The term stress is commonly used in ordinary conversation to refer to all sorts of difficulties: the popular notion of stress seems to be rather vague and intuitive—it is something that every one feels from time to time, a problem that can be recognized from experience and need not be defined in precise terms. There is no agreement among researchers about the best scientifically useful definition (House, 1974). However, stress refers to a situation of threat, frustration, or conflict that strains the physiological or psychological abilities of the individual (Asthana, 1985). In short, stress refers to any force which physically and/or psychologically strains the coping mechanisms of an organism (Baron, Byrne, & Kantowitz, 1980).

Stress has become a popular concept for explaining a wide variety of outcomes, mostly negative, that otherwise seem to defy explanation (Baum, Singer, & Baum, 1981). In the scientific realm, stress has been used as a psychological precursor of illness, as a result of any number of conditions, or as a catch-all for anxiety reactions, discomfort, and the like. It is also fashionable to attribute erratic or unexplainable behaviour of friends and acquaintances to the fact that "they are under a lot of stress". From a cursory reading of psychological and medical texts and from simply listening to people, one can derive a fairly broad definition of stress. Yet, despite its general use, stress refers to a process that is not only specific, but also central to the
relationship between organisms and their surroundings.

Stress may be caused by an unpleasant, painful, dangerous, embarrassing, or otherwise aversive event. Two kinds of stressors have been distinguished: physical or environmental stressors, which confront the organism with physical danger of discomfort, and psychological stressors, which threaten a person's psychological integrity or well-being.

Environmental or physical stressors include such stimuli as high-intensity noise, crowding, extremes of temperature, acute sensory deprivation, social isolation and electric shock. Since these stimuli can be quantified, it is often possible to specify the parameter of environmental stressors by measuring their intensity or their duration (Bell, 1981). Threats to self-esteem, failure in an intellectual task, interaction with a hostile person, and frustration of personal goals are among the many events that have been used in studies of psychological stress (Lazarus & Cohen, 1977).

Stress is a process in which environmental events or forces, called stressors, threaten an organism's existence and well-being, and the organism responds to this threat. The stress reaction, replete with commonly known symptoms such as fear, anxiety, and anger, is only part of this
process. It is probably the most easily recognized, but in many cases may simply represent "sideeffects" of the main attraction—perceiving a threat, coping with it, and adapting to it. This adaptation sequence is almost a daily routine—our lives can be characterized as constant adaptation to sudden change or gradual evolution of our surroundings. Sometimes these changes are minor and we can adapt to them without even being aware of them. At other times, however, these changes can be severe and clearly threatening.

The first systematic treatment of stress were those provided by Hans Selye (1956, 1976), a Canadian Physician and a biomedical researcher, who discovered that when animals were exposed to a variety of demanding conditions (for example, abrupt changes in temperature, injection with toxic material), they exhibited a common set of physiological symptoms: enlargement of the adrenal glands, shrinkage of the lymphatic (immune) system, and the formation of gastrointestinal ulcers. Selye (1956) referred to this triad of symptoms as the General Adaptation Syndrome (GAS), and posited that it occurs in response to a diversity of stressors—environmental demands that tax or exceed the animal's adaptive capacity.

The GAS is based upon the idea that body has a systematic reaction to stress-inducing agents (stressors), it can cope with stress but that this coping has costs for
subsequent coping. GAS consists of three successive stages - alarm reaction, resistance, and exhaustion. When first exposed to stressor, the body responds by mobilizing its coping abilities; this alarm reaction represents preparation for resistance. When these reserves are made ready, the body enters a stage of resistance, applying various coping mechanisms and typically achieving suitable adaptation. When these reactions are repeated often, or when coping is not successful, however, adaptive reserves are depleted, and the organism enters a stage of exhaustion. At this point resistance declines, physiological breakdown occurs and the body becomes high susceptible to disease.

The importance of cognitive and emotional processes in stress was recognized by Lazarus (1966), who developed the concept of psychological stress. According to Lazarus, psychological stress arises whenever the individual appraises the environment as treatening—that is, as potentially uncontrollable and harmful. Psychological stress, thus, occurs when perceived environmental demands exceed the individual's perceived ability to cope. The experience of psychological stress triggers a variety of emotional, physiological, and behavioural reactions (such as anxiety, elevated blood pressure, impaired task performance), the severity of which depends on the degree of threat perceived by the individual.

A stressful situation occurs when there is a substantial imbalance between demands imposed upon an organism by the
environment and the organism's ability to cope with those demands. Thus, stressful situation can arise due to two things - one, environmental overloads, and other, environmental underloads. Since many physical situations evoke similar physiological patterns of response, psychological aspects often are more important in determining stress than the physical aspects of a stressful situation (Cohen, Glass, & Phillips, 1977).

Symptoms of stress usually include anxiety, irritability, high blood pressure, fatigue, inability to concentrate, and many other autonomic responses like Galvanic Skin Responses-G.S.R (Katkin, 1965), heart rate (Hodges & Spielberger, 1966), hyper tension (Kagan & Levi, 1974), etc. The state of stress is often identified with its accompanying neuroendocrine changes (Frankenhaeuser, 1978). It has also been observed that stress increases the weight of the adrenal gland (Hamilton, 1974; McCarty, 1974), and plasma cortico steroid levels (Gisler, 1974), but decreases the weight of spleen and thymus (Hara, Manabe, & Ogawa, 1981). It has also been identified with elevated plasma hydrocortisone level, heightened urinary corticosteroid secretion, and elevated serum cholesterol levels (Hamburg, 1961). Certain neuroendocrine changes, like plasma corticosterone level which are indices of stress (Hamilton, 1974), are also used as parameters of emotionality (Gentsch, Lichtsteiner, & Feer, 1981). Thus, stress and emotionality both often possess common identities.
The stress conditions that have been studied in laboratories include odors (Mohanty & Dash, 1987); neonatal stress (Moberg & Wood, 1981); fasting, exposure to cold, and body restraint (Natelson, Hoffman, & Mckee, 1979); handling (McCarty & Kopkin, 1979); immobilization (Silva, Campos, & Carlini, 1980); tail pinching (Morley & Levine, 1980); ether (Sieck & Ramaley, 1975); hypertonic saline injection (Rottman & Snowdown, 1972); novelty (Pare, 1974); water immersion (Jacobs & Sorenson, 1969); electric shock (Desiderato & Testa, 1976; Misra & Mohapatra, 1984; Mohanty & Mohanty, 1987; 1988); unpredictability (Weiss, 1968); conflict (Weisz, 1957); predator stress (Hamilton, 1974); inadequate living space (McCarty, 1974); illumination (Mohanty & Mishra, 1987; Mohanty & Swain, 1987); noise (Cohen, 1980; Glass & Singer, 1972); crowding (Epstein, 1981; Nagar & Pandey, 1987; Pandey & Nagar, 1987); high temperature (Bell, 1981); sensory deprivation (Das, 1984; Das, Das, & Mohanty, 1987; Mohanty, Mishra, & Pradhan, 1984; Pradhan, Das, & Mohanty, 1984), and social isolation (Mohanty & Mishra, 1984; 1988), etc.

Environmental stress, generally, includes crowding stress, loud noise, extreme heat or temperature, pollution of air, perceptual impoverishment (i.e., sensory deprivation), and social impoverishment (i.e., social isolation). In recent years much emphasis has been placed on the various effects of environmental stress, particularly, sensory deprivation and social isolation, by the researchers (Benton & Brain, 1981; Das et al., 1987; Mohanty & Mishra, 1988; Nabert, 1983; Uttarkabat & Jena, 1987).
The term 'environment' as used in psychology has a wider meaning than ordinarily understood by the layman. It describes the sum total of physical and biotic conditions influencing the responses of organisms. In other words, mere presence of physical objects does not itself constitute an environment unless these objects become stimuli for the individual.

Experiences of an organism early in life exert a pervading influence on its behaviour later in life. Differential rearing early in life of the animals involves differential early experiences. Experience is defined as a function of both external conditions and nature of experiencing organism (Escalona, 1968). The term 'early experience' is used to refer to environmental events (stimulations) that act upon the organism in the developmental period. Early experience is both immediate and long lasting. In the terminologies of Rosenzweig (1971), and Sahakian, Robbins, and Iversen (1977), rearing conditions are crucial determinants of adult behaviour and brain development.

The main experimental manipulations in the studies concerning the effects of experience in differential environments on subsequent behaviours and on brain measures has been to place animals for various periods of time in laboratory environments that are either more complex, free and enriched than standard housing cages or that are more restricted and
impoverished than the standard laboratory condition. In other words, these studies focus on two types of environments: (i) enriched or supernormal stimulation, and (ii) impoverished or subnormal stimulation.

Another parameter or dimension of differential rearing is that rearing the animals either in groups or in isolation for various durations of time. Group-rearing provides extra experiences, more sensory, perceptual, and social stimulations. Isolation-rearing, on the other hand, reduces minimum level of sensory, perceptual, and social stimulations.

Social interactions among animals depend upon the social crowding of animals. Thus, group-rearing of animals provides social interactions among themselves, whereas it is absent in isolation- or individual-rearing. There are various elements of social interactions, such as, olfactory, tactile, visual stimulations, postures, gestures, proximity, and eye movements.

Social interaction system can be classified as intragroup and intergroup. Intragroup interaction is more effective than that of intergroup interaction. An animal, reared in an environment that is low in sensory, and perceptual stimulation, and does not allow opportunities for interaction with other members of its species during some period of early life, will be socially, emotionally, and perhaps, intellectually inadequate (Gardner, Boitano, Mancino, D'Amico, & Gardner, 1975).
While placing the rats or mice in differential en-
vironmental conditions for rearing, the commonly used durations
of rearing are as follows: for 15 days (Mohanty & Mishra,
1984; Mabert, 1983; Syme & Syme, 1976; Turpin, 1977); for
30 days (Ferchnin, Bennett, & Rosenzweig, 1975; Gutwein &
Fishbein, 1980; Levitt & Bennett, 1975; Misra & Mohanty, 1981;
Misra & Parida, 1981); for 45 days (Camallo, Villanua, &
Beato, 1986); for 60 days (Chang & Chung, 1983; Das, 1984;
Das, Das, & Mohanty, 1987; Einon & Morgan, 1976; Mohanty &
Mishra, 1988; Uphouse & Brown, 1981; Weinstock, Speiser, &
Ashkenazi, 1978); for 100 days (Einon, 1980; Pirta, Uttarakabat, &

Early experience is more effective than the same experi-
ence later in life (Hymovitch, 1952). Thus, the age at
which differential rearing was begun is very important. The
early post-weaning differential rearing usually, begins at
17 days of age (Sahakian, Robbins, & Iversen, 1977); at 21
days of age (Watson, Henry, & Haltmeyer, 1974); at 23 days
of age (Chang & Chung, 1983); at 25 days of age (Syme &
Syme, 1976; Will, Pallaud, Ungerer, & Ropartz, 1979); at
26 days of age (Mohanty & Das, 1984; Mohanty, Mishra, &
Pradhan 1984); at 28 days of age (File, 1978; Uphouse &

The observed effects of perceptual impoverishment (i.e.,
sensory deprivation stress) and social impoverishment (i.e.,
social isolation stress) can be categorised under:
(a) physical and physiological, (b) psychological, and
(c) biochemical. The physical and physiological effects
of environmental stress include poor dendritic branching
(Greenough & Janice, 1979; Rosenzweig & Bennett, 1977);
increased adrenal function (Camallo, Villanua, Trancho, &
Fraile, 1986) and increased adrenal weight (Uphouse &
Brown, 1981); and loss of weight of cerebral cortex (Das,
Das, & Mohanty, 1987; Rosenzweig, Bennett, & Diamond, 1972).

The psychological effects of environmental stress (i.e.,
sensory deprivation stress and social isolation stress)
include increased emotionality or fearfulness (Das, 1984;
Mohanty & Mishra, 1984; 1988; Nabert, 1983); hyperactivity
(Chang & Chung, 1983; Chivers & Einon, 1982); reduced
exploration (Einon & Morgan, 1976; File, 1978; Hopf, Herzog, &
Floog, 1985); reduced general drive level (Guyot, Bennett, &
Cross, 1980; Mohanty, Mishra, & Pradhan, 1984); decreased
body weight, decreased feeding and drinking behaviours
(Camallo, Villanua, & Beato, 1986); impaired ability to
acquire and retained new learning afterwards (Gardner,
Boitano, Mancino, D'Amico, & Gardner, 1975); impaired
intellectual efficiency (Basavanna & Rani, 1984; Evans, 1984),
deteriorated learning performance (Einon, 1980; Lin & Tang,
1984; Misra & Jena, 1987); and impaired cognitive abilities
(Misra, Mohanty, Mishra, & Mohanty, 1987; Pradhan, Das, &
Environmental stress (i.e., sensory deprivation stress and social isolation stress) has been shown to cause biochemical and other changes in the normal functioning of the central nervous system (Selye, 1976). The biochemical effects of environmental stress include a decreased in acetylcholinesterase (AChE), cholinesterase (ChE), and monoamine oxidase (MAO) activity per unit weight, especially in the cortex (Bennett, Diamond, Krech, & Rosenzweig, 1964); reduced corticosterone levels (Gentsch, Lichtsteiner, & Feer, 1981); and lower noradrenaline turnover in the brain stem and noradrenaline and dopamine turnover in all other areas except the cerebellum (Weinstock, Speiser, & Ashkenazi, 1978).

The effects of environmental stress (i.e., perceptual impoverishment and social impoverishment) on emotionality, exploration, activity, drive level, learning, and cognitive abilities are reviewed in the next section.
Review of Literature

Environmental stress and Emotionality

Hill (1954) first used the term "emotionality" to conceptualize behavioural and peripheral changes presumed to accompany high sympathetic nervous activity. A number of test situations have been used since then to measure the relative emotionality and activity of animals. These tests include several types of novel environments in which the animal is simply placed for observation.

The novel environments include open field (Hall, 1934; Valle, 1972; Walden, 1968), enclosed maze (Halliday, 1967; Lester, 1968), combined maze and open field (Battling, 1969), exploratory box (Welker, 1957), open arena (McClearn & Meredith, 1964), and runway (Howarth, 1962).

Timidity tests of emotionality include emergence from homecage (Furchtgott & Cureton, 1964), emergence from cage to runway or maze (King, 1968; Montgomery, 1955), whole in the wall test (McClearn & Meredith, 1964), and reaction to handling test (Ader & Flaut, 1968). In addition, measures taken in active and passive avoidance conditioning situations also have been used to measure emotionality.
Tests of emotionality or fearfulness in an open field have been widely used in experimental studies of rodent behaviour. There are, however, conflicting viewpoints on the usefulness and validity of such tests. Ader (1969), Imada (1972), Paré (1964), Tobach and Schneirla (1962), among others, provided evidence questioning the validity of open field tests of emotionality. Some others (Broadhurst, 1969; Denenberg, 1969; Gray, 1971), however, recommended continuation of this test. Archer (1973), and Walsh and Cummins (1976) viewed open field as a useful and valid test of emotionality.

In the open field test of emotionality, several behaviours, such as ambulation, thigmotaxis, rearing, grooming, freezing, defecation, urination, etc., have been commonly used to denote emotionality of the subjects. Sometimes, defecation, ambulation, and rearing have been found to be reliable indices of emotionality. Urination, grooming and centre entries have been found to be less reliable measures of emotionality (Ivinskis, 1966). Defecation, considered to be the most valid measure of emotionality (Blizard, 1971; Broadhurst, 1969; Whimbey & Denenberg, 1967), has been frequently used along with other measures.

Ambulation refers to the locomotion of the subject in a unit time. Thigmotaxis or wall-hugging behaviour refers to the tendency of the animal to move along the walls of the open field. The more the wall-hugging or less the thigmotactic
Ambulation in an open field is often found to be positively correlated with rearing (Blizard, 1968). Rearing may be regarded as a form of exploratory behaviour (Archer, 1973). "Rearing ups" of the subject refers to standing of the animal by its hindlegs. In experimental literature, face washing and body washing are sometimes termed as preening and grooming, respectively. Some of the researchers, however, regarded both face washing and body washing as grooming (Archer, 1973). Passivity, in an open field, is termed as immobility, or freezing (Archer, 1973). Passivity bouts and passivity times are two important measures of immobility (Price & Huck, 1976).

