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Behavioral and physiological consequences of crowding in humans.

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BEHAVIORAL AND PHYSIOLOGICAL CONSEQUENCES OF CROWDING IN HUMANS

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OF CROWDING IN HUMANS

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ABSTRACT

The purpose of this laboratory study was to investigate the effects of crowding on human behavior. Results generally supported the major hypothesis that crowding acts as a stressor mediated by high arousal. Significant increases in blood pressure and heart rate were found for subjects in crowded conditions compared to different subjects in uncrowded conditions. Decrements in complex task performance were also found. These included more errors in a high signal rate task and greater errors in a secondary task during a dual task situation. Less tolerance for frustration as an aftereffect of the crowded experience was also reported. Poorer performance on a group cooperation task was also found for the crowded groups. The main effect of sex was nonsignificant as was the sex by crowding interaction term. Some self-report and observational data were also consistent with the stress hypothesis.

The second major hypothesis of the study was that individual differences in responses to crowding could be explained by a constellation of personality and background variables. This hypothesis was not supported. Analysis revealed that the set of multiple regression equations for the crowded conditions were not unique to that condition, i.e., the regression functions for both major conditions, crowded and uncrowded, were parallel.

Behavioral and physiological consequences of crowding in humans

The human experience of crowding is an extremely complex and important phenomenon. Our understanding of human spatial behavior is at a very early stage of development. This research attempts to deal with two problematic areas that have consistently plagued much proxemic research to date. First, although the emphasis of this research is placed upon the exploration of a little researched phenomenon, some specific testing of existing albeit implicit theories of crowding is carried out. Further the preliminary outlines of a new scheme for organizing some existing findings are presented. Second, a more thorough measurement approach is taken which reflects the multivariate response domain of the human response to high density. This multivariate approach is necessary for more fully delineating the differential contributions of personal and environmental sources of variance in the human response to high density. This approach also has the added advantage of providing a means for outlining what types of behavior are affected by high density and which are not.

This research project has four basic objectives:

1. To examine the behavioral and physiological consequences of crowding;
2. To explore further the distinction between high density and crowding;
3. To monitor the adaptive/coping responses of individuals under crowding conditions and;
4. To investigate what contribution various personological and sociological variables make to an individual's responses to crowding.

To meet this broad agenda, subjects were placed in either a high density condition or a low density condition. Self-reports of affective states, performance measures, physiological recording data and observational indices were collected. In addition, selected personal and background information for each participant were obtained.

This introduction is not meant to be an exhaustive review of the literature. The animal research is briefly outlined and then several theoretical overviews on human crowding research are presented. Findings are introduced which support and contradict each theoretical position and an attempt is made to compare and contrast the various theoretical perspectives on human crowding. From analysis of these positions, certain questions are drawn which, hopefully, lead to the present research project. Note that much of this research is deliberately broadbased and exploratory in nature. While some of the findings lend themselves to post-hoc application to various theoretical issues, most of them only generate more questioning and suggest further areas of research. Given that research on crowding is at an early stage of development, this is as it should be.

Animal Research

The basic conclusion that one draws from animal studies of crowding is that pathological responses are observed for animals living under high density. These responses have been found in many studies of both physiological and behavioral variables. The weight of evidence suggests that the critical mediating mechanism is stress as opposed to the ultimate limitation of resources as suggested by the Malthusian position. Stress as a mediating mechanism is perhaps best demonstrated by the classic Sika deer study of Christian, Flyger and Davis (1960) who found a sudden and drastic population decline in a population of deer who had been confined to an island with adequate resources and no known predetors. After the population of deer had built up to a high level, the deer began dying off in large numbers. During this continued phase of population decline, examination of the dead animals revealed that death had been caused by stress as evidenced by excessive ACTH levels, severe metabolic malfunctioning and greatly enlarged adrenal glands. These data are consistent with earlier work done by others, especially Selye (1956), who had examined the effects of various stressors on different organisms..

More intensive laboratory analysis by Christian and co-workers (1961, 1964) also supported a primary feedback mechanism of the adreno-cortical system which was density dependent. Crowded mice, compared to litter mates who were not crowded, had enlarged adrenal glands, decreased thymus weights and a decrease of testicular androgen in males. Other data also indicate that rats reared under high density conditions have significantly greater adrenal to body weight ratios (Goeckner, Greenough, & Mead, 1973; Morrison & Thatcher, 1969). Furthermore, when female mice were crowded, reproduction dropped off and lactation activity was severely inhibited. The increase in adrenal weight which Christian noted was attributed to cellular hyperatrophy and hyperphasia of the zona fasiculata of the adrenal cortex. The decrease in testicular androgens in crowded males was reflected by partial atrophy and consequent weight loss in the seminal vesicles and testes. In crowded females, Christian reported accelerated involutions of the X-zone of the adrenal cortex. The X-zone is considered a transitory zone which is involuted by androgens and maintained by a lutenizing hormone from the anterior pituitary gland. This zone usually disappears at puberty in males and during pregnancy in females. The abnormal involuted X-zone in grouped female mice suggests that there is either an increase in the secretion of adrenal androgenes or a drop in lutenizing hormones from the anterior pituitary.

Working in a natural habitat, Snyder (1961) has found consistent morphological modifications in crowded woodchucks as a function of density. A less dense population of woodchucks had a signficantly lower mortality rate than woodchucks under denser conditions. Snyder allowed one area of woodchucks to reproduce and systematically removed thirty woodchucks per month for eight months from another area (the less dense group). In addition to mortality differences, the less dense group had higher reproduction rates, larger litters, less infant mortality and a greater percentage of pregnant females.

Of those animals that died in the more dense group, the majority were young woodchucks. In the less dense group, this difference in mortality as a function of age was absent. Synder also cited other research with prairie dogs and snowshoe hares showing similar differential mortalities as a function of age.

Christian (1961) has been able to correlate the differential severity of reproductive deficiency under high density conditions with testicular atrophy in males. He found that the testicular size of males under high densities declined significantly only in animals less than 45 grams (adult weight). Further examination revealed that these males had never reached maturity.

This line of research suggests that the stress response of animals to extreme conditions of high density may be a regulation of population by delaying maturation and inhibiting reproduction.

Southwick (1972) has argued, however, that the extent of the above reported changes in adrenals and gonads is limited to laboratory findings only and has not been found in field studies of natural populations. An alternative explanation of behavioral, physiological mechanisms in population regulation may be olfactory blocking in females wherein there is a 80-90% failure of implantation when impregnated females are exposed to strange males. Alternatively, under natural conditions during pregnancy and nesting, females are highly territorial excluding males from the nest sites. During periods of high density this territorialism breaks down.

While clear effects on natality seem apparent, the influence of high density on the mother may also extend through the neonatal period, as well, in that lactation is suppressed and generally effective maternal care is largely absent (Calhoun, 1962).

Thiessen and co-workers (1961, 1964) have argued for a cautious interpretation of the relationships posited among population density and endocrine functions. They argue that several other mediating factors are important in examining the effects of high density on organisms. First, Thiessen has pointed out that there are clear species differences apparent, plus more complex mediating factors such as critical periods, estrous cycles, social rank and familiarity with the immediate environment.

For example, Christian has found that animals low in dominance are particularly susceptible to the stress of high density. Familiarity with an environment may interact with spacing mechanisms. Many ethologists have argued that crowding occurs because of a breakdown in these mechanisms such as territory or home range (Alexander & Roth, 1970, Leyhausan, Eible-Eibesfeldt, 1970).

Several researchers have focused primarily on behavioral consequences of high density in animals. Calhoun (1962) overcrowded rats and found a general breakdown in normal social behavior. In his now classic study, Calhoun allowed rats to overpopulate within a confined area with adequate food and water. As population density increased, the rats developed acutely abnormal patterns of behavior which included dramatic increases in aggressive behavior, increased infant mortality, deviant sexual behavior and cannibalism. Calhoun also noted the curious formation of a phenomenon he called a 'behavioral sink' in which the rats concentrated in disproportionate numbers around a particular food hopper. The maternal behavior and care of the young were also greately affected by increased crowding. Litters were often abandoned and eventually nest building ceased entirely.

In more recent work, Calhoun (1971) has completed some longitudinal studies of overpopulated rat colonies. In general, he has found that these animals pass through four stages: i) an establishment phase which extends to time of birth to the first successful litter, ii) a period of rapid population growth, iii) a reduction in population growth, iv) stability or slight decline in population numbers.

Near the end of phase iii) aberrant social behaviors sharply increased and by the onset of iv) successful rearing of young was nearly absent. In addition, consistent with previous data reported above, conception dropped off significantly in these latter stages. It is of interest in light of Christian's work that Calhoun also reported that the young in phases iii) and iv) seemed to be in a suspended juvenile state in terms of their behavior.

Research has also indicated that rats reared under high density display reduced behavioral indices of emotionality. Significantly less freezing, and time spent in corners along with more rearing were found for rats raised in crowded cages than uncrowded cages. Furthermore, the effect of grouping in a testing situation significantly interacted with rearing density. The typical reduction of emotionality when animals are tested in groups versus individually was significantly reversed for the crowded reared rats (Morrison & Thatcher, 1969).

Consistent with Chitty's (1955) hypothesis that high population density conditions may adversely affect the viability of subsequent generations, and some physiological data of Christian's (1961), one researcher has examined the effects of crowding on the unborn. Keeley (1962) placed groups of 15 or 5 pregnant albino rats in 6x12x5.5" cages. With birth imminent, the mothers were segregated to deliver their pups. All pups were then raised by either their own mother or another previously crowded or uncrowded mother in uncrowded cages with food and water freely supplied.

The pups were then measured at 30 and 100 days for activity level and amount of defecation when placed in a novel environment. The pups from crowded mothers were generally less active and defecated less than the control mice. Whether the pups were cared for, nursed, etc., by a previously crowded mother or uncrowded mother was not significant. This is of interest because it may suggest that the prenatal environment is more important than postnatal. The responses at 30 days were also not significantly different from one another than at 100 days which indicated some persistence in the responses measured.

