Chapter II

Historical Resume

It has been highlighted in the first chapter that stress profoundly influences the CFF and performance level of a subject. Research in this field is very old. More than five decades ago, Dr. Hans Selye (1936) conducted some experiments related to this phenomenon. Since then, more than 1,20,000 publications have been reported which deal with various aspects of the concept. It has been observed in these studies that various forms and levels of stress may affect both i.e. CFF and level of performance in different manner. The present investigator is interested in studying the 'workload' form of physical as well as mental stress. The concept of 'workload' stress is comparatively a recent one and the studies dealing with such form of stress occur very rare in the literature. Therefore, mainly those studies will be reviewed which deal with the effect of stress in the form of workload or any other similar natured stress on CFF.

Though the investigation was designed to study the effect of stress on CFF, but it was decided later to study this effect on performance level also. Therefore, the studies related to stress and performance shall also be reviewed in this chapter.

In the first section, however, effect of stress on CFF shall be discussed.
Stress and CFF:

It has been indicated by researchers from time to time that many kinds of changes in the mental and physical state of a subject occur as a result of stress. These various kinds of physical and mental changes in turn also alter the perceptual capabilities. CFF has also been found to be influenced by various types of stress in many studies.

Mucher and Wendt (1951) used a group technique to measure CFF. They reported a significant depression in CFF threshold after the normal day's work.

Piern (1952) conducted experiments with small groups of Ss. He concluded that CFF is lowered due to fatigue stress induced by either mental or physical work or by sleepiness.

Busch and Wachholder (1953) have reported increase in CFF after low levels of stress which were induced by 70 to 90 min. of mental calculation and decrease after studying for one full day.

Davis (1955) found that both visual flicker fusion and auditory flutter fusion decreased after two hours of mental arithmetic problems. However, changes in the auditory flutter fusion were more pronounced than the visual flicker fusion. After one hour of mental arithmetic, no change in visual flicker fusion was observed.

Simonson (1959) has suggested that CFF is lowered in sedentary work and it can be counteracted by drugs and rest.
but there is no consistent correlation with visual performance or subjective fatigue. He also found that different types of physical exertion produce variable effects on flicker fusion frequency.

Buhler (1961) conducted a study on the surgical patients. Pre-surgical condition was assumed to be more stressful as compared to post surgery. Experimental group consisting of 30 patients was tested 24 hours before the surgery and after recovery from operation. Control group consisted of hospital employees who were tested with a 7 days interval. Systolic BP and self rating questionnaires were used as confirmatory measures. The results showed a significant decrement in CFF values in stressed condition. So, it was concluded that stress leads to a decrement in CFF.

Kötter, Schrader and Karl (1964) compared the CFF threshold after short physical exercise and several hours of class room work. In both the cases, there was a decrease in CFF. It shows that both physical and mental work, lead to a decrement in CFF.

Wang (1965) in a study measured before and after CFF threshold of punch operators, calculators, and dispatchers on duty. CFF was highest for key puch operators and calculators before work with gradual decrease on job. It increased slightly after each short break but never
reached the initial level. No change in CFF was reported for dispatchers in day shift. The authors have suggested that it can be successfully used as an index of fatigue of CNS.

Bradenkamp (1966) has found moderately positive correlation in changes in CFF under high and low stress conditions.

Hashimoto (1968) used CFF along with various physiological measures—EEG, HR and GSR. It was seen that mental performance began to impair when flicker values reached 85 to 92% of the rest values.

Grandjean et al. (1971) conducted a study on 68 air traffic controllers at Zurich Airport. Self rating questionnaires, catecholamine excretion, tapping test, grid tapping and CFF were used as dependant variables. All the tests showed a significant agreement. CFF showed a moderate decrease during the first six hours of work and a marked decrease in the following four hours. These results clearly show that as the level of stress increases, there is more decrease in CFF threshold.

Stewart et al. (1971) studied the relation of CFF with stress induced by shock presented at random intervals without warning, on 23 male undergraduates. 3 blocks of trials were given for CFF. In first and third block, no
shock was given but during second block Ss received random shocks. CFF threshold declined during the shock trials.

Nagatsuka (1975) conducted 3 experiments on 30 university students. He employed both apparent movement and CFF as dependant variables. Three conditions were used in the experiments—short term physical loading, short term mental loading, and long term measurements for 6 days. The results showed an increment in the apparent movement scores but no change was observed in CFF scores.