Animals are found to be emotional when they are exposed to different stressful conditions, such as, open field, swimming tank, enclosed maze, and other confinement conditions. Sometimes, the subjects are reared under social isolation, sensory deprivation; exposed to prenatal stress; administered with electric shock; subjected to body restraint, loud noise, high temperature, high illumination, handling, or other stressful stimuli. Thereafter, the animals are tested in the open field, thus, making the stress effect more pronounced. Sometimes, also, the open field itself is made more stressful by increasing its level of illumination, novelty, or complexity.
A number of studies were done to find out the effect of environmental stress on emotionality of animals. Most of the studies done in this regard took such stresses like high illumination, loud noise, crowding, social isolation, perceptual stimulus deprivation, etc., as independent variables to measure dependent variables like emotionality, activity, etc. One of such studies was conducted by Hall (1934), who observed albino rats in an open field which was quite novel, well illuminated, and several times larger than the homecage, with floor marked into subdivisions. It was observed that the rats showed fear responses in the open field by defecating and urinating more in comparison with that in their homecages.

In a similar study, Parker (1939) observed emotionality of the albino rats under different test situations (e.g., open field, swimming tank confinement). The animals were found to be more emotional as measured by high frequencies of defecation in all the tests. Gandland and Campbell (1962) also observed that rats defecate at a higher rate in the open field.

Some studies have also reported increase in defecation along with decreasing ambulatory activities in an open field test. Whimbey and Denenberg (1967) exposed rats to an open-field like that of Hall (1934). The animals showed higher rates of defecation and lower rates of ambulation, demonstrating higher levels of emotionality in the open field.
Candland and Nagy (1969) used cardiac measures of emotionality in order to validate the use of the two most commonly used indices of emotionality—ambulation and defecation. The investigators exposed the CPE strain of rats to the open field and compared their scores with that of the homecaged animals. The cardiac rate and defecation of animals were found to be higher in the open field. However, both the measures changed in stable fashions but changed in largely independent ways. Both were considered as suitable indices of emotionality. No consistent relationship between cardiac rate and ambulation was observed.

Some investigators measured wall-hugging activities of animals in the open field as a measure of emotionality. Ader and Conklin (1963) took 138 rats and exposed them for one minute each in a novel circular field. The results revealed that only 15 per cent of the subjects entered into the inner concentric circles. It, therefore, seems that rats always prefer to stay nearer to the walls of the apparatus probably due to fear of the novel environment.

Similarly, Smith (1972) exposed mice to an open field and observed that the subjects not only defecated more but also showed tendencies to keep nearer to the wall. Thus, a close positive association between defecation and wall-hugging tendency was indicated. However, in different studies on Wistar and Sprague-Dawley rats, the coefficients
of correlation between defecation and four other open field measures (such as, grooming, latency to move from the first square, orientation away from the periphery, and rearing) were not found to be significant (Gray, Levine, & Broadhurst, 1965; Ivinskis, 1966).

Face washing behaviour, observed during open field tests, has been used as an index of emotionality. It has been found that rats, when under fear and conflict, exhibit more face washing responses (Thompson & Higgins, 1958). Grooming (which includes washing of face and other parts of the body), and defecation of the wild rats, when exposed to an open field (which appears to be quite stressful for them), are also found to be higher than that of their domestic counterparts (Huck & Price, 1975; Hughes, 1975). In another study, Price and Huck (1976) exposing wild and domestic Norway rats to the open field found that the wild rats spent more total time grooming than the domestic rats. However, when the grooming time was analysed in terms of body grooming and facial grooming, the wild rats spent proportionately less time in facial grooming.

Some studies have been conducted to find out the effect of illumination stress on open field emotionality of rats. For example, Valle (1970) exposed black hooded rats to a white open field under different levels of illumination. It was found that ambulation, rearing, and thigmotaxis (entering
into central region) were all less under higher level of illumination. Thus, high illumination increased emotionality of animals.

Similarly, Blizard (1971) exposed albino mice to open field tests. He observed that increased illumination caused a significant increase in the amount of defecation and decreased rate of ambulation in the subjects. Thus, high illumination was considered to be stressful, and defecation was considered as the prime index of emotionality. However, Broadhurst (1957), exposing rats to high stimulus intensities (like, high illumination and high noise conditions), observed higher rate of defecation but no significant change in ambulation.

Similar results were also found by Williams (1971), taking both hooded and albino rats as subjects. High illumination increased the rate of defecation of both strains of rats, and thus, caused emotionality in them.

In another study, Rath and Katz (1979) tested a standard, relatively nontraumatic, stress induction procedure (noise, and bright light exposure before open field testing and 2 hours after the onset of the dark portion of a 12-12 hour light-dark cycle). Data from 245 adult male Sprague-Dawley rats showed that pre-exposure to the moderately intense light and white noise facilitated open field
activity as measured by initial activity, defecation, rearing, grooming, and centre-field proportion assessments.

Delay and Isaac (1980) reported the effects of illumination, dextroamphetamine, and methylphenidate on behaviour of four squirrel monkeys. Defecation rates of an auditory signal were higher in the light than in the dark. Although myethelinadate did not alter performance, dextroamphetamine affected behaviour of monkeys in the light more than in the dark, particularly in male subjects.

In a study, Crow, Terry, and June (1984) investigated the effects of three conditions of illumination during rearing on specific components of phototactic behaviour of marine mollusk. Rearing in the dark resulted a significant increase in the variability of positive phototactic behaviour of adults as decreased responsiveness to illumination.

Mohanty and Mishra (1987) designed an experiment to study the effects of handling and levels of illumination on the open field emotionality and spontaneous motor activity of Wistar strain male albino rats. The indices of emotionality observed in the open field were ambulation, thigmotaxis, rearing, grooming, defecation, and urination. Analysis of the results revealed that handled animals were found to be less emotional on all the above measures of emotionality, and also exhibited less spontaneous motor activity than their
non-handled counterparts. Moreover, animals tested under high illumination were found to be more emotional on all the above indices of emotionality, and also showed more spontaneous motor activity in comparison to the rats tested under low illumination. It was, therefore, concluded that high illumination condition was stressful, and thus, made the subjects more emotional and more active, whereas handling experience of the animals reduced their stress, and thus, made them less active and less emotional.

A similar experiment was designed by Mohanty and Swain (1987) to find out the effects of varying levels of field illumination during testing on the open field emotionality of Wistar strain male albino rats. The indices of emotionality observed were ambulation, thigmotaxis, rearing, grooming, defecation, and urination. The five illumination conditions under which the subjects were observed in the open field were: low illumination, low-high illumination, random variations of illumination, high-low illumination, and high illumination. Analysis of the results revealed significant effects of varying levels of illumination on three indices of emotionality such as, grooming, defecation and urination, whereas other three measures of emotionality—ambulation, thigmotactic ratio, and rearing—remained unchanged. Multiple comparisons indicated that both the groups of rats tested under high illumination and under random variations of illumination were found to groom more, defecate and urinate more in comparison to other three groups of rats. Although the differences among
five groups of subjects in ambulation, thigmotactic ratio, and rearing could not reach the level of significance, both the groups tested under high illumination and under random variations of illumination tended to ambulate less, rear less, and spend more time near the walls of the open field in comparison to other groups of subjects. It was therefore concluded that high illumination as well as random variations of illumination were stressful and thus, augmented the open field emotionality, and reduced the locomotor activity of rats.

However, Nagy and Glaser (1970) could not find any significant effect of illumination on defecation and other emotionality measures. They exposed pigmented C57 BL/6J mice to different illumination levels but could not find any such differential effects. However, significant interactions between level of illumination, age of subjects, and day of testing were noted. Under high illumination, there were no reliable activity differences due to age, and under low levels, 100 day-old subjects were more active than that of 50 day-olds. The subjects were less active under high than under low illumination on days 1 and 2 of testing but not thereafter. The results suggested that illumination effects were largely transitory for the C57 BL/6J strain mice.

Thus, it could be seen that the results with regard to the effects of illumination stress on emotionality are not quite convincing.
High levels of noise are generally regarded as potent environmental stressors. Livesey and Egger (1970) exposed albino rats of different age groups to white noise of 90 db in an open field and found an increase in defecation and ambulation.

Similarly, Cohen, Krantz, Evans, and Stokols (1979), and Cohen, Evans, Krantz, and Stokols (1980), basing on their experimental findings, reported that exposure to community noise or airport noise had deleterious motivational, physiological, and cognitive effects on children.

In another study, Bell (1981) discusses the consequences of prolonged exposure to heat or high temperature, noting that the performance of acclimatized subject is less affected than that of unacclimatized subjects. It was concluded that extremely high temperature may override the recipient's use of defense mechanisms and may produce debilitating reactions despite resistance.

Some investigators have also observed the effects of crowding stress on emotionality of animals. In a study with male and female Sprague-Dawley albino rats, Morrison and Thatcher (1969) reported that rats, reared in high population density, show more emotionality with decreased body weight.
Another similar study was designed by Levitt and Bennett (1975) to find out the effect of "crowding stress" on emotionality. They used male Charles River albino rats. The animals were either preexposed to circles and triangles in a visually sparse environment or were deprived of all such early experiences with the shapes. Subjects of each treatment condition were initially placed either in a crowded or uncrowded environment. Approximately one month later, half of the rats of each population density condition were shifted to the opposite population density condition. There was no change of population density for the other half. Results indicated that subjects living in an uncrowded condition for the entire experiment, were found to be less emotional than that of the subjects living in a crowded condition for the same length of time. The group of rats living in a crowded condition for one month did not differ from the group of rats crowded for two months on the measures of emotionality. Subjects living in an uncrowded condition for one month or more, immediately after weaning, were less emotional than subjects living in a crowded condition during the same interval. In general, subjects preexposed to the discriminated forms learned the discrimination task in significantly fewer trials than the subjects not receiving such early stimulus preexposure. Subjects that were crowded one month immediately after weaning were poorer performers on the discrimination learning problem than the uncrowded subjects during the same period. In short, it was concluded that the "crowding stress" increased emotionality and decreased discrimination performances.
Misra and Mohanty (1981) designed a similar experiment to find out the effect of spatial density on emotionality, activity, and exploration. They used female Wistar strain albino rats as subjects. All the subjects were divided into four equal groups, and the subjects of each group lived together in four different sized cages for one month prior to testing. Results revealed a significant effect of spatial density on emotionality but had no significant effects on exploration and activity. Ambulation, rearing, urination, and time to leave start box were found to be reliable measures of emotionality.

Similarly, Gamallo, Villanua, and Beato (1986) studied the effect of being reared in a crowd for six continuous weeks postweaning on body weight gain, food intake and gland weight (thymus, adrenals, and testes) in 40 Sprague-Dawley adult male rats. Crowded rats showed a significantly lower body weight at the end of the crowding period than did controls. Crowd-reared subjects also had significantly lower thymus weight and higher adrenal gland and testes weights as compared with controls. Food intake was similar for both groups. Thus, it was concluded that decreased body weight and thymus weight, and increased adrenal weight and testes weight, were indicative of more emotionality in crowd-reared rats than that of the controls.

However, Misra and Parida (1981) did not find any such effect of crowding on emotionality, spontaneous activity,
and exploration. They reared four groups of male adult albino rats of Wistar strain, eight per group, for a period of 30 days in four differing group sizes. The group sizes were one per cage, two per cage, four per cage, and eight per cage, keeping the cage space constant per individual rat. When tested for emotionality in an open field, spontaneous activity in a photoactometer, and exploration in an exploration box, it was found that the four treatment groups did not differ significantly in these three dependent measures. It was, therefore, concluded that crowding may not adversely affect behaviour of animals if available space per individual is kept constant.

Some other investigators studied the effects of "shock stress" on emotionality. For example, Mackay (1966) designed a study to find out the effects of "shock stress" on open field activity and autonomic lability. Rats were exposed to prolonged electric shock, and then they were placed in an open field. Locomotor activity and basal resistance level were observed over two 15-minute-sessions. Results indicated both initial lower arousal for the stressed subjects and faster habituation of the emotional response to the open field, suggesting lability of emotional reactivity. In other words, the shock stressed rats had initially less locomotion, and gradually locomotion increased as emotionality decreased.

Similarly, another experiment was designed by Misra and Mohapatra (1984) to find out the effects of "shock stress"
on emotionality, spontaneous motor activity, exploration, and body weights of male and female Wistar strain albino rats. In order to create stress, the animals were exposed to a mildly painful and unpredictable foot shock. The duration of shock stress was for 15 days, and the observations were made on specified days on which they did not receive any shock. It was found that stressed animals, irrespective of sex, were more emotional on the measures of defecation, urination, retreats, thigmotaxis, and ambulation and thus, were more emotional than their unstressed counterparts. Stress had no effect on spontaneous motor activities of rats. Stress although caused initial fear of the novel and complex stimuli, it had, however, no effect on the investigatory exploration of such stimuli. Stress caused reduction of body weights in animals. However, sex was not found to have significant effects on these four dependent variables.

Another similar study was designed by Mohanty and Mohanty (1987) to find out the effects of "shock stress" on emotionality and spontaneous motor activities of Wistar strain male and female albino rats. The indices of emotionality were ambulation, thigmotaxis, rearing, grooming, defecation, and urination in the open field test. The procedure for inducing stress in the animals were same as described by Misra and Mohapatra (1984), except that the duration of stress was for 12 days. The results revealed that stressed animals, irrespective of sex, were found to
be more emotional on all the above indices of emotionality than their unstressed counterparts. Stress had also a significant effect on spontaneous motor activities of rats. Stressed rats showed more spontaneous motor activity than the unstressed rats. Furthermore, both male and female rats were found to differ from each other on their emotionality. Female animals, irrespective of stress, were found to be more emotional on all the above measures of emotionality than their male counterparts. However, sex had no effect on spontaneous motor activity of rats. Thus, the findings with regard to the effects of shock stress on emotionality and spontaneous motor activity of rats are not conclusive.

Some investigators observed emotional responses to the odors emitted by animals under stress. Stevens and Koster (1972) observed male albino rats on a clean table with extended runways. Earlier, stressed and unstressed subjects were run in these runways. The subjects were found to stop more frequently and for a longer duration in the runways run with stressed predecessors. Moreover, the rats when exposed to the runways run with stressed predecessors had significantly more urination. Thus, it was concluded that the stress odors from the predecessors increased emotionality in the new subjects.
Wuensch (1979) designed another similar experiment in which 16 isolated male Swiss-Webster albino mice were exposed daily for 20 days to soiled litter collected from 32 crowded Swiss-Webster and A/J male mice. Measures of adrenal weight indicated that subjects so exposed showed relative to isolated controls, an increase in adrenocortical activity equivalent to that manifested by crowded subjects. Results suggest that olfactory exposure to compounds excreted by crowded males is sufficient to produce the adrenocortical response typically shown by crowded animals.

Similarly, Mohanty and Dash (1987) conducted another study to find out the effects of stress pheromones and the sources of stress odors on emotionality and spontaneous motor activity of male Wistar strain albino rats. The indices of emotionality observed were ambulation, thigmo-taxis, rearing, grooming, defecation, and urination in the open field test. Results revealed that odors from stressed rats increased both emotionality and spontaneous motor activity of receivers, compared to responses elicited by odors from nonstressed animals. Sources of stress odors had no significant effect on emotionality. However, spontaneous motor activity of the recipients was differentially affected by the sources of stress odors. Urine odor was found to increase the spontaneous motor activity of the recipients more than the bolies odor. Thus, it was concluded that stress odor, like stress itself, potentiates the emotionality of the recipients by making them more restless and aroused.
Some researchers have also observed the effects of prenatal stress on open field activities of animals in a later stage of life. Thompson (1957) observed that prenatal stress produced significant decrease in ambulation, but significant increase in defecation. Moreover, the latency to emerge from the homecage was found to increase significantly in those prenatally stressed animals.

In another study, Ader and Belfer (1962) used prenatally stressed and unstressed Long Evans rats as subjects. At a later stage, the animals were exposed to a circular open field. The results revealed that higher percentage of unstressed animals entered into the inner concentric circles than that of the stressed animals. Further, the ambulation scores of the stressed animals were significantly less than that of the unstressed animals.

However, Joffe (1965a,b) using Maudsley Reactive and Nonreactive strains of rats, some of which were prenatally stressed, observed that prenatal stress produced no effect on open field ambulation and defecation. It was also further observed that prenatal stress produced increased avoidance responses and decreased response latencies in the conditioned avoidance test.