Furthermore, recent work indicates that rodents reared from weaning under high density conditions exhibit impaired acquisition of complex learning tasks, but not of simple tasks (Goeckner et al., 1973). Crowding of previously isolated adult rats, however, tends to facilitate acquisition of the same complex tasks (Wood & Greenough, 1974). Goeckner et al., found that rats reared in crowded conditions were impaired in learning a brightness discrimination task to avoid shock, as compared to previously uncrowded animals. Previously isolated (39-95 days old) adult rats, however, when tested after spending four weeks under high density conditions, were superior to those previously isolated rats housed under less dense conditions.

In summary, crowding in animals has been shown to affect organisms both in their behavior as well as certain physiological responses (particularly centered around the endocrine system). In general,crowded animals have been shown to exhibit changes in physiological indices which include: increased adrenal gland activity, decreased testicular androgen production in males and increased estrogen content in females. Evidence also suggests an effect of crowding on the care and maturation in the young. Furthermore, there is some evidence of increased signs of social pathalogy under conditions of high density.

While this summary represents a consensus view of the effects of high density on animal populations, several cautions are needed. First, as mentioned earlier, there is evidence of some interspecific differences in reaction to high density. Second, important mediating factors such as biological rhythms, social rank, sex, age and degree of environmental familiarity may all affect the individual organism's response to high density. Third, in several cases, group size is confounded with density levels as well as congestion levels. Either of these two variables, group size, or congestion may in itself, be important variables in affecting behavior. Finally, Calhoun's work in particular is based upon qualitative observations and no control group.

In addition to some of the articles discussed here and in particular Christian (1961), and Thiessen (1964), Esser (1971) contains a more extensive review of the literature on high density and animal populations.

Human Crowding

The effects of high density upon human behavior are considerably more ambiguous than those effects associated with high density in other animals. In the case of human crowding, it becomes necessary to distinguish between high density and crowding (Stokols, 1972). There are situations in which high density is perceived as enjoyable or exciting, where individuals would not describe themselves as feeling crowded. High density thus should be treated as a necessary, but not sufficient cause of crowding. Stokols has suggested that the latter term be utilitzed when one's need or demand for space exceed the supply. Various other definitions which have been offered will be taken up within the theoretical context where they appear. Loo (1973) and others have wisely pointed out that high density may be achieved in two separate ways. One can increase the numbers of people in a given area or hold the numbers of persons constant and manipulate available area. The former has come to be called social density and the latter spatial density. This distinction may be an important one in trying to make sense of the available research work to date on crowding where some contradictory work on "human crowding" turns out to have been manipulating density in different ways (Loo, 1973).

Initial speculations about human crowding often drew heavily upon ethological analogies based upon Calhoun's and others work with animals: e.g., that one cause of the 'behavioral sink' in which the inner cities of America was high density. The classical study of crowding and mob psychology by Le Bon (1895) likened the crowds of the French revolution to a great mass which roamed about swallowing up the individual's autonomy. Upon entry into the mob, one gave in to appeals of highly contagious emotionality and no longer listened to the "voices of reason." As a result of this process, persons in a crowd became highly susceptible to demagogic leaders whose clarion calls for supreme obedience were rapidly and gratefully adhered to. More recent sociological analyses (cf., Melbin, 1972) have also described crowds in similar terms as organizations which promote irrational behavior concurrent with a loss of individual autonomy and sense of responsibility.

Biderman, Louria and Bacchus (1963) have reviewed some historical incidents of overcrowding focusing upon severe incidents such as slaves passages to North America, crowding in hospitals and various prison, and concentration camp situations. Surveying the all too numerous instances where people had been forced into inhumane living conditions which included high density, the authors concluded that mortality was particularly high under conditions where: i) the crowded individuals were kept against their will by persons who were perceived as having no concern for the interned persons; and ii) where the interned were ravaged by epidemics.

The problem with drawing any definitive conclusions from such a historical analysis is obvious - not only were persons crowded in the above instances, but a host of other rather hostile, negative conditions covaried with high density, such as poor sanitation, poor food and the emotional shock of incarceration and separation from home and family.

More recent speculations about the inner city as a behavioral sink have related high levels of violence and apparent social disorganization to high density living conditions (Carstairs, 1969; Kyllonen, 1967; Leyhausan, 1965; Winsborough, 1965). Again, the obvious problem arises of other variables which also are operating under environmental conditions of high density such as socioeconomic status, racism or even high levels of pollutants (McHarg, 1969).

Early research efforts on human crowding were undertaken primarily by sociologists and demographers who were interested in examining the relationship between areas of high density, primarily in urban areas, and various social pathologies such as crime, disease, emotional disturbances and mortality. Typically, these studies have been plagued with certain problems. First, their primary approach has been correlational and little, if any, adequate control for potentially confounded variables has been applied. Conditions of poverty, poor health, higher levels of pollutants, etc., often co-exist with inner city high density areas.

Second, researchers have defined density in a myriad of ways ranging from persons per room to people per acre. Recent research suggests that particular density measures both on a micro level (cf. Galle, Gove, & Mac Pherson, 1973) as well as on a more macro, cross national level (cf. Day & Day, 1974) are critical in attempts to delineate relationships between high density and various psychosocial indicators. Galle et al. (1973) for example, found that several density measures in a U.S. urban setting did not correlate highly with selected pathology indicators (mortality, juvenile delinquency, etc.) with the exception of a persons per room measure, which did correlate highly with various measure of social pathology. This relationship held up, furthermore, even when controls for potentially confounding SES and cultural variables were maintained through partial correlation techniques. Turning to a more macro scale of density measure, Day and Day (1974) have argued the point that using areal density and social indicators is misleading because it overlooks patterns of urban concentration and congestion. Thus, while the overall areal density of the U.S. is considerably lower than that of many European countries, urban centers where most people live and spend a majority of their time in the U.S., have substantially higher densities than European countries.

Third, as Altman (1975) has pointed out, the primary intent of many of the early sociological studies was to document an outcome rather than exlpore the process by which density might operate to affect various behavioral patterns.

Initially, studies compared urban and rural settings on crime and mental illness, often yielding little or no differences (Freedman, 1973). The Chombert de Lauwes (1959) studied various aspects of family life and found that the number of residents per dwelling unit yielded no significant relations to various social and physical maladies. They did find, nonetheless, that the number of square meters per person per unit did correlate significantly positively with certain psychosocial indicators of stress such as health indicators and juvenile delinquency rates. Schmitt (1957), on the other hand, found a higher correlation between persons per acre than persons per room and juvenile delinquency rates in Honolulu. Schmitt's attempt to partial out some SES variables has been criticized by Freedman (1973) as insufficient due to a gross dichotomy assignment where SES variables were placed as other high or low. Schmitt (1963) has also introduced the importance of cultural mediating factors into sociological analysis of high density. He pointed out that while extremely high density conditions exist in Hong Kong, various health indicators and crime rates reflect an essentially healthy area, in fact superior to several other countries of the world including the U.S. The caution drawn by Day & Day (1974) is relevant here.

Recently, Mitchell (1971) in a more detailed analysis of dwelling unit density in Hong Kong found that while people were clearly aware of the lack of space and privacy, the affects of high density seemed to be mediated vis-a-vis various social structures. That is, high density was particularly distressing (according to self report measures) for persons who were forced to share spaces with another household. This is consistent with Schmitt's hypothesis that one of the reasons people in the Hong Kong culture and society could handle high density was the rigidly acculturated social hierarchies within the family. Presumably when families are mixed within a space, this hierarcial arrangement is less operative. Mitchell also found that persons on the upper floors of buildings found density more troublesome. He suggested that the constrictions of forced interaction, plus an increased difficulty in escaping from the congestion of high density on higher floors may lead to more serious consequences.

Michelson (1970) has suggested that the congruity between high density and certain family and social peer interaction patterns may lead to situations where high density living is desirable. He cites Gans' work on the West End of Boston which depicted a social group highly desirous of easy, open access to friends and relatives. In order to maintain this life style and support for the more person-oriented, open-to-interaction lifestyle, Gans considered high density housing essential. With the destruction of the West End, high density cluster living was replaced with a renewal project which included less proximate, lower density building accommodations. The resident's preferred person-oriented lifestyle was now lacking the necessary ecological supports to sustain itself suffered greatly, according to Gans' analysis. If we are willing to accept for the moment that high density was a critical component of the West Ender's social structure, Michelson's analysis supports the need to examine the critical motivational and psychological components of various individuals in predicting their reactions to restrictions of physical space. Parenthetically, the issue still remains whether, in fact, the high density factor was the key to the communication patterns so important to this culture. The example is instructive, however, in that once again it underlines the important point that high density is not necessarily synonymous with crowding.

Overall these lines of sociological analysis, plus others which are reviewed by Freedman (1973) suggest that while there may be some relationship between high density and certain social and physical maladies, the nature of that relationship is not specified and its strength is highly variable.

Following these initial research programs, some experimental and field studies examined human behavior under conditions of varying density. The remainder of the introduction organizes much of the existing, fragmentary data into several theoretical outlines. These perspectives are elucidated,compared, and criticized. Finally, the introduction ends with a rationale of the present study.

Theoretical perspectives on human crowding

At least three theoretical perspectives on crowding have been implicity operating in much of the work on crowding in humans to date: i) ecological approach, ii) sensory overload, and iii) stress and perceived control or behavioral restraint.

i) Ecological approach - The ecological approach to human crowding stems from Barker's theories of manning in social settings (Barker, 1968). Settings are conceived of as environmental units which are characterized by standing patterns of regularly occurring behavior that occur in definite time and place boundries. The perspective argues that settings make certain claims on behavior which may be expressed by roles. Manning refers to the relationship between the number of roles necessary for the maintenance of a behavioral setting and the number of capable and willing persons available to fill those roles. Thus, a setting which is adequately manned will have an equal number of roles and such persons. Baker found that some settings existed which were clearly undermanned, such as a small town high school. In such settings, the role requirements necessary to maintain the setting exceeded the number of able persons available to fill those roles. Under these conditions Baker noticed that people felt and acted towards the setting differently than persons in adequately manned settings. Individuals in an undermanned setting were more likely to take on extra responsibilities such as working longer hours and performing a greater number of different tasks and roles.