Baschera and Grandjean (1979) employed CFF and subjective state questionnaires during repetitive tasks of different difficulty levels. In lowest difficult task CFF showed a marked decrease. The same changes, however, less pronounced were found for most difficult task. However, both parameters showed minimal changes in the task with a moderate degree of difficulty.

Urgelles and Luis (1982) reported on the basis of their study that when work effort reached anaerobiosis level, CFF decreased as a result of central inhibition.

In a study, Payne (1982) found an increment in CFF under conditions of mental activity. 21 under-graduates were measured on CFF after 2 minutes rest after the performance of a mathematical counting exercise and after another 2 minute rest, CFF was significantly higher following the counting exercise than after the rest.
Kakimoto (1984) gave different levels of mental stress to the Ss. One group consisting of four male Ss was given different cognitive tasks (DCT) for 120 min. and four male controls were required to perform a single cognitive task (SCT) for 40 min. For five consecutive days, Ss performed these tasks in two sessions at morning and afternoon. Changes in performance were evaluated by Ss' complaints of fatigue, catecholamine excretion, and CFF. The results showed that in experimental group CFF values based on pre-work values decreased gradually during the experimental session. In control group, there was a tendency to increase CFF in afternoon. At the end of five days, mean CFF values of control group were almost similar to pre-work values. These results show that fatigue/stress accumulated in the experimental group and as the level of stress increased, there was more drop in CFF.

Summarising the results of above studies, it is evident that the lower level of stress increases the flicker fusion threshold compared to lowering of CFF as a result of high stress.

Stress and Performance:

The studies related with stress and performance employ various methods of inducing stress including both failure and task stress and performance has been measured on a variety
of tasks such as verbal, perceptual-motor, psycho-motor and so on.

Thorndike and Woodyard (1934) induced stress by pacing the task at various speeds, and the inherent difficulty of the arithmatic problems. As a result, there was a reduction in the rate of learning and failure on 19 out of 20 items.

Similarly Zander (1944) observed impairment of digit span in 5th and 6th grade children when the difficulty level of the material was increased by increasing the number of digits presented beyond the normal span.

Verville (1946) found longer reaction times for completing pictures that were flashed on a screen, when Ss were given unsolvable tasks prior to the measurement of reaction time. Slower reaction times were also found by Verville for Ss who were required to solve a number of difficult problems simultaneously before the test of reaction time. Lindsley (1946) found an increase in speed accompanied by an increase in errors as a result of stress.

One of the most intensive attempts to use stress as a device for personnel selection for 'Aviation Psychology Program' of the Army Air Forces, was made by Melton (1947). He used various tasks such as steadiness, aiming etc. to measure the effects of verbal threat and distraction upon performance. This data was later
analysed by Lazarus, Deese and Osler (1952). They revealed that wherever it can be established that stress produced an effect, the effect seemed to be a small decrement in performance.

McClelland and Apicella (1947) used card sorting as the experimental task and found that stress induced by false failure scores resulted in more trials before the criterion was reached. Thus, a poorer performance resulted as a result of inducing stress.

Postman and Bruner (1948) studied recognition thresholds under stress using three-word sentences. Psychological stress produced by failure and ridicule resulted in poorer performance. However, in this investigation, stress was administered during the actual performance, the results in large part may have been due to distraction.

Zeller (1950), working with non-sense syllables, found a decrement in recall and relearning following an experience of failure. He accounted this decrement to repression of items associated with failure. He reported an improvement in recall and relearning when the knowledge of failure was removed.

In 1951, Sant' Anna demonstrated a decrement in performance as a result of stress produced by fatigue.
He conducted a study on students of an industrial school. Ss were required to count mentally the number of even digits in 160 numerical series of 7 digits each. Each series consisted of both even and odd items. Results showed a significant decrement in number of correct answers in the last 80 items compared to first 80 items of the list.

McKinney et al. (1951) reported two types of reactions to stress in a study. Most Ss speeded up performance at the expense of accuracy and were more variable, while a few Ss showed a stable performance. As a whole, the stressed Ss showed a reduction of efficiency in performance in terms of the percentage of correct items to the numbers attempted.

Clark and McClelland (1951) reported that Ss with mild fear of failure performed better, particularly towards the end of a test. It shows that a mild degree of stress may have a facilitatory effect on performance.