On the contrary, Jolley and Adams (1975) observed a negative relationship between the prenatal stress and
emotionality. They took female rats of Carworth CFE strain and exposed them to high illumination stress during pregnancy. The offspring having gestation stress, when compared with controls, showed higher ambulation and rearing scores but significantly lower defecation scores.

Moberg and Wood (1981) designed a study to find out the effect of neonatal stress in lambs. The experimental lambs were reared in small flocks during their first five weeks of life. During this period they were subjected to neonatal stress three times a week. The neonatal stress conditions were: (a) maternal deprivation, (b) handling, and (c) exposure to Pavlovian conditioning paradigm. The control lambs were reared without being exposed to such stressful conditions. When exposed to stress, the experimental subjects responded with elevated plasma corticosteroid levels and intense vocalization. Later, when both the groups were exposed to an open field, they did not differ in behavioural responses like vocalization, latency to first movement, or locomotion. Thus, the results with regard to the effects of prenatal or neonatal stress on emotionality are inconclusive.

A number of studies have also been conducted on animals and birds to find out the effects of early environmental experiences as stressors on various behaviours. Most of the studies done in this regard took either perceptual experience
or social experience or even both the experiences at a time as independent variables to measure their effects on a variety of dependent variables. The studies manipulating to find out the effects of perceptual experiences reared the animals or birds either in a perceptually impoverished environment, and thus, making the subjects deprived of some sensory stimulations, or in a perceptually enriched environment, and thus, providing the subjects with some extra sensory stimulations. The studies manipulating to find out the effects of social experiences, on the other hand, reared the subjects either in isolation (i.e., social impoverishment), or in groups (i.e., social enrichment). Sensory deprivation and isolation rearing are some of the important environmental stressors.

Koch and Arnold (1972) conducted a study on male Holtzman albino rat pups. These pups were separated from their mothers and then were randomly assigned to different rearing conditions. The rearing conditions were:
(a) living with mother and peers, (b) living with mother and without peers, (c) living in incubators with peers, or (d) living in incubators in isolation. At 65 days of age, the subjects were tested daily in an open field for three minutes over six consecutive days. Higher emotionality (longer emergence latency) was evidenced in maternally deprived subjects. Moreover, lower ambulatory scores and higher urination frequencies were observed in rats reared in isolation.
In another study, Watson, Henry, and Haltmeyer (1974) divided CBA mice pups randomly into handled or nonhandled groups after 24 hours of birth. At age 21, they were all weaned and separated according to sex. Half of males and half of the females of each group were randomly assigned to either socialization or isolation conditions. At four months, all the rats were tested in an open field for four consecutive days. It was observed that the socialized animals were significantly more active (showing more ambulation in the open field) in comparison to the isolated ones.

Huck and Price (1975) investigated the differential effects of environmental enrichment on the open field behaviour of wild and domestic Norway rats. They demonstrated that the early post-weaning experience in an enriched environment had a greater influence on the open field behaviour and body weight of 32 wild Norway rats than that of their 32 domestication counterparts. It was suggested that genetic changes accompanying the domestication process may have reduced the relative impact of post-weaning experience on the development of the domestic subject’s response to changes in its environment.

Klein, Hoffman, and Depaulo (1976) investigated the effects of early social stimulation on the emotional reactivity of ducklings. They took 39 newly hatched khaki
Campbell ducklings which were housed with a conspecific for 24 hours, beginning at either 1 or 5 days of age, or received no social stimulation. When tested on Day 7, subjects afforded early social stimulation exhibited less distress calling and crouching in a novel open field than those exposed to late or no social stimulation. A second study determined whether the above results were due to early social stimulation per se or to the separation which occurred at its termination. Twenty-seven newly hatched ducklings were housed with a conspecific beginning on Day 1. One half of the birds were separated on Day 6. On day 7, subjects that were separated early exhibited less crouching and distress calling in a novel open field than those separated late. This implied that the withdrawal of social stimulation, rather than social stimulation per se, was responsible for the reduced emotional behaviour observed in Experiment 1. It is concluded that early withdrawal of social stimulation generated a strong aversive reaction and that the strength and timing of this reaction mediated the emotionality moderating effects found here. The primary function of early social stimulation was to establish a condition whereby the aversive reaction generated by separation would occur early.

Studelska and Kemble (1979) designed an experiment to see the effects of briefly experienced perceptual enrichment on open field behaviour in rats. A 24-hour socially enriched animals exposed to a novel perceptually enriched environment produced increased open field ambulation and
rearing in 57 Holtzman male rats after a 24-hour but not a 5-day exposure/test interval. The incidence of these behaviours dropped to impoverished control levels in succeeding test days.

In order to find out whether differential environments produce long-term or short-term effects, and the subjects reared in different environments have afterwards the possibility to choose their own environment, Mill, Pallaud, Ungerer, and Ropartz (1979) conducted four experiments. In all these experiments, the subjects were Rattus norvegicus and the number of subjects were 48, 48, 36, and 36, respectively. At birth, the litters were reduced or increased to 8 pups and at weaning (25 days of age), the male pups were assigned by a randomized split-litter method either to large cages containing various objects (Enriched condition, EC) or to empty standard laboratory cages (Standard condition, SC). After two weeks of differential rearing, rats were placed in groups of six in testing cages, which were divided into two compartments with communicating holes. One of these compartments was empty; the other contained six objects (complex compartment). Daily, three objects were moved from one compartment to the other and replaced by new ones. The preference for any of the compartments was chiefly assessed by the localization of feces (Experiments I and II) and directly by the localization of the animals through videorecording (Experiments III and IV).
Both EC and SC rats showed a significant preference for the empty compartment during both light and dark portions of the daily cycle, but particularly during the light portion. Moreover, EC and SC animals differed from one another in that the SC rats showed a stronger preference for the empty compartment seemed to diminish slowly, but EC and SC rats tended to remain distinct in habitat selection, at least during the period tested. This behavioural difference, tentatively interpreted in terms of neophobia, might constitute a possible mechanism for automaintenance of differential rearing effects.

Pirta, Uttarakabat, and Jena (1981) conducted two experiments to study the reactions of Wistar strain albino rats toward unfamiliar conspecifics and inanimate objects. In Experiment 1, 24 rats served as subjects. Half of the subjects were reared in social isolation and the other half in groups of four siblings, after weaning at 22-39 days. After 100 days of rearing these rats were given social and inanimate object preference tests. In Experiment 2, six juveniles (26 days) and six adults (132 days) were tested with seven inanimate objects in an open arena. It was found that: (a) subjects were xenophillic, showed variations in responses toward different social stimuli, and this behaviour was depressed by social isolation, and (b) subjects were neophillic, did not show variations in responses toward different inanimate objects,
and this behaviour was affected by age and social rearing.

Dalrymple-Alford and Benton (1981) designed a study to find out the effect of social isolation of the rats on open field activity and emergence. It has been suggested that naive isolated rats show more "fear responses" than group-housed controls. However, in contrast to previous studies, dark conditions and low-noise levels were used to evaluate the latency of 16 isolated and 16 group-housed Listar hooded rats to emerge from a small chamber into an open field and the subsequent ambulation and rearing behaviour. The prediction that these conditions would be conducive to the rapid development of hyperactivity in isolates was confirmed, but there was no significant differences in emergence latency.

Another experiment was designed by Misra, Mohanty, and Jena (1982) to study the effects of living space (small/large) and social interaction (minimum/medium/maximum) on emotionality, activity, and learning in 48 male Wistar strain albino rats. The indices of emotionality observed were ambulation, thigmotaxis, defecation, and urination. The results revealed that animals living in smaller space were found to be more emotional, less active, faster in learning, and slower in extinction than the animals living in larger space. Increased social interaction produced decreased emotionality, increased activity, faster learning
and extinction. Animals living in pairs in smaller space were found to be least emotional and quickest in learning.

Similarly, Nabert (1983) designed a study comprised of two experiments to find out the effects of environmental stress (individual vs. group housing conditions) on the biting of an inanimate target. He took 56 male Rockland-Swiss mice and 55 male Long Evans rats as his subjects. In Experiment 1, all 56 mice were divided randomly into two equal halves. One half was individually housed and the other half was housed in groups of four for two weeks. At the same time, 20 minutes in each day for two weeks and 5 days per week, target biting sessions were conducted. In Experiment 2, the procedure was the same except that the number of rats per group was 8 and they were run 5 days per week for 22 session. For both mice and rats, individual housing markedly increased the number of target bites per session. Thus, individually-housed animals were found to be more emotional than their group-housed counterparts.

Tang, Sun, and Lin (1984) studied the behavioural effects of social isolation versus non-isolation on 40 male albino rats. The animals were divided at age 4 month. Some were housed in isolation and some in gregarious groups for 8 weeks. Eating, drinking, and sleeping patterns were observed. All rats then were regrouped with 4 strangers placed in one cage as a means of creating social stress, and
studying its effects on the behaviour of isolated and non-isolated rats. It was found that the behavioural changes in eating, drinking, and sleeping induced by social stress were more significant in isolated than gregarious rats, even though the rats were not isolated until four months. However, stress-induced behavioural changes in previously isolated adult rats were less severe than in rats socially isolated at age one month. Isolated rats manifested stronger aggressive behaviour than did gregarious rats.

In a study, Mohanty and Mishra (1984) investigated the effects of social isolation and adult handling on open field emotionality of male albino rats of Wistar strain. Twenty-four rats were divided into two equal groups at 95 days of age. One group was housed in social isolation and the other was housed in groups for 15 days. Half of the subjects from each housing condition were handled once daily for five minutes during rearing for 15 consecutive days. The indices of emotionality observed in the open field were ambulation, thigmotaxis, rearing, grooming, defecation, and urination. It was concluded that adult handling reduces the emotionality or fearfulness of the animals, whereas social isolation augments it.

Another study was conducted by Das (1984) to find out the effects of differential rearing and electroconvulsive shock (ECS) on open field behaviour and discrimination.
learning of albino rats. The analysis of results revealed that the enriched animals reared in groups outperformed (less emotionality, more active, and faster learning) the impoverished rats reared in isolation.

Similarly, Jones (1984) studied the tonic immobility in chickens caused by experimental novelty. He observed tonic immobility reactions of individually caged adult Golden Comet hens in familiar or novel environments when the experimenter wore either a familiar or unfamiliar coat. Subjects tested in isolation in an unfamiliar environment showed longer tonic immobility than did those tested in their familiar environment where they could still see and hear their neighbours. Tonic immobility was significantly prolonged in both test environments if the experimenter wore an unfamiliar coat. Thus, socially isolated chickens showed more tonic immobility (and presumably, fearfulness) due to novel aspects of the experimenter's appearance and novelty of the physical environment.

In another study, Snyder, Graham, Bowen, and Reite (1984) studied seven 7.5-10.5 month old nursery-reared chimpanzees (Pan troglodytes) to determine the effects of a short period of separation from peers on behaviour and heart rate. Subjects were separated from mothers at birth and reared in a nursery in a group living environment. During a 13-day period (4 days in which all subjects were reunited), six quantified behavioural observations and five
heart-rate measurements were obtained daily. Results show that isolated subjects were behaviourally agitated and exhibited increases in vocalizations, rocking, and self-clasp behaviour, as well as changes in facial expression (cry, whimper, and pout face) during 5-9 days. Time spent locomoting decreased in all seven subjects during the separation period. Agitated behaviour of separated subjects alternated with stationary withdrawn behaviour. Their heart rate showed a poorly developed circadian rhythmicity during the 13-day period. Most behaviour scores returned to baseline values following reunion.

Riittinen (1986) demonstrated that impoverished rearing conditions increase stress-induced irritability in mice. He took 56 mixed strain male mice as subjects and reared them in four environmental conditions: (i) impoverished, (ii) impoverished and overstimulated, (iii) enriched, and (iv) enriched and overstimulated. After rearing, the subjects were tested for irritability and the test used involved the subject being attacked by a bottle brush in its homecage. Analysis of data revealed that both overstimulations and individual housing increased irritability and interacted positively with each other. Individual housing but not overstimulation decreased avoidance behaviour in the subjects. Findings suggest that enriched conditions prevent the overstimulation-induced irritability, perhaps by providing opportunities for the subjects to experience a variety of different situations.
and thus develop a rich pattern of behaviour.

In another study, Gamallo, Villanua, Trancho, and Fraile (1986) compared 60 socially reared (SR) male albino Sprague-Dawley rats with 40 male crowded reared (CR) rats and 40 isolated reared (IR) rats to investigate the effects of rearing conditions on adaptation to moderate stress (activity and defecation rate in open field) and intense stress (sensitivity to restraint ulcers). Results show a great lack of adaptation to moderate and intense stress in CR and IR subjects demonstrated by a decrease of activity variables, an increase of defecation rates, and a high sensitivity to restraint ulcers. An increase in adrenal function was also noted in IR and CR subjects. Thus, it was concluded that both IR and CR rats were more emotional than the socially reared rats.

Mohanty and Mishra (1988) designed a study to find out the effects of housing condition and levels of test illumination on emotionality and general activity level of Wistar strain male albino rats. Twenty rats were housed individually and another 20 subjects were housed together for 60 days. Half of the subjects from each housing condition were tested for emotionality and activity under high illumination and the other half under low illumination. The indices of emotionality observed in the open field were ambulation, thigmotaxis, rearing, grooming, defecation, and urination. The results revealed that isolate-housed animals,
Irrespective of test illumination, were found to be more emotional on all the above measures of emotionality, and also exhibited higher level of general activity than their group-housed counterparts. Similarly, animals tested under high level of test illumination, irrespective of housing condition, were found to be more emotional and more active than the rats tested under low illumination. It was concluded that high level of general activity is the indicative of high level of arousal and thus, high emotionality, in the subjects.

Investigators, using the same stressful conditions, however, obtained contradictory results. Fugita and Hara (1971) reared newly hatched white leghorn chicks in darkness, either in isolation or in groups. It was observed that the isolates showed shorter latencies to enter into a novel field, traversed more sections of the open field, and emitted distress calls less frequently. In other words, the isolates were thus found to be less emotional than the socially reared chicks.

Coulon (1971) had also similar observations in guinea pigs. He raised the subjects either with the mother, without the mother but with siblings, or in isolation. Later, the subjects were observed in an open field. It was found that isolated guinea pigs showed less emotionality and more exploration in the open field in comparison to the other two groups of subjects.
In another study on rats, Warren and Ivinskis (1973) reared 40 male hooded rats in social isolation and another 40 male hooded rats in small groups of 5 to 10. In a subsequent test in the open field, the socially isolated rats were found to be less emotional and more active than the group-reared rats. The isolated subjects defecated less, and showed more ambulation and rearings in the open field than their group-reared counterparts. Moreover, the isolation-reared subjects also spent more time in contact with another subject during paired exposure in the open field, which was taken as evidence of greater social seeking behaviour in socially isolated subjects.

In a similar study, Syme (1973) investigated the effects of imposing different housing conditions on 74 female New Zealand black and white strain hooded rats. At weaning (23 days of age) rats were subjected to either social impoverishment or enrichment or control conditions, and subsequently tested for activity in an open field under either individual or group conditions. Results showed that both age at which housing conditions were imposed and the type of activity measured affected the subject’s behaviour. Socially deprived subjects were more active than socially enriched subjects in an open field.

In a similar vein, Einon, Morgan, and Sahakian (1976) designed an experiment to study the development of intra-session habituation and emergence in socially enriched and
socially isolated rats. The results revealed that rats reared in socially impoverished condition from weaning showed several behavioural abnormalities. They were found to be more active in the open field in comparison to socially enriched rats. Socially impoverished animals also showed evidence of retarded habituation in comparison to socially enriched animals.

Syme and Syme (1976) investigated the relationship between cage size and activity in the open field. 60 male hooded rats were housed differentially at weaning (25 days of age) either individually or in groups, by pairing subjects in small, medium, or large cages. The animals were observed, after 15 days of rearing, in an apparatus providing a choice between three environments of identical construction and dimensions to the different homecages. Three experimental conditions were employed. Both socially isolated and grouped subjects were tested alone in the unfamiliar apparatus, and some socially impoverished subjects were first habituated to the apparatus. Time spent in each size apparatus component was recorded. The results failed to explain earlier findings of a positive relationship between open field behaviour and cage size in socially impoverished rats, in terms of spatial preference. Isolated component preferences were inversely related to cage size, while pair-housed preferences were positively related to cage size. Component preference was not related to component area or perimeter distance.
In a study, Monroe and Milner (1977) took 40 male Sprague-Dawley rats and reared them either in groups or in isolation for 60 days. Beginning at 81 days of age, group-reared subjects from the same housing condition were tested for gregarious behavior in a circular open field over a 7-day test period. On each test day, 10 subjects within each housing condition were paired with the same subject and 10 were paired with a different subject. Results indicated that subjects reared in social isolation were more gregarious than those reared in groups.