Wicker (1974) has recently extended Baker's manning concept in the other direction by examining what might happen when settings are overmanned, i.e., more than enough people to fill the maintenance needs of a particular setting. According to this view, persons per unit space may not be the critical element with regards to crowding. Instead, the relationship between the maintenance needs of the setting and the numbers of persons available to assume roles is critical. In other words, the degree of manning in a setting may be more critical in determining whether an area is considered crowded.

While there has been considerable evidence to support the adequate manning and undermanning concepts (see Barker, 1968, Wicker, 1974), very little work has focused on overmanned settings. Hanson and Wicker (1973) manipulated manning level in a slot car task by varying the numbers of persons present and number required to perform the task. In the adequately manned groups either one or three persons were present when two or three, respectively were required. In the overmanned condition, three people were present when two were required for the task. In the latter condition, the group members felt less important, less needed and less valuable to the group than those operating in either of the adequately manned groups.

More recently, Wicker (1974) measured performance, subjective experiences and interaction patterns of four persons working on a slot car task designed for two, four or six persons. In the overmanned condition, subjects felt less involved and less important in decision-making and saw the situation as less pleasant than the individuals in undermanned or adequately manned conditions. No performance differences were found.

The ecological perspective on crowding research has several important implications which need to be further explored. First, as mentioned above, perceived crowding may be more attributable to the degree of manning in a setting than to physical space parameters, i.e., the constraints of a setting are primarily due to the social structure and only secondarily to its physical design. Second, this perspective suggests that more attention in proxemic research needs to be placed upon the setting's basic purpose. What people are doing and are expected to be doing in their day to day functioning relative to setting maintenance is important.

Stokols and Evans (1975) have suggested that ecological analyses of crowding have failed to address certain issues with regards to degree of manning and perceived crowding. First, the ecological approach treats manning levels primarily in quantitative terms which overlooks the possibility that certain types of behavior settings may induce more negative reactions in group members to overmanning. One dimension which might be relevant here is the strength of maintenance demands put on setting participants, which vary from setting to setting, and are also perceived differently by various participants in the setting. Second, resource scarcity which might threaten the existence of the setting independent of manning level may interact with member's perception of setting's demands. Third, is there any carryover between overmanning experiences in one setting to another? Finally, not all behavior occurs within a well defined behavior setting context where degree of manning is said to operate. Yet even in such situations, one could conceivably experience crowding.

ii) Stimulus overload - The most recurrent explanation of various proxemic phenomenon including crowding has been the stimulus overload model. The model suggests that when one is too close to another person, they suffer from an information overload. This overload is due, in part, to the qualitative and quantitative shifts in sensory stimulation that occur with a reduction in interpersonal distance and/or the addition of additional sources of stimulation in the form of proximate others. Hall (1966), for example, suggested that when another individual is very close, not only will one be able to see more facial details (quantitative shift), but one can also pick up olfactory and thermal cues (qualitative shift) at the closer proxemic ranges. There are two aspects of this theory which should be kept separate. One is that there is some quantitative change in the stimulation impinging upon the organism so that in order to access the situation, the individual must process more information and make decisions more rapidly. The other is that qualitative change occurs such that the individual is unaware of the consequences of his decisions because he is not used to dealing with the new information. Actually, it is the quantitative aspect that has dominated research strategies.

Crowding and urban living have also been related to the concept of stimulus overload. Early sociologists, particularly Simmel (1903) and Wirth (1938) argued that the urban environment forced city dwellers to deal with excessive levels of stimulation because of the diversity, size, and density of the urban scene. They suggested that among the consequences of dealing with this 'overload' were various forms of physiological and psychological pathologies, such as higher rates of disease and marked feelings of alienation and impotence.

Milgram (1970) building upon the earlier work of Simmel and Wirth, has developed an analysis of urban behavior which suggests that the moral and social involvement of urban inhabitants is necessarily restricted due to the extraordinary amount of stimulation they are confronted with daily. Milgram's theory is based on a comparative analysis of urban and rural inhabitants behaviors. Urban dwellers were found to give less time and assistance to strangers; were much less likely to intervene in a crisis; were more anonymous and less friendly; and participated in more strictly defined role behaviors than their rural counterparts.

Overload,according to Milgram, occurs when either the amount or rate of environmental inputs exceed the organisms capacity to deal with that input. The differential response of urban and rural dwellers outlined above suggested to Milgram that urban people were adapting to the stimulus overload environment by disregarding low priority inputs, allocating less time to each input and remaining aloof and distant from novel stimulation. Presumably these means of coping might serve to reduce or eliminate some stimulus input.

More direct analyses of crowding have adapted the stimulus overload approach as well. Esser (1972), for example, has suggested that one important factor contributing to the experience of being crowded is stimulus overload, which source can be either internal or external of the organism. An internal source of stimulus overload could derive from altered or diminished functioning of the central nervous system or from the generation of new concepts which might lead to unfamiliar cortical images that the organism is unequipped to handle. External sources of stimulus overload might include forced interactions with too many individuals or constant encounters with novel environments.

Desor (1972) has suggested that the overall level of social stimulation is an important variable in determining crowding experience. Here crowding is defined in terms of extreme stimulation from social sources only. Desor had subjects place stick figures (people) in small models up to the point where the people represented would feel crowded. She found that partitioned rooms of equal area had a greater carrying capacity in that more people were placed in them up to the crowding limit. Further, it made no difference whether the partitions were of full or half height or whether they were opaque or not.

Baum and Valins (1973, 1974) have argued that a socially overloaded environment,as mediated by certain design features, can lead to crowding. They found that college students rated corridor design dorms as more crowded than suite design dorms, and based on questionnaire responses, concluded that this was because of higher rates of forced social interaction with strangers in the corridor design. [Persons from the corridor designed dorms also visited psychological services significantly more] and tolerated fewer people in a given space as measured by a Desor like figure placement task.

In this dorm study, density levels and design type were confounded. The older corridor type dorms were of higher density than the newer, suite type designs.

Recently, Stokols, Smith and Proster (in press) have tested the effects of partitions in a live field experiment on perceived crowding and found contradictory data from that suggested by Desor (1972).

Persons in the same area felt more crowded under a full height partition than in conditions of no partitions or partial partitions (rope). In addition to the potential problems suggested by the Stokols et al. study, there are several other objections which may be raised regarding the stimulus overload explanation of crowding. For example, as mentioned above, Desor found no differences between opaque partitions of full and half height and non opaque partitions. Thus, large differences in visual stimulation were unrelated to perceived crowding.

A third line of evidence against the overload hypothesis comes from developmental findings in the area of overstimulation. Much of the data in this area of research suggest that young organisms which receive extra stimulation have a slight acceleration of maturation (Denenberg, 1972; Newton and Levine, 1968). Young organisms which are raised in conditions of high density, however, have a delayed maturation sequence (Christian, 1961). If high density produces extra stimulation, then high density should accelerate maturation.

Fourth, we have found that increasing the amount of stimulation presented to subjects has no effect on task performance and on stress indicators while personal space invasion does. When distance is changed between the subject and three different sources of visual information varying in complexity, subjects performance in an information processing task is not affected, nor do their skin conductances change, and self-reports indicate states of calmness (Evans & Eichelman, 1973, 1974). Large changes are observed in these indicators under personal space invasion (Evans and Howard, 1972). Thus, we infer, that it is the knowledge that a person is near to you that causes stress. To test this out more directly, we are varying the interpersonal distance between individuals and experimenters who are either present, or behind a barricade. In the second condition, subjects know that the experimenter is invading their space but, since the experimenter is behind a barricade, subjects receive few additional information or sensory cues as a function of decreasing interpersonal distance. We predict that even an unseen person will cause subjects to feel uncomfortable if they know that the person is there and close to the subject.

A fifth objection to the stimulus overload position comes from human performance research in the area of attention which suggests that irrelevant information produces decrements in task performance (Keele, 1973). However, interference usually occurs when the information is unpredictable and of high intensity producing orienting or defensive reactions, or when its meaning is similar to the meanings of the stimuli determining one's choices in the task. For example, if someone sporadically shouted numbers in your ear as you were trying to read a list of numbers aloud, your reading time would be increased relative to either sporadic white noise, or paced digits. Yet, paced letters as distractors would hardly interfere at all. This is important because it suggests that some minimum level of interpretation and comprehension has occurred prior to ignoring the irrelevant information. This makes sense because we would like to be able to ignore information that is not important to us and further evaluate information that is. Thus, we are likely to hear our names called out no matter how hard we are concentrating on some other task.

This critique hints at another area of important concern which has been ignored by the overload argument. Clearly there are some items in the environment of high saliency or high priority to humans. Movement in the periphery, the color red and circularity are some known examples. Other persons may also be information sources which have certain unique configurations that place a high response demand upon us. We may have a definite bias towards responding to other humans as a high priority item in our environment.

On the other hand, it seems clear that we can treat persons as inanimate objects under some circumstances. It would be interesting to examine what function this behavior serves and to examine systematically when it occurs. (See Sommer, 1969, for an interesting discussion about nonpersons and subways.)

Kaplan (in press) has emphasized the need to analyze human responses to the physical environment in terms of information processing needs and biases of the human organism. One area which warrants further exploration is how physical and social sources of overstimulation exert differential effects on behavior.

