if the associated risk is high will decrease, whereas the frequency of making a choice when the associated risk is low will increase.

EXPERIMENT

The risk-taking decision task used for this experiment was developed by Dror, Katona, and Mungur (1998) and is a simplified variant of the game of blackjack. In this task, the decision maker must decide whether or not to gamble by taking another card from a deck in order to maximize his or her total points without exceeding 21. This task was chosen because the information-processing demands (stimulus encoding and response production) are minimal and identical across trials, thus enabling us to isolate the time pressure effects in the decision stage. Furthermore, this task allowed us to systematically manipulate the levels of risk by varying the probability that taking a card would “bust”. For this simple task, sequential sampling models make an a priori prediction regarding the effect of time pressure on the frequency of choosing the gamble (details are presented in the Appendix): Time pressure will increase the frequency of choosing a gamble when the risk (probability of losing) is high but will decrease the frequency of choosing the gamble when the risk (probability of losing) is low. In other words, sequential sampling models predict a crossover interaction effect between time pressure and risk level on frequency of choosing the gamble. Thus, time pressure is predicted not to have a uniform effect (of being either more conservative or more prone to take risks) but, rather, a polarization in terms of behavior: At the low risk, people turn more conservative and take fewer gambles, whereas at the high risk, they are more risky and take more gambles.