In another study on mice, Benton and Brain (1981) took some female mice and reared them either in isolation or in groups. Later, the subjects were observed in an open field. It was found that the amount of ambulation increased with the increase of duration of rearing in isolation. Further, the isolates defecated less and had longer emergence times in comparison with the group reared counterparts. The increase in ambulation and decrease in defecation indicated less emotionality in case of isolates. However, the longer emergence time taken by the isolates created a problem for an unequivocal conclusion.

In a similar study, Gentsch, Lichtsteiner and Feer (1981) exposed isolated and group housed male Sprague-Dawley rats to an open field. The amount of defecation, locomotion, and the corticosterone levels were measured. It was found that isolated rats defecated less, and had less
corticosterone levels than the group-reared subjects. It was concluded that defecation and plasma corticosterone levels are parameters of emotionality. Locomotor activity was not found to be a valid measure of emotionality. It was finally concluded that isolated rats were less emotional than the socially reared ones.

Similarly, Chang and Chung (1983) studied the effect of differential rearing on later exploration and emotionality in A/J albino mice. They took 20 mice as their subjects which were separated from their own litters on the 23rd day of life. Before testing, 10 subjects were reared in isolation and another 10 in groups of 3-4 for 60 days. Exploration was measured in terms of bout frequency and duration of contact to a discrete novel stimulus. Locomotor activity was measured by the number of landmarklines traversed. Each subject was exposed to the test situation on two successive days. Results show that isolation-reared subjects were less emotional, hyperactive, had an increased incidence of exploratory behaviour, and demonstrated a different distribution activity when the novel object was introduced than did the group-reared controls. It is concluded that isolation-rearing in early life facilitated later locomotor exploration, which indicates less emotionality.

Mohanty and Mishra (1986) designed a study to find out the effects of differential rearing on pecking behaviour, distress calls, and locomotor activity of White
leighorn chicks. The results revealed that group-reared chicks made less pecking response, more distress calls and less locomotor activity in comparison to isolation-reared chicks. Moreover, the chicks tested in the open field immediately after being separated from their group companions displayed less pecking responses, more distress calls, and less locomotion than the chicks tested after 4 hours of separation. The varying durations of rearing did not yield a consistent significant effect on these three measures of open field behaviour. It was concluded that both group-rearing and separation from group companions induced emotionality in the birds.

However, Misra and Mishra (1981) did not find any such effect of rearing in isolation on emotionality. They reared three groups of male Wistar albino rats under three different conditions of social interaction. One of the groups of rats was reared in isolation without having the opportunity of seeing other rats. The second group of rats was reared individually in adjacent cages having the opportunity of seeing and smelling other rats. The third group of rats was reared in pairs in adjacent cages. When tested for emotionality in an open field, it was found that the three treatment groups did not differ significantly.
A number of studies have also been conducted to find out the effects of differential rearing conditions on some physiological changes, and have obtained very interesting results. Because the behavioural measures were also involved in these types of studies, some of them ought to be mentioned here.

The works done by Rosenzweig and Bennett (1977), Greenough and Janice (1979) are noteworthy. Both of the review articles have maintained that enriched rats had the most extensive dendritic branchings than the impoverished rats, as a result of which the impoverished rats are deficient with regard to their behaviour.

Weinstock, Speiser, and Ashkenazi (1978) designed a study in which catecholamine turnover was compared in two brain areas of male Wistar rats housed under different social conditions. Subjects reared in isolation for 6-8 weeks, had a significantly lower noradrenaline turnover in the brain stem and noradrenaline and dopamine turnover in all other areas except the cerebellum. In the open field test, isolated subjects were much more active than the group-housed subjects. Noradrenaline turnover increased in both areas of isolated rats, but not in grouped subjects after exposure to the open field.

In a study, Uphouse, and Brown (1981) measured brain, liver and adrenal weights of 324 male Fischer inbred rats
differentially reared from 28-60 days of age. Relative to the standard colony subjects, enriched subjects had heavier brains but lighter livers. Relative to the standard subjects, impoverished subjects had heavier adrenals. It was concluded that heavier adrenals in case of the impoverished subjects were indicative of high emotionality in those animals.

In another study, Das, Das, and Mohanty (1987) investigated the effects of 60 days of enriched and impoverished rearing and repeated electroconvulsive shock (ECS) stimulation on spontaneous motor activity, learning performance, and some selected physiological measures in Wistar rats. Animals reared in groups in an enriched condition (EC) and those which received ECS during the same period did not differ from each other in their brain weights. However, both the groups of animals had significantly heavier brains than their littermates reared in isolation in an impoverished condition (IC). The three differential treatment groups did not show any significant difference in their adrenal weights. Behaviourally, the EC rats outperformed the IC animals on two different behavioural tasks, and the ECS animals were substantially inferior to both groups.

**Summary.** The review of literature on the effects of environmental stress (e.g., isolation stress and sensory deprivation stress) on emotionality leads to contradictory
conclusions. Different studies have either shown facilitatory effect, inhibitory effect, or even no effect of different stressful conditions on emotionality. A number of studies have reported that both socially enriched and perceptually enriched environments depress emotionality (Das, 1984; Das, Das, & Mohanty, 1987; Misra, Mohanty, & Jena, 1982; Mohanty & Mishra, 1984; Mohanty & Mishra, 1988; Nabert, 1983; Uphouse & Brown, 1981). Some other studies, on the contrary, have reported that both social and perceptual impoverishment decrease emotionality (Benton & Brain, 1981; Einon, Morgan, & Sahakian, 1976; Gentsch et al., 1981; Mohanty & Mishra, 1986; Warren & Ivinskis, 1973). However, a few studies reported that environmental stress has no effect on emotionality (Misra & Mishra, 1981). The discrepancies may be due to variations in using indices of emotionality, types of stress conditions, duration of stress, species, and strains. However, a large number of studies reported that environmental stress, in general, increases emotionality.

Environmental stress and Exploration

Emotionality and exploration are found to be closely associated. Emotionality serves as a drive which energizes exploratory behaviour, sometimes negatively (Broadhurst, 1958b), and sometimes positively (Halliday, 1967). Both low and high fear states are found to be associated with
low exploration whereas intermediate fear states are found to be associated with high exploration (Lester, 1968).

The relationship between environmental stress and emotionality has been discussed earlier. It is, thus, expected that environmental stress might affect exploratory behaviour of subjects. According to Hebb (1955), the organism always tries to be optimally aroused by exploring or withdrawing from other stimulus objects. As environmental stress generates arousal, it is naturally expected that high stress would inhibit exploration and mild stress would facilitate it. However, different studies have yielded conflicting results in this respect.

Some investigators studied the effect of "shock stress" on exploratory behaviour of animals. In a study Haywood and Wachs (1967) exposed rats to electric shock and white noise prior to testing for exploration. It was observed that preexposure to such stressful conditions significantly reduced the curiosity and exploratory behaviour of rats.

In a similar study, Aitken and Sheldon (1970) also found that rats, receiving electric shocks prior to exploration in a maze, significantly preferred the familiar arm of the maze. In other words, shocked animals showed less curiosity and less exploratory behaviour than that of the non-shocked subjects.
Another study was conducted by Misra and Panda (1975) to find out the effects of single ECS on locomotor exploration, spontaneous motor activity, and body weight of Wistar strain male albino rats. The results revealed that ECS decreased the locomotor exploratory behaviour but did not affect both spontaneous motor activity and general drive level of rats. ECS did not have any effect on the body weights of animals.

In a similar study, Rath and Mohanty (1979) studied the effects of multiple administration of ECS preceded by FS on locomotor exploratory behaviour and rate of defecation of rats in the open field. Six groups of Wistar rats were administered once, twice or four times ECS in an open field preceded by either FS or sham–FS in a shock chamber two minutes before the ECS administration. The results revealed that as the number of ECS administrations were multiplied the rate of locomotor exploration showed marked decline, whereas the rate of defecation was increased. It was concluded that repeated ECS decreases exploration but increases emotionality of the subjects.

However, Misra and Sahu (1975) did not find any significant effect of single ECS on locomotor exploratory behaviour of animals as measured in an open field. Wistar rats were allowed to explore a black open field for five minutes daily for five consecutive days. On the last day of open
field test, some rats received single ECS and others received sham-ECS treatments immediately after exploration. All the animals were retested in the open field 24 hours later. During retesting, the open field was black for some ECS and sham-ECS treated animals, and it was white for the rest of others. Results revealed that ECS had no effect on locomotor exploration of rats. Moreover, convulsed and nonconvulsed subjects were not found to differ in their locomotor exploration.

The effect of crowding (as a stress) on exploration was investigated by Bell, Miller, Ord, and Rolsten (1971). Male mice of C 57 B 1/10 strain, varying in group sizes indicating varying degree of population density, were reared in their living cages. Subsequently, the rats were tested for maze exploration. It was observed that maze exploration decreased with increased group sizes. In other words, crowding stress was found to have detrimental effect on exploration.

Contradictory evidence has been obtained in studies using sleep deprivation as a condition of stress. Moore, Hayes, and Hicks (1979) deprived rats of the REM sleep. Later, both the deprived and non-deprived groups were tested for exploration. It was observed that REM sleep deprived rats showed higher preference for novelty, and thus, more exploratory behaviour.
The effect of deprivation of biological needs on exploration has also been investigated. Such deprivations have been considered as a condition of stress. In a study, Glickman and Jensen (1961) took hungry, thirsty, and control groups of male rats and observed their exploratory activities in an elevated 'Y' maze. It was found that hungry and thirsty subjects traversed more units and thereby explored more than that of the control group of subjects.

In another study, Richards and Leslie (1962) took three groups of hungry, thirsty, and satiated rats and exposed them to a 'T' maze to choose between a novel and familiar tactile stimuli. It was found that hungry and thirsty rats choose the novel stimulus alternative significantly more than that of the satiated subjects.

A few studies, however, have reported either no effect or negative effect of deprivation of biological needs on exploration. Hurwitz and De (1958) observed that food deprivation did not increase the rate of exploration. In a similar study, Mishra and Mohapatra (1978) could not find any effect of food deprivation on the exploratory behaviour of female albino rats. However, Mohanty and Jena (1983) reported inhibitory effect of food deprivation on the exploratory behaviour of male albino rats of Wistar strain. In a study, they observed the effects of stimulus complexity and hunger drive on the exploratory behaviour of rats. It was found that stimulus complexity elevates the rate and amount
of exploration irrespective of the levels of food deprivation. Hunger, on the contrary, retarded the rate and amount of exploratory behaviour regardless of the levels of stimulus complexity.

The effects of stressful rearing conditions (e.g., social deprivation or perceptual deprivation) on exploratory behaviour of animals have been studied by a number of investigators. One such study was conducted by Thompson and Lippman (1972), in which they investigated the activity and exploratory behaviour in 57 male mongolian gerbils and 57 Sprague-Dawley albino rats, on two consecutive days using a Greek Cross Maze with black, white stripped and checkered arms. Three measures were taken, such as: compartment of first choice, frequency of entrance into each compartment, and behavioural time sampling of each subject's location during each 180 second-trial. Results indicated that handling increased activity for both the species, and isolation-reared animals were less exploratory and less active than the group-reared animals.

Sackett (1972) did an experiment on monkeys. A total of 67 monkeys were reared during first year of life in a feral environment or in the laboratory under different rearing conditions. Group 1 monkeys were reared with their mothers and peers; Group 2, with surrogate mother or alone in a bare wire cage; Group 3, in total social or partial sensory isolation
for 6 or 9 months from birth; Group 4, in total sensory and social isolation for the whole first year of life. Following extensive social and non-social learning experiences from year 1-4, subjects were studied for motor activity and exploratory behaviour in a novel environment and for exploration of visual stimuli varying in complexity. Both motor activity and exploration were found to increase with greater degree of stimulus variation in the rearing situation. Responsiveness to complex visual stimuli was also found to be higher for subjects raised in more complex environments. Females were much more active and showed greater exploratory behaviours than males.

Misra and Nanda (1973) designed an experiment to find out the effect of social isolation condition on exploratory behaviour of rats. The subjects were 16 female albino rats of Wistar strain. Half of the subjects were individually reared and the other half were reared in groups. The results clearly indicated that the individually-housed animals exhibited less exploratory behaviour in comparison to group-housed subjects.

Gardner, Boitano, Mancino, D'Amico, and Gardner (1975) raised 150 naive male Long-Evans rats in one of the four environments: perceptually enriched-socially enriched; perceptually enriched-socially impoverished; perceptually impoverished-socially enriched; and perceptually impoverished-socially impoverished. Half of the subjects of each group
scores revealed that the perceptually enriched group explored significantly more than the perceptually impoverished group. The social variable did not reveal significant effects. However, the perceptually enriched—socially enriched group entered more squares in the open field than other three groups of rats. Therefore, the authors have concluded that perceptual and social enrichment have different behavioural effects, and it is hypothesized that they may reflect different physiological mechanisms.

Ferchmin, Bennett, and Rosenzweig (1975) conducted two experiments to test the relative effectiveness of direct versus indirect interactions with an enriched environment. The subjects were Berkeley SI rats. Some subjects were housed in groups of 12, in large enriched condition (EC) cages, while littermate "observer" (OC) subjects were placed singly in wiremesh cages within EC. A third group was housed singly in an impoverished condition (IC) where stimulation was minimal. After 30 days of differential rearing, the subjects were killed and their brains were dissected. In both the experiments, the usual pattern of EC-IC differences in brain weights appeared, whereas OC showed no significant difference from IC. On measures of exploratory behaviour taken during the last two days of the second experiment, IC fell significantly below EC, and OC was somewhat below IC.
Thus, EC differed from both IC and OC in brain and in behaviour. It was suggested that active contact with enriched environment (perceptual as well as social) are necessary pre-requisites for development of EC effects.

In another study, Einon and Morgan (1976) raised 48 rats either socially or in isolation after weaning. At 60 days of age, the subjects were observed in an open field. It was found that rats reared in isolation contacted less novel objects in the open field than did the socially reared subjects. In other words, the socially enriched animals showed more manipulatory behaviours (number of object contacts and varieties of object contacts) and also more entering, climbing, moving, and rearing activities in comparison to the socially impoverished subjects.

Similarly, Turpin (1977) designed a study in which 32 Long-Evans rats were raised either in isolation or in groups after weaning. After 15 days of rearing, the subjects were tested for preference to novel or familiar environments. The physical environments consisted of horizontally or vertically striped cage walls. It was found that the isolated rats preferred the familiar environment whereas the group-reared rats preferred the novel environment.

File (1978) wanted to know whether socially isolated animals are more active and less exploratory than rats reared
in group conditions. Fifty male Lister hooded rats were reared in socially isolated or group environments from Day 20 to Day 45. Sub-groups of each condition were either left undisturbed or received daily handling and were given objects in their cages. From 45 days, all subjects were rehoused in groups of 6, and testing began at Day 73. In the first test, exploration was measured by the number of contacts with objects placed in the homecage; in the second test, exploration was measured by responses to a hole board; and in the third test, orienting was measured by the distraction produced by the presentation of a tone. When tested in novel situations, in contrast to their enhanced motor activity, socially isolated animals showed reduced exploration and orienting.

Hopf, Herzog, and Ploog (1985) studied stimulus conditions that control attachment and exploratory behaviour. Ten newborn squirrel monkeys were isolated from their mothers as well as from their group, and were provided with a mother surrogate, manipulanda, and social surrogate stimuli designed to elicit behaviour that would otherwise be directed at conspecifics. Subjects displayed largely normal attachment and exploratory behaviour. They modified their behaviour depending on whether their contacts with the social surrogate were answered by aversive or nonaversive calls in the same way as would socially experienced conspecifics. It was concluded that genetic components are involved in comprehending emotional expressions.
Some investigators, using similar stressful rearing conditions, however, reported contradictory findings. One such study was conducted by Nielsen (1970) to find out the effect of the rearing environment on the exploratory behaviour of the adult rat. In this experiment 11 white rats were reared in a cage with moving figures. Another 11 littermates were reared in a similar cage but without figures. The rats from the more complex environment showed less locomotor activity in a checker board maze, and in a two-lever test box, higher preference for the lever which produced complex visual stimuli. It was, therefore, proposed that rearing in perceptual impoverishment increases locomotor activity and reduces curiosity.