Unlike many organisms, humans are not stimulus bound in their behaviors. Rather, we respond to what the stimuli symbolize to us (Dubos, 1965). This process of symbolic interpretation is affected by the entire history of the individual. Momentary expectations and intentions determine behavior and the stimulus situation is but one small link which may serve to elicit and structure plans. Thus, we are arguing that though personal space invasions, crowding and other spatial impositions may indeed change the quantity and quality of the information present in an arrary, it is the interpretation of this information that will determine whether an individual feels stressed or aroused.

One important limitation may be the extent of demand and the richness of the required response as opposed to the richness of the sensory array. This distinction is very similar to that made by Wohlwill in terms of sensory versus information overload (Wohlwill, 1974). The information processing approach to humans response to their environment, stresses the fact that a great deal of active processing of incoming sensory input occurs before any higher order, cortical processing. While too much information may overload the central processor, it is not at all clear that this overload stems from a high sensory input. Rather, the overload of the central processor may occur when too many responses are required simultaneously or in rapid succession. The stimulus overload hypothesis of crowding and other spatial impositions overlooks this distinction.

iii) Stress - A third major conceptualization of crowding in humans has derived from the stress perspective. Stress is generally characterized in terms of physiological and psychological response. Selye (1956), whose work forms the basis for most research on stress, has proposed that stress is a bodily state manifested by the general adaptation syndrome (GAS). The GAS is a tripartite, nonspecific reaction consisting of alarm, resistance, and exhaustion. The physiological chain of events concurrent with the GAS is manifested by several indices centered around the endocrine system. The most common indicators include enlarged adrenal glands, increased 17-ketosteroids in the urine, increased ACTH or glucocorticoid levels in the blood and increased heart rate, blood pressure, and skin conductance (Appley and Trumbull, 1967; Moss, 1973; Selye, 1956).

Psychological stress (see Lazarus, 1966) takes into account the fact that stress reactions in more complex organisms, including humans, are less dependent upon the direct impact of the stimulus and more contingent upon mediating cues subject to the organism's interpretation (Dubos, 1965; Glass and Singer, 1972). Thus, psychological stress emphasizes more cognitive aspects of an individual's assessment of the particular situation. Behavioral indices of stress include increased reaction time, erratic performance, malcoordination, increased errors and fatigue, self-reports of stress, nervousness and anxiety.

Two distinct lines of analysis have emerged in human crowding research and thought which suggest that high density operates as a stressor to disrupt social organization and normal interaction patterns or that crowding as a stressor operates primarily by way of behavioral constraint.

a. Social distruption - Several investigators have suggested that high density environments precipitate a general breakdown in communication among members of social units and thus, foster social disorganization. Cassell (1971) studied epidemic records and found little correlation between density levels and disease. Instead, Cassel found that the principle mechanism which was highly associated with disease was social cohesion. If social cohesion became weakened due to an inability to handle high density or in combination with other environmental stressors, such as war, etc., then disease was more likely to occur.

Michelson's (1970) observations of the ways in which the Japanese seem to handle high density are consistent with this interpretation. He found that it was not high density which was crucial in affecting dis-organization, but "rather the nature of the separation of these people from each other." (p. 157) Rules and cultural norms which are rigidly adhered to appeared to interject sufficient stability into the social structure such that some people appeared to be quite able to cope with the close presence of others. For example, school achievement and density were not found to correlate very well, but in situations where there was high density, plus no regularly assigned time and place for studying, school performance was quite poor. Thus, crowding may disrupt social disorganization, but the effects are likely to be very dependent upon desired behaviors and goals and the availability of various physical and social props to either suspend or rigidly control the effects of the high density, at least temporarily.

Several observational studies with children under different densities have found that they interact significantly less under high densities (Loo, 1972; McGrew, P.,1970; McGrew, W., 1972; Preisser, 1972). Children play less together and talk less to each other when the amount of space their nursery school or primary school contains is reduced. Loo (1972) also noted an increase in the number of tasks which were not sustained to completion under higher densities.

b. Behavioral constraint - The behavioral restraint perspective suggests that high density becomes adversive when one is frustrated in the pursuit of some goals by the presence of others (Proshansky, Ittelson and Rivlin, 1970). Thus, the perceived limitation in freedom to operate successfully to fulfill one's needs at the time is the cause of stress. The concept of personal space as a comfortable, minimum interaction zone which one maintains between oneself and others may be relevant here as well in that the operation of certain distancing norms may function in part to allow sufficient personal security, such that one can operate comfortably without constant threat of aggression or restraint.

Personal space may be interrelated with crowding via the behavioral restraint model in another way as well. Perhaps a potent cause of the experience of being crowded is the situation in which one feels that the probability for a personal space invasion is high. If one has to attend to the potential or actual disruptions of the invasion, this may in turn impose behavioral restraint,in that less options for additional behaviors will be available. Furthermore, when density is high, we also have less freedom to adjust interpersonal distances in a manner which fit various normative and personal expectations. Considerable data support the position that personal space changes as a function of various situational and interpersonal factors (Evans and Howard, 1973). Under high density, the freedom to make such spatial adjustments is likely to be restricted.

Consistent with the above point, recent data support the assertion that there is a direct relationship between the size of the personal space zone and perceived crowding. Both Cozby (1973) and Dooly (1975) have found that persons with large personal space zones generally feel more crowded under given densities than individuals with smaller zones.

Stokols (1972b) proposed a model of human crowding wherein crowding was defined as a subjective experience in which one's demand for space exceeds the supply. According to this model, the experience of crowding develops through an interaction of environmental qualities and personal attributes which combine to either affect the individual's saliency of spatial needs or limit available behavioral options.

Given that one's perceived behavioral options should be a critical variable in crowding experiences according to the behavioral constraint notion, several recent analyses of human crowding have examined, in part, the interaction of various social and interpersonal situations with high density. Galle, Gove and Mac Pherson (1972) attempted to correlate various measures of density in an American city with several psychosocial indicators of pathology, including mortality, fertility, aid to dependent child, juvenile delinquency and admissions to mental hospitals. Various precautions were taken to control for SES and cultural variables through extensive partial correlation. The investigators found that person per room was substantially correlated with several of the indicators, where areal measures were not. In their view as density increases, so will the number of social obligations and the need to inhibit individual desires. Persons per room is a more sensitive measure precisely because it is closest to a measure of interpersonal press where the restrictions of others will be maximized with high density.

Stokols, Rall, Pinner and Schopler (1974) found that a competitive task set which may be seen as introducing some social interference, heightened the effects of density as subjects rated their degrees of perceived crowding. Consistent with this study, Schopler and Walton(in press) found that by decreasing expected behavioral interferences, subjects perceived a high density environment as less crowded than subjects who expected high behavioral interference.

The personality variable of locus of control has also been investigated in relation to crowding (Schopler and Walton, in press) and personal space (Duke and Nowicki, 1972). Persons with external locus of control feel that they are less in control of their behavior and that the major source of control of their behavior is external to themselves, i.e., other people, circumstances, fate, etc. Internals, on the other hand, believe that they are in charge and can determine for the most part what happens to them. Both Schopler and Walton and Duke and Nowicki's research, respectively indicate that internals feel less crowded and have smaller interaction distances with certain types of people (strangers) than do persons with external loci of control.

Summarizing these two views of crowding as a stressor, we see that there is some evidence that humans may feel crowded due to social disorganization and consequent disruption of behavior from the close presence of others. Further, the perception or actual experience of reduced behavioral options to carry out some desired behavior(s) because of the lack of space available may also contribute to a crowding experience as stressful.

While there may be some overlap between indices of stress and unmet spatial needs, some differences exist. First, spatial restrictions by definition refer to a unique component of stressors related to unmet spatial needs. Second, there is considerable controversy and ambiguity over definitions of stress and consequently indices of stress (Moss, 1973). Third, there are some data which indicate that the effects of stressors on developing organisms are quite distinct from that of crowding (Evans, Pezdek and Nalband, 1975).

In line with the behavioral constraint notion, the effects of high density may affect different persons in an urban area particularly as a function of their own control over the environment and a consequent range in ability to shield or escape from high density when desired.

Unwanted social interaction with strangers, in particular, may contribute to stress which is more likely to occur in high density and congested areas. Urban dwellers tend to avoid involvement with strangers to a much greater degree than their rural counterparts (Milgram, 1970), and individuals when interacting with strangers, tend to maintain greater personal space zones (Evans and Howard, 1973).

Recently, Draper (1974) studied the phenonmenon of preferred high density living by people who live in areas of great expanse. The !Kung bushmen who are basically a hunting, gathering society live at extremely high densities, but indicate little evidence of physiological and psychological stress. Draper suggests several potential mediating factors which exist in their culture which may be instructive for us to consider in light of behavioral constraint and forced interaction with strangers.

While the particular villages are extremely high density, the villages themselves are distantly separated and it is extremely rare for one to bump into a stranger from another village. Furthermore, mobility and ease of leaving and returning to one's immediate group in the village is readily apparent and equally accessible to all parties. Thus, when one wants to migrate or go off for awhile, one is free to do so without any fear of social sanctions.

Perhaps, behavioral restraint needs to be looked on at different levels. With the !Kung there may very well be high behavioral constraint in their immediate environment, but other options due to high mobility exist for at least temporary withdrawal. The high behavioral restraint that Galle et al. (1972) found in an urban setting which correlated with some indices of social pathology may not be coupled with potential outlets where one can easily 'get away from it all.' This suggests the need for further research in the area of the ratio between immediate and surrounding densities.

4. Continuities and differences in theoretical conceptualizations of human crowding.

Each of the above analyses of human crowding: ecological analysis, stimulus overload, and stress share at least three common themes. First, each position recognizes to some extent that the experience of crowding in humans is not entirely density dependent. Human responses to physical space are mediated via various cognitive and affective factors. High density should be treated as a necessary, but not sufficient, condition for crowding to occur. Second, when crowded, persons will seek to cope with the discomfort that the experience brings with it. This coping may include outright withdrawal or a host of adaptive processes. Third, in each case a dynamic interaction is posited whereby there is some behavioral tension built up vis-a-vis the environment's effect on the individual's behavior, who in turn attempts to alter his environment to better suit his needs.