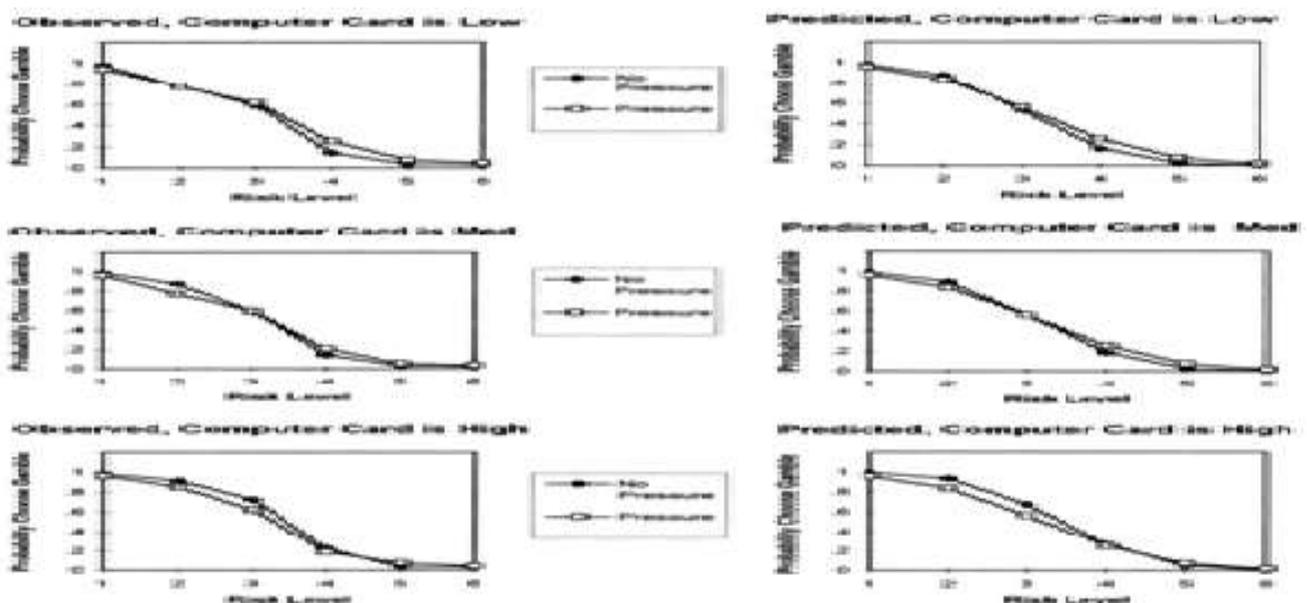


Figure 1. The left three panels show the probability of taking an additional card by the participants as a function of risk level. The top, middle, and bottom panels are for low, moderate, and high computer card levels. In all panels, there is a backward-S-shaped curve as risk level increases, and the time pressure curve is flatter than the no time pressure curve. Furthermore, there is a crossover interaction between the curves for the time pressure and no time pressure conditions in each of the panels. These effects are moderated by the computer card level, but only for the no time pressure condition. The right three panels show the predictions of the model for choice probability under the same experimental conditions. The steeper curve represents the predictions when the inhibitory threshold is set to a high criterion and the bound is increased, and the flatter curve represents the predictions when the inhibitory threshold is set to a low criterion (under time pressure) and the bound is smaller. The precise quantitative form of the curves depends on specific parameter values estimated from the data, but the crossover interaction pattern and the effect of the computer card level is a parameter-free prediction of the model



Choice probability. As is illustrated in Figure 1 (left panels), choice probability decreases as risk level increases. More important, the curve within each panel for the no time pressure condition is steeper than the corresponding curve for the time pressure condition, producing a crossover interaction between risk level and time pressure. This crossover result confirms the a priori prediction made by sequential sampling models. We observed the following results: First, the difference between the no pressure and the pressure conditions for the risk level 2 produced a positive contrast; second, the difference between the no pressure and the pressure conditions at highest risk level produced a negative contrast.

Therefore, time pressure for making a choice or decision is directly proportional to the risk associated to that particular choice or decision outcomes. One of the hypotheses suggests that the decision maker will take fast and random guess under time pressure to make a choice.

Study has proved that the emotion plays important in the decision making and intrinsic emotion has beneficiary effects on decision making. Called as somatic state (Bechara, Damasio, & Damasio, 2000). Other studies also suggest that the emotion may be unrelated to the decision-making task as it either existed before or developed during the course of making decision. Unrelated emotion and incidental stress often have effect on the decision-making process. Incidental effects of stress on memory are complex and depends on the task, phase of memory, age and gender of the participant and even the time of day (al'Absi, Hugdahl, & Lovallo, 2002; Domes, Heinrichs, Reich-wald, & Hautzinger, 2002; Het, Ramlow, & Wolf, 2005; Kudiel-kaa, Buske-Kirschbaum, Hellhammer, & Kirschbaum, 2004; Parfitt, Hardy, & Pates, 1995; Wolf, Convit, et al., 2001; Wolf, Schommer, Hellhammer, McEwen, & Kirschbaum, 2001).

EXPERIMENT

One of the experiments to see the effect of stress on decision making had been conducted on the participant and they were told that they have to deliver a public speech at the end of the experiment in the laboratory (e.g., Kudielkaa et al., 2004; Levenson, Sher, Grossman, Newman, & Newlin, 1980; Steele & Josephs, 1988). While anticipating the speech, participant performed the Iowa Gambling Task (IGT) repeatedly to rely on an intact somatic marker system which is affective and emotional in nature. When somatic marker system is triggered during the pondering of the decision they helped in providing internal information about the costs and benefit of alternative and thus demonstrated bias decision making in an advantageous direction (e.g., Bechara, Damasio, & Damasio, 2000; Bechara, Damasio, Damasio, & Lee, 1999; Bechara, Tranel, & Damasio, 2000). Because the stressor was unrelated to the decision task at hand, we hypothesized that the speech anticipation stress would impair performance by creating interference with the task-related emotion necessary to guide advantageous choices. Although a rationale for this hypothesis based on theoretical grounds has been previously provided (Bechara & Damasio, 2005), no empirical evidence has been obtained that would support or refute such a hypothesis. This was the primary aim of this study.

Result

The statistical validation of the experimental setup VS control group concluded that

1. The experimental participants had greater increase in heart rate from the speech anticipation stress.

2. In Self report experimental participant were more anxious during the test game, The State–Trait Anxiety Inventory (STAI- state) and were exhibiting less positive emotion, Positive and Negative Affect Schedule (PANAS)- positive effects than control participants. But both groups had similar level of negative emotion, PANAS-Negative effects.
3. The anticipation of giving a public speech was effective as a stressor; its increased anxiety and heart rates only for participants in the anticipatory stress condition and only after the stressor was introduced. The participants in the experimental condition were slower to learn the task, meaning that it took them longer to shift toward advantageous decision making