In a similar vein, Sahakian, Robbins, and Iversen (1977) conducted two experiments to test the hypothesis that isolation rearing enhances exploration. In Experiment 1, 24 female hooded rats were randomly divided into two equal groups after weaning at 17 days of age, and were housed individually or in three groups of four rats per cage. In Experiment 2, 20 female hooded rats randomly selected from the same population of rats used in Experiment 1. Ten rats had been isolation-reared and 10 were group-reared. Another population of male hooded rats was used in a partial replication of the experiment. Again 10 male rats had been isolation-reared and 10 were group-reared, after weaning at 16 days of age. Experiment 1 measured exploration as contact of a discrete novel
stimulus, in terms of bout frequency and duration. Locomotor activity was measured by photocell beam interruption. It was found that isolation-reared rats were hyperactive, showed an increased incidence of exploratory bouts but no differences in duration of exploratory behaviour, compared with group-reared controls. Experiment 2 measured, independently, locomotor activity and the preference for a novel environment over a familiar one. Again, it was found that isolation-reared rats, whether male or female, showed enhanced novelty preference compared with controls. No significant differences were found in locomotor activity. The results were discussed in terms of the hyperactivity of isolates interfering with investigative behaviour by response incompatibility.

One study was designed by Pati and Dikhit (1982) to find out the effects of rearing conditions on the activity and exploratory behaviour of chicks. Forty one-day old white-leghorn chicks were randomly divided into two equal groups. One of the groups was assigned to individual-rearing condition and the other to group-rearing condition, for a period of 7 days prior to testing. Each subject was observed for five minutes a day for six consecutive days in an open field and photoactometer. The results revealed that the individually-reared chicks were found to be more active and exploratory than the group-reared chicks.
Another similar study was conducted by Pati and Mohapatra (1983) to find out the effects of rearing conditions and stimulus complexity on the exploratory behaviour of chicks. Sixty one-day old white-leghorn chicks were randomly divided into two equal groups, and were reared either in isolation or in groups for 25 days prior to testing. Each subject was observed in the open field for five minutes daily for five consecutive days. It was found that the amount of exploratory behaviour of isolation-reared chicks was more than that of group-reared chicks.

However, in a similar study, Uttarakabat and Jena (1987) could not find any significant effect of rearing condition on the exploratory behaviour of chicks. In this study, 24 male white-leghorn chicks were randomly divided into two equal halves, and were reared either in isolation or in groups, for one day or 10 days prior to testing in the open field for exploratory behaviour. It was suggested that rearing condition has no effect on chick's exploratory behaviour.

Summary. The review of literature on the effect of environmental stress (e.g., both social and perceptual impoverishment) on exploratory behaviour leads to contradictory conclusions. Some investigators observed that rearing the animals either in a socially isolation or in a sensory deprivation condition reduces the exploratory
behaviour of the subjects (Einon & Morgan, 1976; Ferchnin et al., 1975; File, 1978; Gardner et al., 1975; Hopf et al., 1985; Misra & Nanda, 1973; Sackett, 1972; Thompson & Lippman, 1972; Turpin, 1977). Some other studies reported that environmental stress enhances the exploratory behaviour of the animals and birds (Nielsen, 1970; Pati & Dikhit, 1982; Pati & Mohapatra, 1983; Sahakian et al., 1977). However, a few studies did not find any significant effect of environmental stress on exploratory behaviour of the subjects (Uttarakabat & Jena, 1987). One of the reasons for such incompatibilities of results may be the variation of measures used to measure exploration. Locomotor exploration may really reflect activity level rather than exploration itself. Moreover, variations in the types of stressful conditions, duration of stress, species and strains are also some of the important factors contributing to the discrepancies in results. However, a large number of studies, even using other types of stress (e.g., shock stress, ECS stress, food and water deprivation stress, sleep deprivation stress, crowding stress), reported that environmental stress, in general, reduces the exploratory behaviour of the animals and birds.

**Environmental stress and Activity level**

Environmental stress generates a state of arousal. It is, therefore, expected that an organism will be more active and responsive to different environmental stimuli under stress. The level of motor activity of animals is usually inferred
from different types of their motor movements. These activities may constitute whole or major body movement, part body movement, or other spontaneous movements. The whole body movement may be any movement with the whole body of the animal, such as distance covered per unit time, time spent in ambulation, rearing frequency, escape attempts, etc. Examples of part body movement are manipulation of objects, sniffing, scratching, digging, grooming, etc., without movement of the whole body. Other spontaneous movements (such as, movement of head, legs, tail, etc.) are involuntary movements of the animal (Robbins, 1977).

It has been the long practice of behaviourists, experimental psychologists, and others to obtain an objective measure of locomotor activity. However, because of the fluctuating and multifarious nature of many overt movement patterns comprising spontaneous behaviour, it is generally recognized that any single measure of locomotor activity will be confounded with other aspects of behaviour (Bindra & Spinner, 1958).

There is a continuous stream of new devices, as yet not validated, to measure activities of animals. There are, however, five such devices which are commonly used to measure activities of small animals. These are:

(a) photoactometer or photocell cages, (b) running wheels, (c) stabilimeters, or jiggle cages, (d) tilt cages, and (e) open fields.
Photoactometer is a reliable measuring instrument of spontaneous motor activity of rats (Krsiak, Steinberg, & Stolerman, 1970). Photoactometer, used to measure the spontaneous activity level, really measures a general arousal state of the organism. It records different body movements together. The type of activity measured by photoactometer is different from that of the activity measured by running wheels. The running wheel is essentially a device that rotates about a central axis as a result of running by an animal. Irwin (1961) used the running wheel as a measure of 'disorganisation' of behaviour. Running a wheel can be a suitable measure of disorganisation of behaviour since it involves a considerable amount of sensory motor coordination. Inspite of their specificity, the individual measures nevertheless depict the activity level of the subjects. It has already been shown how stress decreases the ambulation in an open field. Along with this, other aspects of activity level in the organism under different environmental stress conditions are discussed below.

Some investigators studied the effects of "shock stress" on activity level of animals. One such study was conducted by Ray and Barrett (1969) on mice. The subjects were tested in the open field after 8, 16, 30, 60, 120, 240, and 480 minutes of the administration of the footshock. Freezing behaviour was found to increase over time. But it was observed that the mice tested only after 8 and 16 minutes were found to be more active than that of the control group.
In a similar experiment, Pinel, Corcorun, and Malsbury (1971) administered footshock of 1 mA intensity for 1 or 5 second duration to group of naive male rats. Immediately after the shock, their activity was observed in the open field for 1 minute, 10 minutes, 1 hour, 3 hours, or 5 hours duration. The general activity level was found to be decreased in both shock conditions.

In another study, Corum and Thurmond (1977) took 300 male CF-1 mice of 90 days old and divided them into control and experimental groups. The experimental subjects were either delivered escapable or inescapable electric shock. The effect of such shock on locomotor and aggressive behaviour was evaluated. Measures of plasma corticosterone levels indicated that animals exposed to inescapable shock were more severely affected. Both locomotor activity and aggressiveness decreased following exposure to the stressor but returned to the non-stressed control levels within 48 hours. It could be interpreted that the footshock makes the feet physically less conducive for locomotion immediately after the shock and thus, with greater interval the locomotion increases.

Electroconvulsive shock (ECS) serves as a stressor. A number of studies have also been conducted to assess the effect of ECS on motor activities of animals. One such study was conducted by Mohanty (1980). Mistar rats were administered ECS in an open field once, twice or four times
preceded either by footshock (FS) or sham-FS in a shock chamber two minutes earlier. All subjects were observed in an open field followed immediately in a photoactometer 24 hours after FS-ECS treatment. The results revealed that thigmotactic ratio in the open field and motor activities in the photoactometer decreased with repetition of ECS administration whether preceded by FS or not. In other words, repeated administration of ECS caused more fear and less activity in animals.

Similarly, Dokla, Olson, Haviland, Jennings, Sideleau, Zimmerman, Sprano, and Boitano (1981) conducted an experiment on 72 hooded rats which were divided into control and experimental groups. The experimental subjects were administered with ECS. It was found that ECS significantly decreased the locomotor activity of the subjects.

Mohanty and Jena (1987) designed a study similar to that of Mohanty (1980). The investigators observed that repeated administration of ECS produced lower level of activity in Wistar rats as measured in photoactometer and activity wheel.

Investigators, using the same stressors, however, obtained contradictory results. In a study, conducted by Misra and Rath (1979), Wistar rats received single ECS or sham-ECS in an open field five minutes after receiving FS or sham-FS in a shock chamber. Locomotor activities in the
open field were recorded 24 hours after FS-ECS treatment. The results revealed that animals treated with ECS showed increased locomotor activity than those treated with sham-ECS. FS was not found to affect the activities of the animals. It was concluded that ECS probably increases the general activity level of the subjects and is not aversive.

As an additional check on locomotion, Winocur and Mills (1970) investigated the aversive consequences of multiple ECS on wheel turning activity. Wistar rats received a series of 15 ECS or sham-ECS treatments. Thereafter, all the subjects were observed in an activity wheel. The results failed to reveal any effect of ECS on wheel turning activity of rats.

Rats, studied under REM sleep deprivation stress conditions, have also been found to show increasing, decreasing, or no change in the activity level.

Albert, Cicála, and Siegel (1970) observed that the sleep deprived rats showed more locomotor activities than that of the control group of rats. Ogilvie and Broughton (1976) also observed increased locomotor activities in the sleep deprived rats. Hicks and Adams (1976) similarly observed that REM sleep deprivation increased locomotor activities in the rats. In one of the recent studies, Hulzen and Coenon (1981) took three groups of Wistar rats of
which two groups were paradoxical-sleep-deprived for 72 hours.

One of the groups was tested in a classical platform where no movement was possible. It was found that in both the deprived conditions locomotor activity increased and rearing scores decreased.

Boyaner (1970) deprived the experimental rats of REM sleep at a classical platform which is considered to be stressful and where movement is not allowed. It was found that REM-sleep-deprivation stress did not increase the locomotor activity of rats. Moreover, Fishbein and Gutwein (1977) did not find any such effects in the sleep-deprived rats. They rather questioned the view that sleep deprivation increases locomotor activity. They suggested that this effect may be due to lack of movements in that small platform rather than due to the sleep deprivation stress.

A number of studies, using stressful rearing conditions like isolation or group-housing, sensory enrichment or sensory deprivation, have also given evidence in support of increase in activity level.

Essman (1966) observed the activity differences between socially isolated and aggregated Swiss-Webstar strain male mice. The subjects were exposed to such rearing conditions just after weaning. It was observed that by the fourth day of weaning significant differences in motor activity between the groups emerged. It was observed that isolated mice were
more active than the group-reared ones. It was further observed that the activity of group-reared rats decreased over days whereas isolates tended to maintain higher stable levels of activity.

In another study, Essman (1968) reared CF-1 mice in either isolation or in group-housing conditions from weaning till they were 45 days old. Then the rats were tested for their activity. It was observed that socially-isolated animals showed higher levels of locomotor activity than the group-housed animals.

In a similar study, Morgan (1973) observed the activities of socially isolated and group-reared rats in novel open field or photocell cages. It was found that the socially isolated rats showed higher stable levels of activity in comparison to the group-reared rats.

Similarly, Syme (1973) subjected 74 female Newzealand black and white hooded rats to either isolation or group rearing conditions after weaning. It was found that the isolated rats were more active than the group-reared subjects in the open field.

One psychopharmacological investigation was made by Sahakian, Robbins, Morgan, and Iversen (1975) to find out the effects of psychomotor stimulants on stereotypy and
Locomotor activity in 12 controlled and 12 socially deprived adult female hooded rats. Locomotor activity was measured by means of photocell cages. Analysis of the data revealed that socially impoverished rats were found to be more active in photocell activity cages. The locomotor response to drugs acting on either presynaptic or postsynaptic amine mechanism was the same in socially deprived and normal rats. In contrast, significant difference between the two groups in intensity of stereotypy was found. The later results show that differentially rearing experience can modify stereotypy and therefore, presumably different underlying neural mechanisms are involved in controlling this behaviour. It was concluded that: (a) socially impoverished animals show evidence in controlling this behaviour; and (b) socially impoverished animals show evidence of retarded habituation compared with socially enriched animals.

In another experiment, conducted by Joseph and Gallagher (1980), 185 Zivic-Miller rats, reared in either an enriched or restricted environment until 72 days of age, were tested during adulthood to determine the influence of gender and rearing environment on three related response characteristics, such as, activity, overresponsiveness, and exploratory behaviour. Eight experiments were performed. It was found that although females are more active than males, rearing environment does not influence behaviour in the running wheel or open field. When tested in a complex compartmentalized open field females, in general, and restricted rats
were significantly more active than enriched males. In addition, over subsequent testing, restricted animals were increasingly responsive and failed to habituate to the testing stimuli. When tested and retested for maze learning ability, males exceeded over females, and enriched rats maintained their ability to outperform restricted rats, although both groups had previously learned the problem. Moreover, enriched rats demonstrated a greater tendency to explore and make irrelevant section entries on a maze in comparison to the restricted rats. Furthermore, the restricted rats were found to be deficient in the ability to passively avoid or escape noxious stimuli than that of enriched subjects. Therefore, it was concluded that rats reared in a restricted environment developed a limited behavioural repertoire which is characterized by a generalized tendency to overrespond, a propensity towards perseverating in repetitious patterns of limited and circumscribed responding, and a failure to habituate to repeated contact with novel stimuli.

Gentsch, Lichtsteiner, Kraeuch, and Feer (1982) tested the reaction of individually and group-housed Wistar rats to a slight modification of a test environment, and determined the period of isolation required for hyperactivity in a new environment and an adequate response to the environmental modifications. Subjects were behaviourally compared after various periods of different housing: (1) during a
first exposure to the new environment, (ii) after habituation (two repetition trials) to the situation, and (iii) during a fourth exposure in a slightly modified test box. Compared to group-housed controls, an elevated locomotor activity upon first exposure, and a reduced reaction in response to the slight modifications were found in individually housed subjects. Further, Sahakian, Burdess, Luckhurst, and Trayhurn (1982) also observed that the isolated rats were hyperactive in comparison to the group reared subjects.

Another study was designed by Chivers and Einon (1982) to find out the effects of early social experience on activity and object investigation in the ferret. It was hypothesized that play may develop adaptive behavioural flexibility because many effects of early social isolation are due to deprivation of social play. Thirty pole cat ferrets were, each assigned to one of three conditions: isolate, social or partial isolate (exposed to other ferrets two hours per day). At a mean age of 147 days, subjects completed two object tests and two activity tests. On the activity tests, the isolates were the most active, but showed no differences in habituation. This greater activity may be due to a lack of experience in social play. Partial isolates behaved similarly to the social subjects. On the object investigation tests, the partial isolates behaved similarly to the isolates. While the social
subjects showed habituation to the objects, the other subject showed no such effects. The difference in behaviour is again attributed to lack of social experience in the isolates and partial isolates.

In another similar study, Siegel and Jensen (1986) studied the effects of naloxone and cage size on social play and activity in isolated young rats. Three experiments investigated the effects of large and small housing environments as well as naloxone on social play (as defined by pinning behaviour) in 92 isolated post-weaning Long-Evans male rats. It was found that subjects housed in small cages played significantly more than those housed in large cages. This effect was not observed when cage size was reversed. Subcutaneous naloxone resulted in significant decreases in play behaviour both before and after housing environments were switched. Moreover, compared to subjects that were socially housed, isolated subjects showed increased social play and more time in active social interaction. While housing in a small cage increased play behaviour, it had no effect on the amount of time spent in active social interaction or on activity. Only those subjects housed in small cages and injected with the highest dose of naloxone differ significantly in activity from saline-treated controls. In subjects having no prior play experience, the activity of subjects housed in the large and small cages differ significantly from
each other only in the saline and 50 mg/kg naloxone conditions. Since naloxone's effect on play behaviour was strong, but its effect on activity was not profound, data suggest that naloxone, primarily affects the affective component of play rather than altering activity levels.