The basic difference between each of these approaches to crowding is in the particular mechanism which is posited as the principle operator in the crowding experience. According to overmanning theory, the ratio of available persons and roles necessary to maintain the behavioral setting is the key concept. For stimulus overload theory, the total amount of sensory input impinging upon the organism is seen as the critical factor. Persons are viewed as having some optimal level of stimulation which maximizes performance and comfort. High density is viewed as increasing sensory input, greater than the optimal level. Third, behavioral restraint and social disruption focus more on crowding as a stressor, due to frustration in one's ability (actual or perceived) to carry out desired functions or goals.

Overview and rationale of proposed study

The basic purpose of this research project is to explore how crowding affects human behavior. This will be done at three levels of analysis.

1) First, given our state of knowledge about human crowding and our present inability to establish under what circumstances high density is more likely to lead to a crowding experience, a variety of different types of behaviors will be measured and observed under conditions of high and low density. At this level, the analysis is clearly exploratory.

2) At a second level of analysis, it seems clear from the theoretical overview presented above, that the processes of the individual are going to be important in determining one's reaction to high density. A preliminary attempt will be made to explore what contribution, if any, selected personal and background factors may play in one's reaction to crowding. The basic strategy here will be to collect personality and background data on all subjects which will then be regressed onto behaviors under different densities.

The personality dimensions studied include locus of control, aggression, dominance, creativity, arousal-seeking tendency and imagery ability. Locus of control as discussed above has been shown to be related to personal space and crowding.[1] It is expected that externals will

[1] Prior to conducting the experiment, the Schopler and Walton article had not appeared.

be more uncomfortable under higher density.

Prediction One: Aggression

Several lines of evidence in the animal literature suggest that high density has pronounced effects on aggressive behaviors (Calhoun, 1962; Esser, 1970; Eible-Eibesfeldt, 1970). Recent work with children has also found some effects of crowding on aggressive behavior (Loo, 1973). Furthermore, Evans and Howard (1973) have also suggested that personal space maintenance functions, in part, to minimize aggressive encounters among humans. It seems worthwhile to look at the other side of the coin as well. Thus, what effects might an individual's trait level of aggression have on their reaction to high density? There is some evidence, for example, that more aggressive prisoners have considerably larger personal space zones than less aggressive prisoners (Kinzel, 1970). Thus, one would hypothesise that persons who test out as more aggressive should react more negatively to the high density environment.

Prediction Two: Dominance

Christian's (1961) and Thiessen's (1961) reviews, plus Eible-Eibesfeldt's (1970) disucssion of crowding and dominance all suggest that more dominant individuals fare better under conditions of high density. On the other hand, persons of high dominance or status generally maintain greater personal space zones and are more apt to perceive themselves as having more control over situations. If their personal space zones are more likely to be invaded under high density due to their larger size, then perhaps higher dominant persons may feel greater crowding. Furthermore, if behavioral restraint is greater under high density conditions, then presumably the discrepancy between usual modes of operation where the more dominant person is in control will be greater than for less dominant persons who are not as use to having maximum control over their behavioral options. Therefore, despite indications from the animal literature, more dominant persons will experience greater discomfort under higher densities than less dominant persons.

Prediction Three: Conceptual Space

Calhoun (1971) noted that certain rats under extremely high densities seemed to be oblivious to the general pathologies associated with the behavioral sink. Of interest, Calhoun noticed that many of these rats demonstrated extremely creative modes of living, and presumably coping more successfully to the chaos around them. Calhoun suggested that the amount of physical space which one needs to be comfortable and operate effectively in may be inversely related to one's available conceptual space, i.e., the extent of intellectual, and cultural thought span, operationalized here as creativity given that one at least has methods available which may give a round approximation of individual creative capacities.

Prediction Four: Cognitive Mapping

Recent work by Evans and Eichelman (in press) has argued that cognitive mapping abilities may play an important role in individual's reactions to different environments including ones that vary in density. They argued that persons with superior mapping abilities may conceivably better and more rapidly organize information in an environment, thus orienting faster and becoming more readily accustomed to a location. Such persons should be able to handle the disruptive effects of high density more easily than others,in that a greater amount of their total processing capacity will be available. Here cognitive mapping ability is operationalized in terms of individual imagery ability. It is recognized that most likely there may be a heavy overlap in cognitive mapping abilities and conceptual space.

Prediction Five: Arousal

Finally, an argument is made below that crowding can be looked on as a stressful experience mediated by arousal level. Recent work by Mehrabian and Russell (1974) has found that person's who are seeking a high level of arousal vs. a lower level of arousal prefer different types of environments which vary in the amount of information they contain. If crowding increases arousal as is argued below, then persons seeking higher arousal should respond less negatively to high density than individual's seeking lower levels of arousal.

Prediction Six: Background Variables

Background data include two standard measures of socioeconomic status (SES), income level and educational level of the subject's family which might be partialled out at a later time while examing the contribution of other variables. Freedman (1973), Galle et al. (1973) and others have discussed the importance of examing the contribution of other variables to the crowding experience with SES type variables removed.

Measures of the individual's density levels as a child and his mother's density levels were also included as background variables. Cassell's (1972) work on reactions to environmental stress over time, plus Dubos (1965) theoretical discussion of long-term adaptation to stressors both suggested that past experiences with density levels should influence one's present reactions to a high density situation. Milgram's (1970) analysis of the urban dweller's development of coping strategies to deal with the overload city environment suggests that persons who are used to high density should be better able to withstand the immediate effects of high density exposure. This is consistent with recent work by Wohlwill (1974) finding an adaptation-like function between present organism-environment perceptions, as measured by individuals' preference for different stimuli and these persons' past experience with those particular dimensions of environmental experience and stimulation. Persons who had more exposure to complex, high stimulus content environments, for example, seemed to prefer environments that were more complex than persons who had not had such previous experience. Cross-generational effects from high density have also been found to affect the organism's later reactions to stress as discussed above in the work by Keeley (1972). Furthermore, it also seemed reasonable that an individual's immediate living circumstances qua density should also be an important determinant of their reactions to density. Bauam and Valins (1973), for example, found that present living densities influenced subjects task performance under cooperative versus competitive set when working alone versus in groups. Persons who perceived their present living conditions as more crowded did best under cooperative together conditions. Thus, measures of present perceived crowding and past measures of density are included plus a scale concerning maternal density.

3) Finally, a third level of analysis examines a particular theoretical perspective which argues that crowding is a stressor which is mediated by arousal level. More specifically, it is argued that

crowding increases arousal such that it is greater than an optimal level.

In studying the possible stressful effects of crowding, several points about stress should be noted. First, our response to an acute, short-term stress experience are not the same as long-term chronic exposure to stressful conditions. This raises the immediate issue of laboratory data versus long-term field research.

Second, we know that when confronted with short-term, acute stress, the human organism often is able to rise to the occasion as it were, and muster its defenses to deal with the immediate stress. It is after the experience that the organism may reflect signs of exhaustion, shock, etc. (This is, of course, consistent with Selye's GAS where there is first the initial stages of alarm and mobilization of resources followed later by exhaustion and collapse. Glass and Singer's (1972) work on short-term exposure to loud bursts of noise supports this sequential pattern. They found that during the presentation of a stressor (particularly unpredictable noise without perceived control), no decrements in performance on simple tasks were found. It was only after the tasks that signs of stress appeared. Subject's tolerance for frustrating tasks (tracing impossible figures, proofreading, etc.) were markedly less when previously stressed by noise. Thus, in the present study, I have measured performance after the experimental condition.

Both the type of task and the particular stressor involved are important as well. Broadbent (1971) found very different behavior patterns as a function of heat, noise, and sleep deprivation. His subjects were presented with a pentangonal array of lights and were instructed to tap a corresponding button to extinguish the light, immediately after which another light comes on. Noise produced errors only after some time had passed on the task, while heat created immediate errors and sleep deprivation was reflected in slower reaction times. Subjects who performed the task during noise and who had been sleep deprived, had fewer errors than subjects who were sleep deprived only. In addition to exploring conceptual mechanisms for the operation of various stressors, combinations of stressors adds to the ecological validity of research. Recent work on the combination of high density and noise (Freedman, et al., 1972) and high density and heat (Griffitt and Veitch, 1971) are encouraging in this regard.

Incentives, produced by providing knowledge of results and posting individual's scores publicly, also interacts in some interesting ways with these different stressors. Lack of sleep under no knowledge of results (low incentive) significantly reduces performance compared to no sleep deprivation. With knowledge of results, however, this difference is removed. Under noise, the opposite pattern of results is found. Signal rate is another important variable. A high signal rate with noise significantly reduces performance, whereas a low rate plus noise yields slight facilitation. Again the opposite pattern is found with sleep deprivation.

This complex array of results, plus other data have led some investigators to consider the construct of arousal as a mediating mechanism. Arousal is seen as a mechanism through which stress works. Since noise increases arousal and lack of sleep reduces it, the arousal construct is attractive in explaining the effects of various stressors on human behavior.

In addition to the type of stressor involved, the particular task employed is also an important variables in stress research. Generally, noise produces no change or slight facilitation on easy or boring tasks, but causes deterioration on tasks that are more complex. The Yerkes-Dodson law which relates performance to arousal level provides an elegant explanation for this interaction of stress via arousal and task type. The law states that task performance is an inverted U-shaped function of arousal. It has been posited that maximum performance on complex tasks will occur at a lower level of arousal than for simple tasks. Figure 1 is a rough sketch of the Yerkes-Dodson law after Kahneman (1973). While the effects of under-arousal can readily be explained, investigators have recently begun to explore in some detail why over-arousal should cause a breakdown in task performance and more particularly, why this should occur at a different level of arousal of complex versus simpler tasks.