Ross, Hussman, and Andrews (1954) investigated the performance decrement produced by the stress of fatigue and threat of bodily damage occasioned in the competitive athletic sport of boxing. The dependant variables included steadiness score, body sway score, body sway test, and CFF. Steadiness, body sway and CFF were significantly
lowered by fatigue. The authors also reported that steadiness scores were most affected by fatigue.

Gibson (1971) conducted a study on 90 male naval officers. A 3X3 factorial design was employed using a complex perceptual-psychomotor task. Stress was induced by an electric avoidance shock as physical threat. It was found that performance was adversely related with both proximity and frequency of occurrence of the shock.

Carron and Ferchuk (1971) induced stress by physical work of pedaling a bicycle ergogram. The effects were studied on performance and learning of a gross motor task, the stabilometer. All Ss were given 32 practice trials over 3 sessions. 1 and 2 trials were performed under no stress for both the groups. Experimental group was then required to perform under conditions of physical fatigue during trials 3-26. Trials 27-32 were similar to trial 1 and 2. Results indicated that physical fatigue deteriorated both the performance and learning of experimental group.

Davey (1973) studied the effect of physical exertion on mental performance. The main conclusions of the study were that moderate physical exertion leads to an improvement of mental performance, a very severe exertion leads to a deterioration, and an intermediate level of physical exertion produces different results in different subjects.
Pack, Cotten, and Biasiotta (1974) investigated the effect of physical fatigue on performance and learning of Bachman Ladder task. 48 male college physical education students were randomly assigned to four groups. Different levels of fatigue as determined by heart rate (Control, 120, 150 and 180 bpm) were assigned to each group. Each subject was fatigued to his assigned level prior to the task and following each trial. 20 trials were given. Learning and performance data showed that performance was deteriorated at 150 and 180 bpm levels. So, it showed that strenous physical stress has a deteriorating effect on performance.

Cochran (1975) investigated differences in learning to perform a novel motor task between 2 groups. One group learned the task following a physical exercise and the other without any exercise. The fatigued group performed significantly better than the non-fatigued group. It shows that there is a favorable effect of fatigue on performance.

In a study, Williams and Cooper (1976) gave 75, 10 sec. trials on a novel tracking task on 58 female students over 2 days. Following the first three trials under non-fatigue condition, the experimental group performed a 4 min initial exercise. Further one min
exercise was interpolated between one min. period of continuous practice on the learning task. The control group followed the same procedure except that a vowel cancellation task was substituted for the exercise task. Results showed that fatigue produced little or no impairment in the learning or performance of the motor skill. However, in this study, level of fatigue was very low, so it had very little effect on performance.

Dickinson (1979) conducted an experiment to study the effect of preliminary exercise on performance and learning of the Fitt's reciprocal tapping test. Preliminary exercise was performed by 10 volunteer students with either preferred or non-preferred arm. The tapping task was performed with preferred hand. The results showed an increased performance in both preferred and non-preferred hand groups, in low levels of stress. In higher stress group a decrement in performance was observed for the preferred hand group. In another experiment by the same authors, on 22 Ist class long distance runners, preliminary exercise was provided by treadmill running to exhaustion. In this experiment facilitatory effect on tapping performance was obtained even after exhaustive levels of running.

Singh & Singh (1985) examined the relation between job anxiety and vigilance performance in locomotive
drivers. Twenty cards of various difficulty levels were tachistoscopically presented with two exposure times and two noise intensities. Immediate correct recognition of the signal was the index of vigilance performance. The results showed the lowest performance with high noise and low exposure time. Significant correlations were also found in job anxiety and vigilance performance.

Hancock and McNaughton (1986) conducted a study on 6 experienced orienteers. The Ss were given a Vo 2max treadmill task prior to the visual perception tests. The visual perception tests were given either in a state of rest or in a fatigued state i.e. when Ss were working at or above their anaerobic threshold. The results showed a significant difference between fatigue and rest scores. This data suggested that under the influence of fatigue, an orienteer's ability to perceive visual information is greatly impaired.

This review of studies shows that effect of stress on performance largely depends on the level of stress used. Low stress has been usually found to have a facilitatory effect on performance, whereas higher level of stress has a deteriorating effect. Besides this, the effect is very task specific. In some tasks, there is more deterioration in performance as compared to other tasks.
With this background we may pass on to the next chapter to formulate the exact problem and various hypotheses.