Some investigators, using similar stressful conditions, however, reported contradictory findings. For example, Mitani (1975) designed an experiment to study the effects of the rearing environment on the general activity levels of white rats. Nine experimental males lived in a large pen with a number of objects, for a period from the 20th to 40th postnatal days, while six littermate males (control group) and 12 females remained in group cages, six to a cage. The experimental subjects were found to be more active in an open field than the controls. There were no significant differences in running wheel activity, or in urination and defecation. It was therefore, concluded that enriched environment increases locomotor activity of rats.

Some evidence suggests that cage floor area can affect open field behaviour and spontaneous motor activity. In this connection Manosevitz and Pryor (1975) designed one study to assess the effects of cage size and cage surface texture, as factors of enrichment, on activity of mice. For this purpose, a wooden exploratory box was divided into four equal compartments, which would be entered through an
opening at opposite ends of the walls. A photoelectric beam passed from one and through small holes drilled through the centre of each wall. The results indicated that the animals reared in the large cages were found to be more active in the open field than those reared in small cages.

Guyot, Bennett, and Cross (1980) assessed the effects of social isolation on the behaviour of juvenile domestic cats by rearing four male and four female infant kittens in four rearing conditions: (i) mother littermate, (ii) mother only, (iii) brooder littermate, and (iv) brooder only. They were then tested twice a week individually and twice a week socially from 2 to 6.5 months of age in a play room, using multiple categories of behaviour. The mother only "reared subjects were hyperactive in both object play (when tested individually) and social play. The "brooder only" reared subjects displayed retarded social behaviour. Observation indicated that littermate-deprived subjects did not learn social communication skills, and that some prolonged separation effects existed for littermate-reared subjects. Results suggest that the determinants of social play are more complex than the determinants of object play.

Hennessy (1984) investigated the effects of the presence of companion in moderating the arousal of monkeys having
restricted social experience. Five male and three female squirrel monkeys (Saimiri sciureus) were reared with inanimate maternal surrogates in individual cages. The surrogates were removed at 8 months, and at approximately, one year of age, each subject was paired with a similarly reared peer for 4 weeks prior to testing. When placed in a novel environment for 30 minutes, the subjects emitted significantly more high pitched vocalizations, and were significantly more active. When tested alone than when tested in the presence of their cagemates. A significant elevation of plasma cortisol over resting levels was observed only when subjects were exposed to the novel environment alone. Separation from the peer in familiar surroundings had no effect on any measure. These results indicate that the capacity to use social patterns to moderate arousal can develop in squirrel monkeys raised from shortly after birth without a mother or physical interaction with other conspecifics, and with relatively little social experience overall.

Another very interesting study was conducted by Mohanty and Das (1984) to provide a direct behavioural comparison of ECS-treated animals with enriched and impoverished animals. There are eight triplet sets of male littermates of Wistar strain albino rats, ranging from 28 to 30 days of age, used as subjects. The rats were reared either in an enriched environment or in an impoverished environment for 60 days. A third group of
rats received repeated ECS during the same period, one ECS daily for 60 days. All subjects were observed in an open field followed immediately in a photoactometer 96 hours after treatment. Results revealed that the three treatment groups differed significantly in behavioural measures. The behavioural measures were emotionality and spontaneous motor activity. The results indicated that the enriched subjects were less emotional but more active than both the impoverished and ECS subjects and the ECS subjects were the worst performers.

Mohanty, Mishra, and Pradhan (1984) designed a study to find out the effects of post-weaning experience on activity and learning in rats. Forty-eight naive male Wistar strain albino rats were assigned randomly by the split-litter technique, after weaning at 26 days of age, to one of the four rearing conditions: perceptually enriched-socially enriched (PE-SE), perceptually enriched-socially impoverished (PE-SI), perceptually impoverished-socially enriched (PI-SE), perceptually impoverished-socially impoverished (PI-SI). After 60 days of differential rearing all subjects were tested for spontaneous motor activity, and learning and extinction of a simple discrimination task. It was found that post-weaning experience in a perceptually impoverished environment retarded both learning and extinction but did not affect the spontaneous motor activity of animals. Post-weaning
experience in a socially impoverished environment, on the other hand, was found to reduce motor activity, and retarded both learning and extinction of a discrimination task.

**Summary.** The review of literature on the effects of environmental stress (e.g., social isolation stress and sensory deprivation stress) on general activity level leads to contradictory conclusions. A number of investigators observed that rearing of animals either in social isolation or in a perceptually impoverished environment increases the activity level of the subjects (Chivers & Einon, 1982; Gentsch et al., 1982; Joseph & Gallagher, 1980; Morgan, 1973; Siegel & Jensen, 1986; Syme, 1973). However, some other studies reported that both social impoverishment and perceptual impoverishment reduce the general activity level of the animals (Guyot et al., 1980; Mohanty & Das, 1984; Mohanty, Mishra, & Pradhan, 1984). The discrepancies may be due to variations in the types of stressful conditions, duration of stress, types of activity (i.e., locomotor activity or spontaneous motor activity), species, and strains. However, a large number of studies, even using other types of stress (e.g., shock stress, ECS stress, sleep deprivation stress), reported that environmental stress, in general, increases the activity level of the animals.
Environmental stress and Learning abilities

In recent years, the impact of environmental stress on subsequent learning ability has received considerable experimental attention. Studies have been conducted to show the effect of "shock stress" on learning performances of animals. In one such study, Pryor, Otis, and Uyeno (1966) observed the effects of chronic electroshock on Wistar rats. Animals were given one ECS per week for 20 weeks or three ECSs per week for 17 weeks. Three days after termination of the treatments, all animals were observed for motor activity, emotionality, and spatial discrimination learning in an underwater T-maze. The results revealed a nonsignificant effect of ECS on emotionality and motor activity. However, the threshold seizure group tended to be more timid and less active in comparison to sham control and maximum seizure groups. Minimum or maximum convulsions, due to repeated administrations of ECS, resulted in increased brain weight, total brain cholinesterase (ChE), total protein, and total acetylcholinesterase (AChE). Convulsed rats made more errors in the underwater T-maze in comparison to both subconvulsive and sham-ECS control animals. It was concluded that chronic electroshock had an attenuating effect on the learning ability of the animals.
In another study, Pryor, Otis, Scott, and Colwell (1967) observed the effects of duration of chronic electroshock on Wistar rats. The animals were administered 3 or 5 ECSs per week for 4, 8, 12, or 16 weeks. Electroshocked animals were found to have greater cortical weight. Particularly, the ventral cortex, including hippocampus and amygdala, were found to have increased in weight. Total protein and total AChE activity increased throughout most of the brain in proportion to the increase in weight. Specific ChE activity decreased in the cortex of electroshocked subjects, especially in the visual and ventral cortex. Electroshocked animals, having maximal seizures five times per week, performed more poorly than controls on a spatial discrimination test in an underwater T-maze. Thus, it was concluded that multiple ECS had deleterious effects on learning ability of animals.

In a similar vein, Pryor and Otis (1970) conducted a study to find out the persisting effects of chronic electroshock seizures on brain and behaviour in two strains of rats. Fischer strain and Buffalo strain male rats were used as subjects. Fischer rats were given minimal, maximal, or sham-electroshock seizures daily, 5 times each week for 6 weeks, beginning at 30 days of age. Animals were sacrificed 48 hours, 2 weeks or 6 weeks after the last treatment. The initial depression in body weight
and increase in cortical brain weight by the maximally convulsed group returned to that of the control level by 6 weeks. Monoamine oxidase (MAO) activity was elevated throughout the brain 48 hours after the last treatment and remained so in the ventral cortex for 6 weeks. Buffalo rats, treated exactly like those of Fischer rats, exhibited only the decreased body weight and elevated MAO activity after 6 weeks of treatment. Treatment of Buffalo rats for 10 or 12 weeks produced some of the other changes observed in Fischer and Wistar strains. Treatment for 6 weeks did not affect acquisition of a successive brightness discrimination in an underwater T-maze in either strain when tested 48 hours or 4 weeks after the last treatment. Acquisition of a pole-displacement conditioned avoidance response was depressed in both strains at both 48 hours and 4 weeks test intervals. Thus, repeated ECS was found to have detrimental effect only on avoidance learning of animals.

ECS treatment was found to have a deleterious effect not only on the discrimination learning ability but also on the avoidance learning ability of the animals. In this connection the study conducted by Mohanty and Mohanty (1982) is noteworthy. In this study, male albino rats of Wistar strain received either sham-ECS, single ECS, 7 times of ECS, 14 times of ECS, or 21 times of ECS
administration of 54 mA for 0.5 second, once daily, for 1-21 days. The primary objective of this study was to find out the aversive effects of multiple administrations of ECS on emotionality, inanimate object exploration, and learning and retention of a one-trial, step-down passive avoidance task. Results revealed a significant effect of ECS treatments on emotionality. Animals given ECS were found to be more emotional than sham-ECS controls, and emotionality increased with increase in ECS administration. With regard to the inanimate object exploration, results revealed no general overall differences among five ECS-treated groups. With regard to the learning and retention of a one-trial, step-down passive avoidance task, ECS was found to have deleterious effects. Animals received ECS treatments, showed poor learning and retention in comparison to sham-ECS animals, subjects received multiple administration of ECS showed highly impaired learning and memory than that of animals administered single ECS. Thus, it was concluded that ECS, particularly, multiple ECS, adversely effects the learning ability of animals.

Most of the studies dealing with "crowding stress" have reported detrimental effects on performance. Levitt and Bennett (1975) reported that crowding stress decreased performance of albino rats in discrimination tasks. Ellen (1976) reared 140 male and female albino rats 1, 2, 3, or 4
per cage until they were 60 days old. The subjects were then trained to make a position response until the criterion of 8 out of 10 trials was reached. Results revealed that rats reared in a crowded cage took more trials to reach the criterion in comparison to the rats reared in less crowded cages. In other words, crowding has detrimental effect on learning.

Effects of dietary or "malnutritional stress" conditions on learning ability have also been studied. Smart, Dobbing, Adlard, Lynch, and Sands (1973) observed that undernourished rats performed better than the control rats in different learning tasks. Hsueh, Simonsen, Chow, and Hanson (1974) provided restricted diet to one group of rats for some period and then tested them in different learning tasks. It was found that the undernourished rats were almost equal to others in learning showing no adverse effect of dietary restriction.

In one of the recent studies, Stephens and Tonkiss (1981) investigated the effects of undernourishment on male rats. During the first three weeks of life, the subjects had restricted feeding of mother's milk. Later, the rats were tested for suppression of bar-pressing response when a signal was presented to avoid electric shock. When the signal was 1000 Hz tone and light, no difference between
the undernourished and control group was marked. However, when only 1000 Hz sound was presented, the control group showed better discrimination than that of the undernourished group.

Studies have also been conducted to show the effect of biological deprivation as a condition of stress on maze performances. MacDuff (1946) observed that prolonged food deprivation progressively enhanced maze performances of rats. Munn (1950) also reported that increases in length of food deprivation prior to exhaustion caused improved rates of maze learning (a perceptual restructuring task) in rats.

However, Jensen (1960) observed that rats, even with short term stress like 5 hours of food deprivation, showed impairment in their maze performances. Brozek and Taylor (1954), in an earlier study, observed that severe deprivation conditions (such as, semi-starvation for 24 weeks, sleeplessness for 72 hours, prolonged exposure to severe heat of 115-120 degree etc.) impaired performance on serially repetitive tasks like tapping time, simple discrimination, etc. Seligman (1970), in a similar study, also observed that REM sleep deprivation impaired difficult discrimination task performances.
A number of studies, using stressful rearing conditions (e.g., isolation or sensory deprivation), have also given evidence in support of the detrimental effects of environmental stress on learning abilities of animals and birds. Myers and Fox (1963) observed that rats, reared in differential housing conditions (in isolation or in groups), differed in their maze learning performances. The rats were trained in a five-choice-point multiple maze until a criterion of 10 consecutive errorless trials within 10 seconds. The criterion was achieved in a shorter time by the group reared rats. During the initial trials, socially enriched rats made more entries into the blind alleys but took less time than that of the socially impoverished animals.

Doty (1972) placed 18 Sprague-Dawley rats in an enriched environment at 300 days of age while keeping 18 littermates in standard laboratory cages. After 60 days of differential experience, the rats were tested on a light-dark active avoidance task, an avoidance reversal task, and a passive avoidance task. The enriched condition group was only slightly better than the control rats on the first task but was significantly better on the latter two tasks.
In another study, Wood and Greenough (1974) observed that rats, reared in isolation or in overcrowded environments, were inferior to those reared in small groups in complex learning tasks. However, to examine the age dependance of this phenomenon, 128 adult male Sprague-Dawley albino rats, isolated from weaning, were placed in groups of 1, 4, or 16 for either 1 or 4 weeks. It was observed that the performance in Lashley-III maze improved by one week of grouping. Similarly, the 4 weeks of grouping in the group of 16 also improved shock avoidance brightness discrimination, when compared with the performance of the isolation-reared subjects.

Similarly, Morgan and Einon (1975) took some female hooded rats and subjected them to different rearing conditions. When tested in different learning tasks, it was observed that the socially isolated rats were slower to learn both a lever-panel alternation or two-lever alternation schedule.

Morgan, Einon, and Nicholas (1975) designed a study to find out the effects of socially impoverished environment rearing in behavioural inhibition in the rat. The possibility that isolation rearing in the rat affects the development of inhibitory mechanisms was studied in a series of experiments with a total of 74 female hooded rats. It was found that socially impoverished rats were:
(a) slower to learn both a lever panel alternation, and a 2-lever alternation schedule of reinforcement; (b) more persistent than controls in pressing a lever for food when a supply of identical "free food" was introduced into the operant chamber; but (c) similar to controls in their response to preloading with food, a procedure which inhibited lever pressing to the same extent in the presence of free food were qualitatively different from the effects of social deprivation, and therefore, the group/isolate difference can not be interpreted as motivational. The possible contributions of neophobia to the difference are discussed. It is concluded that isolates may well suffer from a disinhibitory defect, but that there are probably other effects of isolation in addition.

Gluck and Sackett (1976) did an experiment to study the extinction deficits in socially impoverished rhesus monkeys. In a study with 18 5-year-old rhesus monkeys, six subjects, reared in total isolation, made more unrewarded responses and took longer time to stop responding in the face of nonreward than 12 subjects, raised in partial isolation or normally. It is suggested that isolates have difficulty in inhibiting high probability responses.

Frank, Gluck, and Strongin (1977) raised four rhesus monkeys in social impoverished environment for the first
9 months of life and four monkeys, reared with social contact, were trained to leverpress for food reinforcement on a VI 60-second schedule as reinforcement as adults. A 3-minute auditory CS that terminated with the delivery of an electric foot shock was then presented at random intervals during each test session. Results indicate that through preshock response rates did not differ, the isolates failed to suppress responding in the presence of the shock predicting CS at the same rate or to the same degree as did socially reared subjects.

Einon (1980) investigated the spatial memory and response strategies in rats. He described 5 experiments with 112 female and 28 male rats (Wistar albino hooded and Lister hooded). Subjects, reared in social impoverishment, made more errors on spatial memory task and made errors earlier in each trial—than socially enriched subjects. The difference in performance only occurred when subjects were isolated prior to 50 days of age and it survived 100 days of subsequent social enrichment condition. Hundred days of impoverishment after 50 days of age did not influence performance on the spatial memory task. Subsequent experiments suggest that spatial abilities may not differ between groups but that isolates are slower to learn to make a particular response cues are irrelevant. In contrast to previous experiments,
clear response strategies were seen in the present experiments. These were prevalent in the young (50-day-old) subjects, were less common at 90 days, and had completely disappeared by 180 days. Response strategies were more common in male and in socially reared subjects.

Gutwein and Fishbein (1980) conducted two experiments with 108 male (F-I mice), reared in either enriched environment (EE), social control environment (SE), or impoverished environment (IE) for 30 days. Environmental enrichment resulted in a significant and selective increase in paradoxical sleep (PS) and also enhanced recall of a multiple-trial, brightness discrimination task, 28 days after training. Conversely IE subjects exhibited a decrease in PS and impaired task performance relative to SE subjects. Results support the hypothesis that PS plays an integral role in the maintenance and stability of long term memory.