One basic hypothesis is that high arousal narrows the focus of attention (Easterbrook, 1959). Under high arousal, subjects filter out more information. Thus, performance on simple tasks may improve because irrelevant cues are rejected. Under complex tasks where presumably more cues are relevant, subjects who are highly aroused begin to reject relevant cues as well. This position makes the reasonable assumption that more complex tasks have a wider range of relevant cues to attend to. Recent work has demonstrated in dual task situations, that subject's relative performance for the primary task is reduced under sleep deprivation and increased under noise conditions (Broadbent, 1971). At the same time noise impaired performance of the secondary task. When highly aroused, there appears to be an increased tendancy to focus on a few relevant cues. A greater proportion of processing, in other words, is

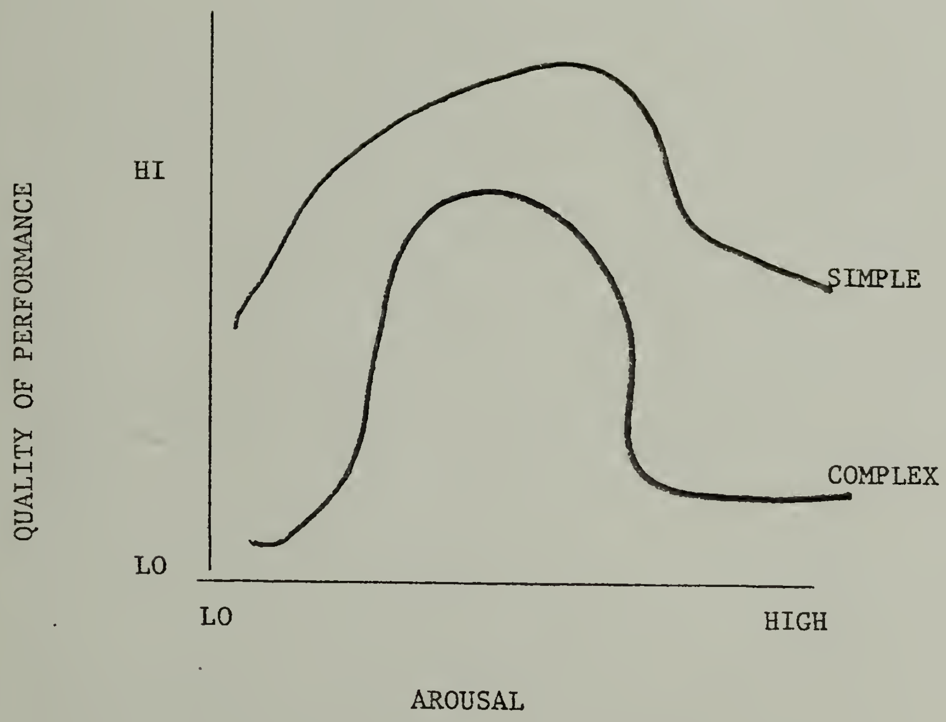

Figure 1. Yerkes-Dodson Law

directed toward information from dominant sources and less toward relatively minor sources (Broadbent, 1971). Other tasks which improve under high arousal reflect the increased ability of the subjects to reject irrelevant, potentially interferring information. See Broadbent (1971) and Kahneman (1973) for more detailed explanation and criticisms of the arousal notion. They and others have suggested modifications in the arousal construct as briefly presented here. Data from research on drug stimulants, circadian rhythms and the personality dimensions of introvert-extrovert all suggest the need for more than a unitary arousal construct or mechanism.

There is some evidence which suggests that crowding may increase arousal. The most direct evidence for this assertion comes from Epstein and Aiello (1974) who have found significantly elevated skin conductance in subjects under high density conditions compared to subjects under low density. Bergman (1971) has reported consistent findings as well. Less direct evidence; but consistent with the potential interactions of personal space and crowding discussed above, is evidence from Evans and Howard (1972) and McBride et al., (1966) which also indicate significantly heightened levels of skin conductance with invasions of personal space. Furthermore, in light of the discussion above of the Yerkes-Dodson law relating arousal level to performance, Evans and Howard (1972) found that the forced invasion of personal space interacted with task difficulty. When subjects had to process information at slow and moderate rates of speed, little or no effects were evident from forced invasions of personal space. On the other hand, at a high rate of signal input, there was a marked drop in performance as personal space in invaded. This pattern of results is quite consistent with that predicted by the arousal task complexity function of the Yerkes-Dodson law (see Figure 1).

The hypothesis that crowding increases arousal suggests two immediate problems. First, as suggested above, the arousal mechanism and theory itself has recently begun to come under some criticisms (see Kahneman, 1973 and Broadbent, 1971 for overviews). Second, the work of Freedman and colleagues (1971, 1972) purports that crowding does not increase arousal. Freedman, Klevansky, Ehrlich (1971) varied spatial density and found no significant effects on simple or complex task performance. Based on this finding, they suggested that crowding does not heighten arousal.

A close examination of this study reveals two critical flaws which do not allow them to draw satisfactory conclusions about the possible effects of crowding on arousal level. First, Freedman et al., 1971, performed no manipulation check to determine what subjects' perceived levels of crowding were. Given the distinction we have elucidated, that high density does not necessarily equal crowding in humans, (see Stokole, 1972) this is an important omission on Freedman's part. Second, the complex tasks used by Freedman consisted of two versions of the Guilford creative uses test and forming words from a group of ten letters. It is my contention that these complex tasks are not at all complex in terms of information processing demands placed on the organism. It is the latter criterion which is the critical dimension in assessing the effects of arousal level on varying levels of task difficulty. The so called complex tasks used by Freedman are not complex because no pressure is put on total capacity either in terms of the spatial allocation of processing or in terms of time allocation. Considerable research indicates that a task's demand on human capacity increases when either rate of signal input is high; there are a large number of competing signals; or when the signal is unpredictable (Kahneman, 1973, Keele, 1973). Freedman's assertion that because no differences were found in the complex tasks, that crowding therefore does not produce high arousal is misleading. Similar criticisms also apply to Freedman's second study as well. In addition, claims are made about arousal level by Freedman with no psychophysiological indicators of either initial arousal states or changes in arousal state over the experiment.

As the work of Broadbent (1971) and others has shown, to tap into the immediate effects of stressors on performance is quite difficult. The enormous capacities of the human brain seems to require either considerable competing attentioaal demands, very rapid inputs or unpredictable inputs before immediate stress effects will arise. The emphasis on immediate is deliberate, given the work of Dubos (1965) and Glass and Singer (1971) discussed above which suggests that some performance aftereffects may occur when stress is applied.

In order to examine the possible role of arousal in the crowding experience, various measures of arousal are included in the present study which include: physiological measures, observational measures, and tasks which more adequately reflect the information processing dimensions of task complexity. Again, as mentioned above, some aftereffect measures have also been included.

Furthermore, several investigators in crowding research have found that affective, self-report measure tend to reflect the effects of high density on the persons involved (Freedman, et al., 1971, 1972; Epstein and colleagues, 1973, 1974; Stokols et al., 1972). Stokols has also reported that some observational indices, such as amount of laughter seems to indicate greater nervousness in high density groups. Thus, in the present study several different self-report scales were employed to tap subjects self-reports of stress, nervousness, discomfort and feelings about others in the room. In addition, a measure of inappropriate laughter is also developed.

As a partial test of the stimulus overload perspective, an attempt is made to measure the level of stimulation available in both conditions of the experiment.

Finally, because of the consistent findings of different responses of males and females to high density (Freedman et al., 1971, 1972; Epstein and Karlin, in press), sex is treated as a second independent variable in addtion to density level. In the present study, however, mixed sex groups are used unlike most past research.

<u>Summary and hypotheses</u>

To reiterate, this research project has four basic objectives:

i) to examine the behavioral and physiological consequences of crowding on humans

ii) to explore further the distinction between high density and crowding

iii) to look at the adaptive/coping responses of individuals under crowding conditions and

iv) to investigate what contribution various personological and sociological variables make to individual's responses to crowding.

The major hypothesis of this study is that crowding is a stressful experience which is mediated by an increase in arousal. Complex task performance errors, various observational indices of arousal and physiological indicators of arousal are expected to increase significantly in the crowded condition compared to a non-crowded condition. Subjects self-reports of stress and discomfort are also expected to increase under the crowded conditions. Group task performance where some degree of cooperation is necessary is expected to suffer under the crowded conditions as well. Simple task performance is not expected to be effected by crowding level. Further, it is expected that the measure of stimulus overload will reflect no significant difference between the two groups.

It is further hypothesized that persons who are more: externally-oriented, dominant, aggressive and less: creative, imagery ability and arousal-seeking will react more negatively to the crowded environment. Present and past density levels are expected to relate to reactions to density in an adaptation level like function, i.e., the more experience persons have had with high density environments, then the better able they are to withstand problems in the crowded condition.

Coping with crowding as it were, is not expected to wash out or cover up all the effects of crowding. Again, both complex task performance and aftereffect measures, especially, are expected to reflect the effects of crowding.

Finally, based on the data collected and various analyses of that data, several lines of analysis and further exploration will be discussed. The more exploratory aspects of this study, in particular, are expected to contribute to this effort of expansion and future speculation.

METHOD

Subjects - One hundred undergraduates from the University of Massachusetts participated voluntarily and by doing so earned points toward their grades in their respective psychology courses. Prior to the experiment subjects were informed only that they were to participate in an experiment relating group and individual cognitive performance to a variety of individual differences and personality measures.

Design - Subjects were randomly assigned in a between-groups design to either a small room (high density condition) or a normal size room (low density condition). Random assignment was subject to the restriction of at least a 4:6 sex ratio. Density condition and sex of the subject were the two independent variables.