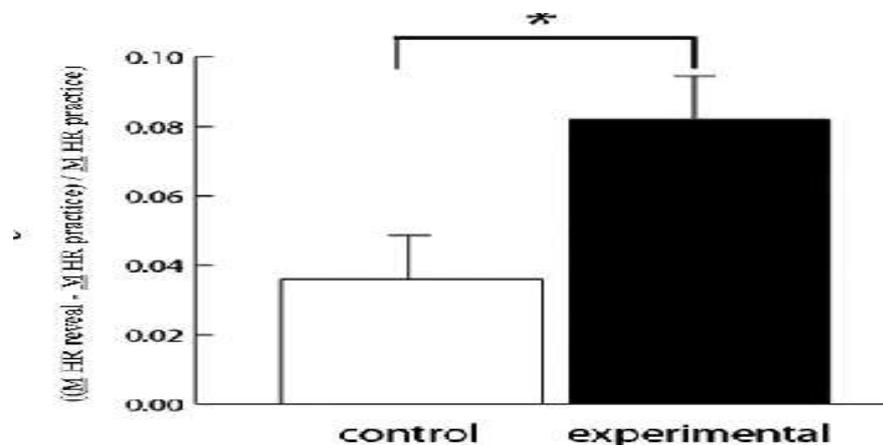


Figure 2. Experimental participants were physiologically aroused by the manipulation. Graph shows percentage change in heart rate for control and experimental participants from the baseline to the reveal period (c , calculated as [mean heart rate for reveal period – mean heart rate for practice game] / mean heart rate for practice game) when the experimental participants learned about the speech. Error bars show standard errors.

Because the main effect was observed in the learning phase and associated with increased arousal and anxiety and decreased positive affect (but not increased negative affect), it is likely that there is effect of anticipatory stress on decision making. The learning phase of this experiment, was mediated by competition between the primary card game and the unrelated speech stressor for limited working memory resources. Indeed, evidence shows that increased working memory load during the IGT prevents participants from developing the somatic markers associated with the contingencies of the four decks, thus impairing decision making (Hinson, Jame-son, & Whitney, 2002), and that this effect is due specifically to a disruption in the executive component of working memory and not to competition for the verbal buffer (Jameson, Hinson, & Whitney, 2004)

Effect of stress on cognitive behavior

Emergency, Worry, Tension, Concentration, Emotion, Confidence, Time pressure, Physical stress, Mental stress, Anxiety

According to Cognitive Psychologist, Cognition is a mental process and analysis of the mental operation is the fundamental component of mental life such as attention, memory, problem solving, decision making, and Behavior. Behavior is often influenced under stress



and emergencies or another abnormal situation. Emergency situation is always dynamic because the effect of the surrounding situation impacts the behavior and action of the individuals. Stress generally affects the behavior of an individual, their emotional state and neurophysiologic function. These changes in term of focus on arousal, tension, motivation, awareness, interference, worry, concentration and confidence can be measures to evaluate the stress condition. These are the factors of cognitive stress and can be analyzed to evaluation of stress degree. The three scales to measure stress are engagement in task, distress and worry. Engagement in task involve how much attention and focus a person is giving for the task, second distress due to factors like time pressure, mental overload, appraisal in term of threatening and third is worry when there is self-evaluation that provoke assessment of personal qualities and goal but it is also true that boring tasks leads to loss of concentration thus provoking worry. The most important effects of stress are on behavioral performance efficiency. The most common way to respond under stress by human being is performance degradation, physical or mental stress related to emotional & Cognitive abilities. According to Cognitive Continuum Theory (CCT) Environmental events and cognitive events share equal and joint billing in the determination of behavior. Stressors should always be examined in relation to cognitive activities. Disruptions of homeostasis should be differentiated into endogenous v/s exogenous and the current cognitive mode recognized (intuitive/analytical) The few common theories of the stress emphasize on the biological consequences of the stress , treating behavior as the byproduct of stress, secondly , automatic neurological and hormonal change that occur in the individual under stress and their cognition that mediate the stress/behavior relationship which is reflected in the term of performance

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