Lin and Tang (1984) studied the learning ability of socially isolated rats. They compared rats reared in isolation with rats reared in group conditions, and found that socially enriched groups did better in learning a spatial water maze, and a food maze than the socially impoverished rats. The extent of the negative effects of isolation on learning ability was related to the complexity of the maze.
Another study was designed by Misra and Jena (1987) to investigate the impact of levels of social interaction and size of living space on the discrimination learning of rats. In this study 96 Wistar strain male albino rats were taken as subjects. The results revealed that animals living in pairs or in a smaller space were found to learn a discrimination task or its reversal faster than the animals living in isolation or in a larger space. Moreover, animals living in larger cages or in isolation showed retarded extinction. Furthermore, discrimination learning, its extinction or its reversal learning was quickest for animals living in smaller cages in pairs. It was thus concluded that lack of social interaction, probably, causes more fear of a strange environment and retards acquisition, reversal learning, and extinction.

Some investigators, using similar stressful rearing conditions, however, reported contradictory findings. One such study was conducted by Gluck, Harlow, and Schiltz (1973) and found out that monkeys reared in enriched environments did not differ from monkeys living in partial isolation on two choice discrimination or delayed response problems, but after this lengthy testing, when complex oddity tasks were given, the animals having enriched experience were found to be significantly superior to the restricted experience monkeys.
Schulze (1975) did an experiment to find out the influence of social enrichment and impoverishment on learning. He raised 55 rats in social impoverished environment and 60 rats in social enrichment for 50 days following weaning, and then, tested on a variety of learning tasks in an operant conditioning chamber. Findings show that isolation produced significantly better learning when the training period directly followed the different conditions. After a 28-day-period of social deprivation for the subjects raised in enriched condition during infancy, no differences in learning between originally socially isolated and enriched subjects could be observed.

Gluck and Pearce (1977) conducted an experiment on Long-Evans hooded rats. Thirty-six rats reared in either socially impoverished or control environments were trained to bar press for food on a VI schedule of reinforcement, beginning at 125 days of age for 37 consecutive days. Subjects were then tested for response persistence during an extinction test. Next, the subjects were compared on measures of spontaneous recovery and the rate of response reacquisition when the reinforcement contingencies were once again reinstated. Though no difference was discerned between the groups on measures of acquisition, maintenance, and reacquisition, socially impoverished rats emitted many more responses than the controls during extinction testing.
deVans, Gibbs, and Ng (1980) did an interesting study in which they investigated the effects of social isolation on memory formation. Memory formation for a single-trial passive avoidance task in 100-day-old chicks was inhibited by intracranial potassium chloride, ovabain, or cycloheximide (CHX) when subjects were trained in pairs; when subjects were socially impoverished during training the onset of amnesia resulting from potassium chloride or ovabain was delayed, and amnesia due to CHX was prevented. It is suggested that the counteractive effect of isolation on CHX-induced amnesia was due to isolation extending some phase of memory preceding the CHX-sensitive protein synthesis-dependent phase, until CHX inhibition of protein synthesis started to dissipate. The release of noradrenaline associated with isolation induced changes in hormonal levels is considered to be a possible mechanism in this process. Although findings indicate that a similar mechanism underlies the delay of onset of ovabain-induced amnesia the mechanism for the delay of potassium chloride-induced amnesia as a result of isolation is not clear.

Some physiological studies were also conducted to find out the effects of environmental stress on learning ability of rats.

The environmental complexity paradigm had its origins when Hebb (1949) took rats home to be raised as pets by children and later found the rats to be better at learning
mazes. The protocol had been refined such that animals were usually assigned to one of three conditions: EC, environmental complexity; SC, social condition; or IC, individual condition. About 10 EC animals were typically housed together in a large set of toys that were changed daily. In addition, the EC animals were placed in a playpen for 1 hour, each day, with another set of toys. The SC animals were maintained in pairs in standard laboratory caging without toys. The IC rats were housed individually in similar cages. Early studies found that EC rats had a heavier cerebral cortex, especially visual cortex, than their SC and IC littermates (Bennett, Diamond, Krech, & Rosenzweig, 1964), in part, because the cerebral cortex was thicker (Diamond, Law, Rhodes, Lindner, Rosenzweig, Krech, & Bennett, 1966).

In another study, Rosenzweig, Bennett, and Diamond (1972) demonstrated the effect of early rearing environment on the neurological system of animals. They took two groups of rats. Both groups of subjects were socially enriched but one group of subjects was placed in larger cages with a variety of objects that were changed daily. The controls were raised in ordinary animal laboratory wire cages. After 30 days of differential rearing, the rats were killed and a variety of consistent and significant differences were found between two groups. Perceptually enriched rats had a greater weight of cerebral cortex, a
greater thickness of the cortex and a greater total activity of acetylcholinesterase. The cortex-subcortex ratio increased markedly and the RNA-DNA ratio was also increased, suggesting a higher metabolic activity. Similar studies have documented improved problem solving ability and improved memory for enriched rats.

**Summary.** The review of literature on the effects of environmental stress (e.g., both social impoverishment and perceptual impoverishment) on learning abilities of animals leads to contradictory conclusions. A number of investigators reported that both isolation stress and sensory deprivation stress have deleterious effects on the learning abilities of animals (Doty, 1972; Einon, 1980; Frank et al., 1977; Gluck & Sackett, 1976; Gutwein & Fishbein, 1980; Lin & Tang, 1984; Misra & Jena, 1987; Morgan & Einon, 1975; Morgan, Einon, & Nicholas, 1975; Myers & Fox, 1963; Rosenzweig et al., 1972; Wood & Greenough, 1974). However, some other studies reported either facilitatory or no effect of environmental stress on learning performances of animals (devans et al., 1980; Gluck et al., 1973; Gluck & Pearce, 1977; Schulze, 1975). The discrepancies may be due to variations in the nature of stress, duration of stress, types of learning, species and strains. However, most of the studies, even using other types of stress (e.g., ECS stress, crowding stress, malnutrition stress, food and sleep deprivation stress), have reported adverse effects of stress on the learning abilities of the animals.
Environmental stress and Cognitive abilities

Cognitive abilities include those abilities as perception, reasoning, intelligence, thinking, problem solving behaviour, memory, and other higher processes. Stressful conditions are found to affect these cognitive abilities. A few studies have been conducted to see whether or not perception, particularly, depth perception is altered by environmental stress.

One such study was conducted by Routtenberg and Kay (1965). Male albino rats of Sprague-Dawley rats were used as subjects. Results revealed a facilitatory effect of a single ECS on the rat's response to stepping from a platform 6-8 hours after ECS administration. It was concluded that the one-trial step-down passive avoidance (PA) task is commonly used to assess the so-called amnesic effects of ECS stress on learned responses. This task, however, entails perception of depth cues, and ECS stress has been shown to affect animals' perception in certain situations.

Another similar study was conducted by Misanin and Lewis (1970). In this study, male albino rats of Sprague-Dawley CD strain were used as subjects. The subjects were given either single ECS or pseudo-ECS on an open platform. Animals were tested for sensitivity and reactivity to foot
shock (FS), 0, 1\frac{1}{2}, 3, or 24 hours after the 15 minutes recovery period. The FS levels used in threshold test were 10, 20, 30, 40, and 50 volts. The shock-aversion threshold was found to increase initially after ECS stimulation and, within a 24-hour-period, returned gradually to a level comparable to that of a control group. Thus, ECS was found to decrease the rat’s sensitivity to FS by raising its shock-aversion threshold. The initial increase of thresholds of the convulsed animals reflected impairment of discriminatory abilities of the animals. It was concluded that ECS stress affects animals' perception.

Muir and Mitchell (1973) raised two kittens from the age of 3 weeks to 5 months and one from 3 weeks to 5 weeks in an environment which restricted their experience either to vertical or horizontal gratings. When not in those special environments, the kittens were kept in the dark. They were then treated normally from about the age of 6 months and were tested for visual acuity 3 to 6 months after that, compared with two cats that had been reared normally from birth, the deprived cats showed markedly decrease acuity when tested for their ability, to discriminate between a grating and a gray field.

Some evidence that impoverished early experience impairs cognitive abilities in primates came from a study
on chimpanzees by Davenport, Rogers, and Rumbaugh (1973). They compared wild born animals with restricted subjects born in the laboratory and raised singly in enclosed cribe for their first two years. At approximately three years of age, all subjects were caged together in a large "relatively enriched laboratory environment of continual varied social contact". The chimpanzees had a common and extensive experience on a variety of learning and problem solving tasks prior to the present study which begun at the age of 12 to 14 years. In this experiment, animals learned two-choice object discrimination problems to a present criterion. As soon as discrimination of a given pair of objects reached criterion, the previously correct object was made incorrect, and the previously incorrect object became correct. Although the early restricted animals were almost as good as the wild born chimpanzees in original learning of each problem, the restricted subjects made significantly more errors on the reversal tests. The authors concluded that the severe early restriction caused persistent cognitive deficits that were not overcome by subsequent prolonged environmental enrichment.

In order to test the hypothesis that there is a positive relationship between stress and the resistance to perceptual change, an experimental study was conducted by Muhar (1974), using before-after design on a sample of
60 subjects. Stress was induced by using pursuit meter, threat of shock, and white noise simultaneously. Resistance to perceptual change was measured in a leaf roof with the help of Ames Aniseikonic lenses by using three different measures: (i) the initial time lag in the appearance of the first change, (ii) time required for achieving stabilization, and (iii) the extent of distortion. The results of the first and third measures statistically rejected the hypothesis while the result of the second measure was inconclusive.

Creighton and Tees (1975) examined the effects of early visual deprivation on selective attentional mechanisms in 48 female hooded Long-Evans rats. A factorial design involving simple orientation or intensity discriminations, reversal or nonreversal shifts, and overtraining or non-overtraining, was employed using light and dark reared subjects. Dark but not light reared subjects failed to increase their perseverance score to the previous positive stimulus following a shift to a new problem after overtraining on the initial task. This result was taken as evidence of an attentional deficit. It is concluded that early visual experience is necessary for the development of selective attentional as well as visual information processing mechanisms, and that these two mechanisms interact to produce the deficits in visual discrimination learning observed in previous studies following dark rearing.
An exploratory level experiment was conducted by Naidu and Thapa (1978) to study the influence of stress on distance judgement. Ten male and 10 female undergraduate students were randomly assigned to each of the conditions; a control condition of no stress and three experimental conditions involving increasing order of stress generated with the help of different combinations of a flashing light, electric shock, and noise. Subjects were required to judge the distance of a playing card, kept on the table at six different distances. Time taken in making these judgements was measured. Analysis of errors of judgement revealed that: (a) there was no difference between the performance of male and female subjects; (b) compared to controls, subjects of the experimental conditions made more errors, but subjects of the three experimental stress conditions did not differ among themselves; and (c) the errors caused by stress increased as the distance judged increased objectively. The performance of experimental subjects was more variable and they took more time in judging distances. Data suggested that stress acts by accentuating initial response propensities.

Chatterjea, Bhattacharya, and Bhattacharya (1978) conducted a study to show the effect of failure stress on perceptual (cancellation of vowels) and conceptual (coding of meaningful words) tasks. The subjects
(9-10-year old) of each sex were divided into low and high achievers on the basis of their school records. They were tested in perceptual and conceptual tasks. Results showed that stress facilitated performance in perceptual task but impaired performance in conceptual task.

Another very interesting study was conducted by Mohanty (1985), on male albino rats of Wistar strain, to find out the behavioural effects of repeated administration of noncontingent ECS. For this purpose, groups of subjects were administered ECS of 54 mA for 0.5 second, once a day, for 1, 7, 14, and 21 consecutive days. Subjects of the control group received sham-ECS for one day only. Effects of ECS were observed 24 hours after the last ECS treatment day. It was found that noncontingent ECS:

(a) increased emotionality, (b) decreased spontaneous motor activity, (c) reduced general activity level or drive level (wheel turning activity), (d) reduced body weight, food intake, and water intake, (e) retarded discrimination learning and reversal learning of a visual form discrimination task, (f) retarded avoidance learning but not escape training, (g) delayed the latency of descent from a raised platform but did not impair depth perception in a visual cliff test, and (h) retarded the reasoning ability or intellectual capacity of rats as measured by Hebb-Williams Maze test. Thus, it was concluded that ECS, particularly, repeated administrations of noncontingent ECS, had detrimental behavioural effects.
Miara, Mohanty, Mishra, and Mohanty (1989) conducted an experiment to determine the main as well as the joint effects of photic condition, 3-dimensional object experience, and duration of such object experience on the depth perception of white leghorn chicks. The dependent measures were latencies of descent, and the side of descent from the platform of a visual cliff apparatus. The results revealed that chicks possess an innate tendency to descend from a raised platform irrespective of photic condition, 3-dimensional object experience, and duration of such object experience. Rearing in light, and increasing experience of 3-dimensional objects facilitated depth perception. In other words, depth perception of chicks reared in light and exposed to 3-dimensional objects for a longer duration would be better than those of chicks reared in dark without being exposed to 3-dimensional objects. Freezing response was more frequent when chicks were reared in darkness. Thus, depth perception was found to be learned to a great extent.

In contrast to the findings that environmental stress affects depth perception of animals, several other studies demonstrate that depth perception of animals is not affected by environmental stress.

In this context, one study was conducted by Shinkman (1963), who investigated that discrimination can take place without prior experience or learning. He took
chickens as the ideal subjects and tested on the visual cliff very shortly after hatching. It was found that the newly hatched chicks preferred the shallow surface. The evidence seems clear that the visually naive chicks discriminate between the two visual patterns provided by the shallow and deep sides of the cliff. Thus, without prior learning or experience the subjects could perceive depth; it is innate in nature.

In another study, conducted by Hinderliter and Misanin (1973) Long-Evans Black and Wistar albino rats of both sexes were used as subjects. On the treatment day, equal number of animals from both strains and sexes were given either ECS or pseudo-ECS treatments. Half of the ECS and half of the pseudo-ECS treated animals were tested for visual cliff behaviour 6 hours after and the other half of animals were tested 24 hours after treatment. Both side and latency of descent of each animal were recorded. Results revealed that various treatment groups did not differ from each other with regard to their latency of descent. Moreover, ECS did not impair the depth perception of rats, since in both experimental and control groups a significantly greater number of animals descended to the shallow rather than to the deep side. Thus, it was concluded that impaired depth perception can not account for the post-retention deficit in the step-down PA situation.
Another study was conducted by Pradhan, Das, and Mohanty (1984). The effects of early post-weaning experience in different perceptual environments, and ECS on depth perception, conditioned avoidance learning, and spontaneous motor activity of rats were investigated. Naive, male Wistar strain albino rats were used as subjects. The analysis of data revealed that both perceptual enrichment and ECS treatment did not affect either depth perception or conditioned avoidance learning whereas spontaneous motor activity was significantly reduced by these two variables.

Uttarakabat and Jena (1987) designed a study to examine the effect of rearing conditions on the visual cliff behaviour of chicks. The subjects were 24 male white leghorn chicks. Half of the subjects were reared in isolation and other half in two equal groups, for 1 day and 10 days prior to testing. Thereafter, each subject was observed in visual cliff for depth perception. It was found that rearing condition has no effect on chick's depth perception.

A few number of studies were performed to find out the effects of environmental stress on intelligence or reasoning ability of subjects. Some of these studies are cited below:
Hebb (1949) reported that rats reared in perceptually impoverished environments were inferior to rats reared in perceptually enriched environments on tests of problem solving, form discrimination, and the like.

Ravinovitch and Rasvold (1951) did an experiment and took a group of 28 male hooded rats and reared them in three conditions. One group was reared in small cages. The second group was also reared in similar cages after removal of different cortical regions without showing any gross sensory and motor defects at the time of testing. The third group was reared in a large free environment. All the animals were subjected to Hebb-Williams Maze test. It was found that the rats reared in the free environment made least errors. The highest number of errors was made by the cortically damaged subjects.