Setting - The small room was a laboratory setting 8x12 feet in size. The larger room was also a laboratory setting of 20x30 feet in size. Both rooms have white walls and white ceiling tile with flourescent lighting. Neither room contained any windows. One side wall in each room was lined with a rectangular, one way mirror. The experimenters were in the adjacent room for most of the experiment as detailed below. All sessions were run on week nights from 7:30-10:30.

Materials and apparatus -

1. Selected personality scales - Personality measures were taken to assess individual difference in: creativity, imagery, dominance, aggression, arousal-seeking tendencies and locus of control.

a) Aesthetic sensitivity - The Barron-Welsh Art Scale (BWAS) was used to index creativity. Creativity as used here was defined as an originality of thinking and a freshness of approach to problems (Barron, 1965).

MacKinnon (1970) and(Barron, 1965) have both discussed the concurrent validity of the test to differentiate among high and average creative members of various professions such as architects. Other validation data and reliability figures are available in Welsh (1959). This test consists of a series of figures for which the subjects check off "like" or "dislike" (forced choice). The particular patterns of liking and disliking is serived from a pattern of preferences that differentiated bwtween artists and non-artists. Scoring and administration were as outlined by Welsh (1959). Appendix I gives an example from the test.

b) Imagery test - Three imagery tests were combined additively to obtain one imagery score. The first test, Space Relations consists of unfolded paper forms in two dimensions which when folded up, represent some three dimensional figure. Subjects are to choose which alternative figure(s) would be obtained from assembling the flat, unfolded pattern. An example from this test is given in Appendix I. The next test, the Paper-folding Test, consisted of different figures folded up which were then punched through by a pencil in one or more places. Subjects choose which of five alternatives would accurately represent the original folded up piece of paper when it was unfolded, i.e., where would the different holes now be. See Appendix I for an example from this test. The third test, the Cube Comparison Test, consists of two cubes with a letter on each of three visible sides. Subjects are to decide if the pair could be the same cube or not. See Appendix I for an example. Scoring and administration of all three tests were completed as outlined by French, Ekstrum and Prince (1963) of the Educational Testing Service. These tests are a part of their cognitive abilities package.

c) Dominance - Dominance was assessed by the dominance subscale (Do) of the California Psychological Inventory (CPI). Data on reliability and validity are discussed by Gough (1964). This test consists of a list of statements which subjects indicate as true or false. See Appendix I for a sample of the test.

d) Aggression - The Buss-Durkee scale was chosen as a measurement of aggression. Validity and reliability data are available in Buss (1961). The test consists of a series of items which subjects indicate as true or false. Scoring and administration were as outlined in Buss (1961). See Appendix I for a sample of the test.

e) Arousal-seeking tendency - Individual's arousal-seeking tendencies were assessed by Mehrabian and Russell's (1974) arousal-seeking scale. Development of this scale has been rather recent, but some reliability and validity data are available in Mehrabian and Russell (1974). The scale is an attempt to ascertain the desired level of arousal that persons seek in their environments. Some of the major components of arousal as used here include perferences for: high degree of change in the environment, unusual and novel stimuli, risk and sensuality. This scale is reprinted in its entirety since it is a new scale and not yet generally available (see Appendix I).

f) Locus of control - Rotter's I-E scale was used to assess locus of control (Rotter, Chance & Phares, 1972). Validity and reliability have been discussed by Rotter et al., 1972. Scoring and administration were outlined by the same source and a sample of the test is given in Appendix I.

2. Background variables

At the end of the experiment, all subjects completed the questionnaire contained in Appendix II. Data were collected on each individual's perceived crowding level during the experiment, the number of persons per room where they grew up, number of mother's siblings, family income and educational level (SES) and present crowding levels in their living environment, i.e., on campus or in town. The manipulation check which was a nine point Likert type scale ranging from "crowded" to "uncrowded" is important, given the discussion earlier in the introduction about the importance of distinguishing between high density and crowding (Stokols, 1972).

The family density measure was in terms of persons per room because that particular measure appears to be related with various behavioral indices to a much greater extent than other measures of density (Galle et al., 1972). To get an indirect measure of possible cross-generational effects of density, the number of mother's siblings was chosen for two reasons. Pilot data revealed that father data had no relationship to present reactions to density. Second, subjects could not adequately estimate their mother's living density conditions, but did report that they felt they could accurately gauge the number of siblings their mother had.

The two SES measures are standard census data variables. The last scale simply asked subjects to rate their present living conditions in terms of crowded-uncrowded, again on a nine point scale. The background questionnaire is given in Appendix II.

3. Semantic differential scales

Six nine-point, bipolar adjectives, scale (Likert type) were employed throughout the experiment as outlined in the Procedure subsection. The scales were printed six to a page in different orders with instructions adopted from Osgood et al. (1957). Scales were scored from +4 to -4 with a 0 neutral, or does not apply alternative.

Three sets of scales, "happy-unhappy"; "excited-calm"; and "influential-influenced" were adapted from Mehrabian and Russell (174). Their work had included the development of scales to assess individual's reactions to their immediate environments. These three scales were the highest loading scales on each of three major factors which the researchers found characterized a significant proportion of person's responses to their environment. The environment here was defined as both the social and the physical environment, i.e., the setting as a whole.

"Stressed-unstressed" was used as a direct attempt to measure the degree of self-reported stress people felt during the experiment, and similiarly, for the"physically comfortable-physically uncomfortable" scale.

Finally, "frustrated-not frustrated" was included as a partial check on the behavioral constraint approach discussed in the Introduction. If the presence of too many others or the lack of space is perceived as preventing one from acheiving some particular behavioral goal, then it seems reasonable that the person should feel frustrated. An example of one semantic differential response sheet is included in Appendix III.

4. Performance materials and apparatus

The information processing material was presented orally via a tape-recorder through a loudspeaker in the experimental room. Subjects' response sheets for the information processing task are shown in Appendix IV.

For the dual task situation, subjects used two types of search sheets which are presented in Appendix IV. The sheets without any figures blackened in are termed clear and the other type, filled. Subjects indicated which pairs were the same shape (irrespective of shading in) by putting a line through the pair. Subjects timed themselves by manually starting and stopping an electric timer which was marked off in seconds and .01 seconds. The auxiliary task was recognition of information from a story which was presented orally while subjects performed each of the search tasks a second time. The two stories which are reprinted in full in Appendix IV were newspaper stories which can be characterized as high in information content. The stories were each presented orally over the taperecorder. Recognition tests for each story are also in Appendix IV.

The group cooperation game was a 3x3 matrix game of numbers which was presented visually to the subjects through the one way mirror. Each array of 9 numbers was painted on cardboard which was slid onto an easel-like holder. A light was under each number. The group indicated their choice of column by flipping one of three switches (one switch per column) which was in their room adjacent to the window. The interaction of the group's choice and the experimenters' (one switch per row) caused one light to illuminate indicating the intersection of choices, and the group's payoff value for that trial. Subject's recorded their own choice of column and the groups choice on an answer sheet for each trial.

Aftereffects were assessed by measuring the number of attempts subjects made to trace an impossible figure. Piles of each of four figures (two impossible, two possible) were presented to subjects as in Appendix IV.

5. Physiological apparatus

Heart rate was measured manually by taking each person's pulse for one minute. Blood pressure (systolic, diastolic) was recorded manually as well under standard procedure (Lywood, 1967) with an occular cuff, manometer and stethescope. Research has indicated that increases in heart rate and blood pressure occur under high arousal (Broadbent, 1971; Bridges, Jones and Leaks, 1970; Lindsley, 1951).

6. Other scales

The two scales used to assess overall stress and hostility were the Subjective Stress Scale (SSS) (Berkum, Bialek, Kern and Yagi, 1962) and the Hostility Checklist (Berkum, Burdick, and Wooding, in press). The SSS is generally considered one of the more valid and reliable pencil and paper measures of stress and has had extensive use (Berkum et al., 1962). The scale is reproduced in Appendix V. Scoring and administration were outlined by Berkum.

The Hostility checklist is a newer measuring device which has received some preliminary validation and reliability checks which appear encouraging (Berkum et al., in press). It is also in Appendix V.

The information rate scale which was employed as a partial check on the information overload position as outlined in the Introduction has been developed by Mehrabian and Russell (1974). Building upon information theory concepts and the work of Berlyne(1967), they have attempted to establish a scale to measure the rate of information available in complex environments where traditional information theory analyses cannot be applied. Of interest, in light of the overload position and my critique of it in the introduction, Mehrabian and Russell (1974), in passing remark that a high density environment is expect to increase information rate. This scale and its development are outlined by Mehrabian and Russell (1974) including instructions and scoring procedured. The scale is included in Appendix V.

Finally, subjects filled out a 'departmental research questionnaire' which purportedly asked questions about the experimenter and the overall experiment. A copy of the questionnaire is in Appendix V. Only questions 5,6,7 and 9 were actually of interest. Question 5 dealt with the adequacy of the facilities, while 6,7, and 9 were attempts to pick up projections of displeasure, hostility, etc. from the subjects onto the experimenter. Thus, question 6 asked subjects to judge how they felt the experimenter felt about the subject. Question 7 asked subjects to rate the overall competency of the experimenter and 9 to give an overall evaluative judgment about the experimenter.

7. Observations

All sessions were videotaped on ½" black and white video tape with a wide angle lens camera through the one way mirror. Categories and observational procedures are detailed under a special subsection of the Procedure section.

Procedure

Because of the size and complexity of this study, this subsection is broken up into two major parts. The first part attempts to give an overall chronological flow of the experiment. The second part goes into more detail about the actual procedures.

1. General experimental outline

The first session of the experiment consisted of the administration of the personality tests which took place at least one week prior to the density manipulations. Random groups of 20 subjects took the tests together in a classroom setting for a period of 1½ hours.

Upon arrival at the experimental room, each subject took a chair into the experimental room. Subjects were instructed not to smoke and to use the bathroom, if necessary then, since the experiment would last for a little over three hours. After all ten subjects were in the room, two experimenters took each person's blood pressure and heart rate. It is important to note that subjects were free to place their chairs at any point in the room. The chairs were deliberately chosen to be moderately uncomfortable and with no arms.