Hymovitch (1952) conducted an experiment in which rats were raised in four types of environments. Group 1 lived in a "free-environment", a large box containing runways, blind alleys, and objects that could be visually explored and manipulated. Group 2 lived in small mesh cages that restricted the rat's activity somewhat but afforded a rich visual environment. The mesh cages were moved each day to a different location in a laboratory, with 6 of these locations inside the free environment box. Group 3 lived in small stovepipes, which allowed little
movement and presented a very limited visual world. The animals of Group 4 were raised in enclosed activity wheels, visually they were as restricted as the rats of Group 3, but they were not deprived of motor activity. After a little over six weeks of living under these conditions, the rats were tested over a period of 3 weeks, in the intelligence testing apparatus used by Hebb, the "enclosed field" test. It was found that Groups 1 and 2 were superior to Groups 3 and 4, while neither 1 and 2, nor 3 and 4 differed from each other. The results of the test were as follows: Group 1 made an average of about 161 errors, Group 2 249, Group 3 153, and Group 4 222 errors. Group 1 made significantly fewer errors than Group 2. This is consistent with the hypothesis that early experience is more effective than the same experience later in life. Group 3 was not significantly better than Group 1, again indicating the relative unimportance of late experience. The same inference can be drawn from the failure of Group 2 to perform better than Group 4.

Similarly, Woods, Ruckelshaus, and Bowling (1960) tested rats, reared either in a free or in a restricted environment, on a Hebb-Williams maze. It was observed that the rats reared in restricted environment made more error scores.
In a similar vein, Smith (1972) designed an experiment to investigate the effects of early enrichment on both open field behaviour and Hebb-Williams maze performance. He took 24 male and 24 female rats of the Carworth Europe strain as subjects and reared them in groups in a perceptually enriched, or in a perceptually impoverished environment. It was found out from the experiment that subjects reared in restricted conditions made more errors in Hebb-Williams maze test than those reared in enriched conditions.

Goldman, Gomer, and Templer (1972) found that the Bender-Gestalt and Benton Visual Retention Test performances of male chronic schizophrenic inpatients, with a history of 50 or more ECT treatments, were significantly inferior to those of control patients matched for age, level of education, and race.

Another study was conducted by Templer, Ruff, and Armstrong (1973) on 14 male and 30 female schizophrenics. Of these patients, 22 had a history of receiving ECT from 40 to 263 with a median number of 58.5. The rest 22 control patients were matched for age, sex, race, and level of education. It was found that the performance of ECT patients on the Wechsler Adult Intelligence Scale (WAIS) was inferior to that of control patients. Thus, it was concluded that ECT affects intellectual abilities of the subjects.
In a study, Holm (1974) investigated the effects of environmental deprivation on academic performance, development of intelligence, use of language, and social integration in children of ship's masters (inland navigation). In each of these areas significant differences between children of ship's masters and other children were noted. Differences in intelligence and academic performances were significantly reduced after 2 years of elementary education.

Tripathi and Misra (1976) conducted one study to investigate some cognitive processes as functions of prolonged deprivation. They took 645 human subjects ranged from 15-25 years. The main aim of the authors was to discover the quantitative relationship between deprivation and relative efficiency in various types of cognitive processes such as depth perception, perceptual identification, and conceptualization. It was found that there is negative relationship between deprivation and cognitive efficiency.

A similar study was conducted by Squire, Chace, and Slater (1976). The main purpose of this study was to investigate whether intellectual abilities of subjects were affected by ECT. Before ECT, subjects' scores on the intelligence test were similar to those of a control group of 30 hospital volunteers. About 1 hour after the 5th ECT, performance was markedly impaired. Impairment
persisted 1-3 weeks after completion of ECT. Results indicated that: (a) ECT selectively affects memory acquired in recent years, (b) ECT disrupts the ability to make temporal judgements about remote events, and (c) resistance of memory to disruption increases with time.

Another similar study was conducted by Reichert, Benjamin, Neufeldt, and Marjerrison (1976). The performance in nonsense syllable learning of 23 psychiatric inpatients receiving unilateral, non-dominant ECT was compared with the performance of 27 inpatients receiving bilateral ECT. Assignment to treatments was random. In sessions held during the period when ECT was being administered, patients receiving bilateral ECT did more poorly in acquisition and in recognition tests. There were no significant differences between unilateral and bilateral ECT patients on the free recall measure. Bilateral patients did less well on the Quick Test of Intelligence, which patients took on the day after the last ECT treatment. By one week after the last ECT, deleterious effects of ECT on Quick Test performance had disappeared.

Mohanty (1980) conducted a study to find out the effects of sociocultural disadvantage on intelligence and short-term memory (STM). Socioculturally advantaged and disadvantaged subjects were drawn from two grade levels (i.e., 3 & 4), with 50 subjects in each of the four
resulting subgroups. Raven's Progressive Matrices (RPM) test (Colour Form), and STM test were administered. Socio-cultural dimension variances and grade variances were significant for RPM, STM, Clustering and Ratio of Repetition Index (RRI) scores. The scores on all these four measures of cognitive abilities showed favourable trends for advantaged subjects.

Ruff (1980) described a 53-year-old woman who developed a movement disorder, rigidity, and cognitive impairment during the course of ECT. Similarly, Freeman, Weeks, and Kendell (1980) observed the effects of ECT on a battery of 19 cognitive tests given to patients. The analysis of data revealed impaired cognitive functioning in the patients receiving ECT, but not in case of controls.

Basavanna and Rani (1984) conducted an experiment to find out the differential impacts of social and economic factors on intellective and scholastic abilities of Indian children. Four Hindu groups (10 subjects, each) of 7th and 8th grade students were administered the Progressive Matrices, a reading test, and the number subtest of the SRA Primary Mental Abilities test. Group 1 subjects had neither social nor economic handicaps (upper-caste, wealthy subjects); Group 2 subjects suffered social handicaps but not economic ones (lower-caste, wealthy subjects); Group 3 subjects suffered economic but not
social handicaps (upper-caste, poor subjects); and Group 4 subjects suffered both social and economic handicaps (lower-caste, poor subjects). Results show that economic and social factors had no effect on intelligence. However, social disadvantages affected verbal and numerical abilities.

An interesting study was conducted by Lancer and Rim (1984). They took 1,985 6th graders as subjects and administered them the Milta Intelligence Group Tests and Raven's Progressive Matrices. Data for the two tests were also collected for 796 of their older siblings who had been tested in the 6th grade. Data were also collected concerning subject's number of siblings, the order and spacing of their births, and family socioeconomic status. Larger family size and shortage age spacing were associated with lower intelligence test scores, with the effect being greater on verbal than nonverbal measures. The negative effects of family size on intelligence were more pronounced among low and middle socioeconomic status subjects than high socioeconomic status subjects. Results support the view that it relates different intelligence levels in various family configurations to environmental factors that influence more directly the development of verbal intelligence. Results may contribute to the issue of the influence of nature and nurture on intelligence and may have implications for social educational intervention.
Schooler (1984) reviews the literature supporting a theory of psychological effects of complex environments, which was suggested by research on the causal relationship between occupational conditions and psychological functioning. According to the theory, the complexity of an individual's environment is defined by its stimulus and demand characteristics: stimuli of greater diversity and complexity will lead to increased intellectual flexibility and more self-directed orientation. It is suggested that environmental complexity leads to effective cognitive functioning across all stages of the life span. This effect has been found in both sexes, in several nations, and in other species. Although the evidence is not as extensive, environmental complexity also appears to lead to a self-directed rather than conformist orientation because, it is contended, complex environments reward initiative and independent judgement.

In another study, Mohanty and Mohanty (1988) investigated the effects of electric shock stress on the general activity level or drive level, simple discrimination learning, and cognitive ability of both male and female Wistar albino rats. The results revealed that stress increased the general activity level or drive level of animals. Males were found to be superior to females in the general activity level. In addition to this effect, stress impaired the simple discrimination learning and
also retarded the cognitive ability (i.e., reasoning ability, intellectual capacity, and complex perceptual processes) of rats as measured by Hebb–Williams Maze test. It was concluded that stress has deleterious effects on the drive level, discriminatory ability, and intellectual capacity of animals.

In contrast to the findings that environmental stress adversely affects the reasoning ability or intellectual capacity of animals, a few other studies demonstrate that intellectual capacity of animals is not affected by environmental stress.

In such a study, Evans (1984) investigated the effects of variation in the physical environment and of stress on the cognitive representation of space. One hundred twenty eight 16-36 year old subjects saw one of four environmental conditions (variations on landmarks and grids or no landmarks and grids) under either quiet or noise conditions. Results indicate that manipulations of the pathway-grid configuration and landmark placement in a setting cause changes in environmental knowledge. The experimental manipulations were accomplished using a realistic, dynamic stimulation technique. Measures of environmental knowledge include memory for incidental information along the stimulated urban route, accuracy of route maps, relocation memory for scenes along the
route, and questionnaire measures. Data showing both positive and negative effects of stress from noise on the processes of environmental cognition are presented.

Summary. The review of literature on the effects of environmental stress (e.g., social isolation and perceptually impoverished environment) on cognitive abilities (i.e., perception, intelligence, reasoning ability, etc.) leads to contradictory conclusions. A number of studies reported that stress adversely affected the perceptual abilities (Chatterjea et al., 1978; Creighton & Tees, 1975; Davenport et al., 1973; Misra et al., 1987; Mohanty, 1985; Muhar, 1974; Muir & Mitchell, 1973; Naidu & Thapa, 1978) and the intellectual capacities (Basavanna & Rani, 1984; Hohn, 1974; Hymovitch, 1952; Lancer & Rim, 1984; Mohanty, 1980; Mohanty & Mohanty, 1988; Schooler, 1984; Smith, 1972; Tripathi & Misra, 1976) of the subjects. However, a few other studies reported either no effect or facilitatory effect of stress on perception (Hinderliter & Misanin, 1973; Pradhan et al., 1984; Uttarakabat & Jena, 1987) and reasoning ability (Evans, 1984) of the animals and birds. The discrepancies may be due to variations in the types of stress, duration of stress, species and strains of the animals, and types of tasks employed to measure the perceptual abilities, reasoning abilities, and intellectual capacities of the subjects. However, a large number of
studies, in general, have reported experimental evidences in favour of the adverse effects of environmental stress on perception and intelligence of the subjects.
Statement of the Problem

The review of literature in the preceding section on the impact of perceptual and social environmental stress on the behaviour of animals leads to conflicting conclusions. In some studies, rats reared in a perceptually impoverished environment are found to be more emotional (Das, 1984; Das et al., 1987; Riittinen, 1986; Studelska & Kemble, 1979; Uphouse & Brown, 1981; Will et al., 1979), and in some other studies they are found to be less emotional (Gluck et al., 1973; Syme, 1973; Syme & Syme, 1976) than the rats reared in a perceptually enriched environment. In some measures of emotionality socially impoverished or isolation-reared rats are found to be more emotional (Misra et al., 1982; Mohanty & Mishra, 1984; Mohanty & Mishra, 1986) and in some other measures found to be less emotional (Benton & Brain, 1981; Binon et al., 1976; Gentsch et al., 1981; Warren & Ivinskis, 1973) than socially enriched or group-reared rats. A few studies, however, reported no significant effect of social environmental stress on emotionality of animals (Misra & Mishra, 1981).

In most of the studies, however, a few number of indices of emotionality were taken into consideration. Some of these indices do not yield consistent and reliable results. It is, therefore, necessary to include a large number of such indices in order to assess reliably the
effects of environmental stress (i.e., sensory deprivation stress, and social isolation stress) on emotionality.

Emotionality is closely related to exploration, spontaneous motor activity, and avoidance learning. Environmental enrichment, both perceptual and social, is found to modulate exploratory behaviour of animals. In some studies, perceptual impoverishment is found to inhibit exploratory behaviour (Ferchnin et al., 1975; Gardner et al., 1975; Hopf et al., 1985) whereas some others observed impoverished environment to facilitate exploratory behaviour (Pati & Dikhit, 1982; Pati & Mohapatra, 1983). Similarly, some investigators observed higher exploration in animals reared in socially impoverished environment or in social isolation (Nielsen, 1970; Sahakian et al., 1977) whereas some other investigators observed socially enriched or group-reared animals to be more explorative (Einon & Morgan, 1976; File, 1978; Misra & Nanda, 1973; Turpin, 1977).

In some instances perceptually impoverished environment is found to reduce spontaneous motor activity and general activity level of animals (Guyot et al., 1980; Manosevitz & Pryor, 1975; Mitani, 1975; Mohanty & Das, 1984) whereas reverse results are found in some other instances (Joseph & Gallagher, 1980; Siegel & Jensen, 1986). Similarly, some observers reported that isolation-rearing enhances spontaneous motor activity and general activity level of animals.
In some studies, animals reared in perceptually impoverished environment are found to learn an avoidance task (de Vans et al., 1980) and a discrimination task (Gluck et al., 1973) faster whereas some others found faster avoidance learning (Doty, 1972) and faster discrimination learning (Gutwein & Fishbein, 1980; Mohanty et al., 1984) in animals reared in a perceptually enriched environment. Similarly, isolation-reared animals are found to be better learners of an avoidance task (Gluck & Pearce, 1977; Rasmussen, 1939) and of a discrimination task (Schulze, 1975; Woods, 1959) in some studies whereas in some other studies group-reared animals are found to learn an avoidance task (Russell, 1973; Wood & Greenough, 1974), and a discrimination task and its reversal (Einon, 1980; Lin & Tang, 1984; Misra et al., 1982; Misra & Jena, 1987) faster.

Perceptually impoverished environment is also found to retard perceptual abilities (Misra et al., 1987; Muhar, 1974) and intellectual capacities (Basavanna & Rani, 1984; Hymovitch, 1952; Lancer & Rim, 1984; Mohanty, 1980; Schooler, 1984) of subjects in some instances although in some other studies either no such effect or reverse effect was found (Evans, 1984; Pradhan et al., 1984). Similarly,
social isolation-reared animals are found to be poorer in perceptual abilities (Creighton & Tees, 1975; Davenport et al., 1973) and in problem-solving abilities (Denenberg et al., 1968; Smith, 1972) than group-reared animals in some instances although no such difference was found in some other instances (Smitz, 1972; Uttarakabat & Jena, 1987).

A comparative theoretical approach is necessary to reconcile the above contradictory findings on the impact of stress induced by early rearing environments on behaviour of animals. An animal lives in a physical or perceptual environment which may vary in size and quality, and thus, in providing sensory stimulations, from individual to individual and from time to time. In such a varying physical environment (either perceptually enriched or perceptually impoverished), the animal acquires varying social experiences (reared in isolation or in groups). The experiences acquired by an animal from its interaction with the physical and social environments, therefore, differ from individual to individual. Each individual develops a typical response tendency which is a product of its genetics and environment. In order to assess the impact of stress induced by early rearing environments (i.e., perceptual and social environments) on behaviour of animals at a later stage of life, the physical (or perceptual) and social environments of the animals should be defined precisely and quantitatively and should not be considered in isolation. A large number of
indices of emotionality should be under observation to assess the impact of such environmental stresses on emotional reactivity of animals. A number of other abilities, known to be affected differentially due to stresses induced by differing rearing environments early in life, should also be under observation in order to develop a comprehensive view about the impact of such environmental stresses on behaviour. Unfortunately, a few attempts have been made so far to show the joint effect of perceptual and social environmental stresses on behaviour of rats (Gardner et al., 1975; Mohanty et al., 1984).

With the logic and rationale outlined in the preceding paragraph, eight independent experiments are planned to study further the impact of rearing environmental stress on behaviour of rats. In each experiment, male Wistar rats of comparable age would be reared, just after weaning, in a perceptually impoverished or in a perceptually enriched environment either in isolation or in groups for 60 days.

The dependent measure under observation in Experiment 1 would be emotionality (neophilic/neophobic reactions) in the open field. The indices of emotionality would be: (a) ambulation, (b) thigmotaxis, (c) rearing, (d) grooming, (e) inactivity bouts, (f) inactivity time, (g) defecation, and (h) urination. Similarly other seven dependent measures under observation would be: (a) investigative exploration
in the Exploratory Box (Experiment 2), (b) spontaneous motor activity in the Photoactometer (Experiment 3), (c) general activity level or drive level in the Activity Wheel (Experiment 4), (d) acquisition and extinction of a simple discrimination task in the Discrimination Box (Experiment 5), (e) retention of a step-down passive avoidance learning task in the Step-down Passive Avoidance Apparatus (Experiment 6), (f) depth perception in the Visual Cliff Apparatus (Experiment 7), and (g) intellectual ability or reasoning capacity in the Hebb-Williams Maze (Experiment 8).