The instructions regarding the experiment in general were now read to the subjects. They were reminded again that this was an experiment about the potential interrelationships among different types of cognitive abilities and the personality measures which they had earlier taken. Subjects were informed that the experimenter and his associates were in the next room and could observe them through the one way mirror. Subjects were not told that they were being videotaped. Communication was demonstrated via an intercom. Subjects were then told of the general outline of the experiment and showed how to fill out the semantic scales. At this point, the experimenter left the room, closed the door and proceeded next door where he then carried out any further instructions via the intercom.

Tasks and free periods were in a set order for all groups which is outlined in Table 1. Following the experimental tasks, the same initial two experimenters who had administered the physiological measures returned to the room and repeated the process. Subjects then filled out the three additional scales; SSS, Hostility and Information Rate. At this time the subjects and the experimenters left the room and walked down the hall to a nearby classroom where the adaptation tasks were immediately administered. These were followed by the departmental questionnaire and then the background questionnaire. See Table I for a summary of the entire experiment.

Subjects were then debriefed and asked not to discuss the purposes of the experiment with anyone else.

2. Specific experimental tasks and procedures

a) Free time periods (FT_1 & FT_2)- The first part of the experiment commenced right after the experimenter who had read the instructions left the room. This part was an initial five-minute free time period in which no constraints were placed on the subjects in terms of task demands. The subjects were told that we had to set up the apparatus for the first task and that it would take just a couple of minutes. At the end of the five-minute period, the experimenter informed the subjects that he was not ready to begin, but could they first fill out a semantic differential sheet rating how they felt while waiting for him to begin. A second five-minute free period was also inserted after the dual task (see Table 1). The free time periods were included primarily because I was interested to see if less structured time had any important relationship to the crowding experience.

Table 1 General experimental outline

Session I - Personality testing

Session II - Experimental session

A. Physiological measures (initial)
B. Instructions
C. Free time one
D. Free time one semantic differential (SD)
E. Information processing one
F. Information processing one SD
G. Information processing two
H. Information processing two SD
I. Search one (clear), search one (filled)
J. Search one SD
K. Search two (clear), plus story 1
L. Story one recogniton test
M. Search two (filled) plus story 2
N. Recognition test story two
O. Search two SD
P. Free time two
Q. Free time two SD
R. Matrix game
S. Matrix game SD
T. Psysiological measures (terminal)
U. SSS, Hostility, Information rate scales
V. Adaptation tests
W. Departmental questionnaire
X. Background questionnaire

b) Information processing tasks - This task was included to examine the impact of a high signal rate and a normal signal rate on performance under crowding. In this task, subjects heard a series of numbers at two rates of presentation; one number every two seconds (information processing one-moderate signal rate) and one number every one second (information processing two-fast signal rate). Subjects were instructed to indicate on an answer sheet (Appendix IV) whether each number was high (<32) or low (≤32) and whether the number was odd or even. After a series of numbers at the one speed, subjects filled out a semantic differential sheet.

c) Search tasks - This set of tasks was designed to create a dual task situation. The primary task consisted of a sheet of pairs of circles and squares (see Appendix IV). Subjects were to indicate which pairs on a sheet were the same shape as rapidly as possible with accuracy. A second level of difficulty was invoked by filling in some of the figures on a second sheet (see Appendix IV).

Subjects timed themselves on this task. After completing a clear and a filled sheet, subjects rated how they felt while doing the two sheets on the semantic scales. They were then instructed to repeat each task again (new sheets). Additionally they would now also hear a story read to them during their search which they would later be tested on. The instructions stressed that the search task was the primary task that they should concentrate on. After each search and story, subjects filled out multiple choice answer sheets for the story (see Appendix IV). After both sets of searches and stories, they filled out semantic scales.

d) Matrix game - Following the second free time period, the group cooperation task was administered. Subjects played a 3x3 matrix, minimax game based on variations of the game presented in Figure 2. Subjects played up to 35 different variations of the game, plus three practice trials. The group decided which column it wanted to choose and the experimenter chose a row. The resultant intersection of column and row indicated a payoff value which was accumulated by the group. The experimenter chose rows according to a prearranged minimax strategy .80 of the time. This stragegy means that if the group tried to maximize their gain, then they would lose points, whereas if they attempted to minimize their losses, they would win a small amount. Thus, in Figure 2 the experimenter, if playing the minimax strategy, would choose row 2. If the group tried to maximize their point total by going after the 10, they would have lost -3 (-means the group loses that many points; + they gain that many). Still looking at Figure 2, if the group had tried to minimize their loss and chosen column 3 since it has the smallest loss payoff (-1), then they would have gotten a +3. The .2 trials which were randomly played, were randomly chosen before the experiment, but then played the same the whole way through.

After three different practice trials, a maximum total of 35 games were played. If a group made 5 correct minimax choices in a row, the game was terminated. After the game was terminated, each group filled out a rating sheet.

Groups were informed that the group with the highest point total would win $50. As mentioned earlier, before the group indicated their choice by throwing the column switch, each subject wrote down their own personal choice on an answer sheet. The percentage of individual agreement with

Subject chooses column

Experimenter chooses row			
	10	-4	1
	-3	1	3
	3	2	-1

Figure 2 Matrix game

the group was later calculated as an indicator of conformity behavior.

e) Adaptation tasks - Following the three physiological measures and the administrations of the SSS, Hostility and Information rate scales, the subjects were taken to an uncrowded classroom and administered the adaptation task. This task was adapted from Glass and Singer (1972) who have demonstrated in their work with various types of stressors, particularly noise, that while few immediate effects of stress can be discerned, some effects do appear after the task. Essentially, the aftereffect task consists of four puzzles which are presented 50 to a pile as in Appendix IV. Subjects were instructed to try to trace each puzzle without going over any line twice and without picking up their pencil. They start from the puzzle on the left working each puzzle until it is done or until they give up on it. Once they leave a pile and move to the right, subjects cannot go back to a previously worked on pile. Subjects are told that it is a timed test, but are not told how long they have to work on the task.

f) Final scales - Following the adaptation tasks, subjects were given the departmental questionnaire and background questionnaire, respectively. Following their completion, subjects were debriefed.

g) Observational indices - As indicated earlier, the experiment was videotaped and observational analyses were performed on much of the data. Only five subjects per group were scored because that was the minimum number of people on tape clearly at all times.

Observers were trained for six weeks on tapes from pilot data with similar tasks and interactions. The scoring categories can be subdivided into several classes of description. In addition, they are methodologically of two distinct types; group and individual. Individual categories are units of behavior that must be analyzed one subject at a time in order to achieve satisfactory reliability. Extensive pre-testing (10 weeks) indicated which categories were scorable at an acceptable reliability level and also which ones would have to be scored on an individual basis. Group categories are molar enough so that the observer could pick up on them while looking at the whole group.

All behavior was placed either in one category or another, i.e., no categories overlapped. The training of observers stressed the need for using the operational criteria that had been developed for each category. Observers were also taught how to score units of behavior. A unit was defined as one independent sequence. For example, if a subject tapped their pencil several times in a row, that was counted as one unit of object play; not a unit of play for each tap. If a person tapped their pencil several times, stopped, tapped some more and then stopped, that was counted as two units of object play. There had to be a discernable break in the sequence of the behavior in order to count is as more than one unit.

Each group's tapes were scored by two independent observers who scored from the beginning of free time one to the end of the matrix game. Instruction periods and the filling out of semantic differentials was not recorded. Furthermore, no scoring of the search tasks was possible because the clocks were plugged into the rear wall of the room such that nearly all the subjects moved to the rear of the room with their backs to the glass in order to time themselves during the search tasks.

All categories eventually scored had to meet two major criteria.

First, the category had to be sufficiently reliable that it could be independently assessed with a high degree of agreement. Several additional categories of interest had to be dropped during pretesting because we could not obtain sufficient reliability. Second, the category had to make some sense as an indicator.

1. Individual categories - Criteria and detailed examples are presented in Table 2.

i) Defensive postures - Sommer (1969) reported that when individual's personal space zones on a bench was invaded, the person would adopt various defensive, nonverbal postures. These included orienting away from the intruder, crossing the extremities or actual movement away from the intruder. Scheflen (1974) and Birdwhistell (1970) have both argued that people communicate a defensive affect or unwillingness to interact vis-a-vis similar nonverbal patterns. Crossing the legs or arms, for example, is highly correlated with an unwillingness to engage an other in any exchange.

ii) Stereotypical behavior - Stereotypical behavior was subdivided into two scoring categories; object play and automanipulative. Various researchers, most notably the Hutts (Hutt and Hutt, 1970) have investigated the relationship between nervousness and anxiety with stereotyped behaviors. Their work, plus that of others, (see for example, Altman and Taylor, 1973) has indicated a significant increase in stereotypical behaviors under conditions of stress. Object play essentially is any physical manipulation of objects not related to the task at hand. The classic example is worry beads. Automanipulative behavior includes such things as scratching, playing with one's own hair or fiddling with clothing.

Table 2 Observational categories: Individual

1. Defensive postures - (i) arm(s) across median axis of body. Two arms crossed or arm and leg crossed counts as one. One arm and then later another arm (i.e., break in the sequence) would count as two units. Hands folded together in front would also count. Do not count hand on face or chin (counts as automanipulative). (ii) leg(s) - same as arm; (iii) object(s) - held up in front of body or face; (iv) movement - direct movement away from another person only when that other person has moved towards the subject. Do not count leaning or orientation shifts. In other words, the person has to literally get up and move, slide their chair over, etc.

2. Stereotypical behavior -
a. object play-playing with objects such as pencil tapping, shuffling papers when not suppose to be marking answer sheet, taking glasses off and playing with them (do not count pushing glasses up on nose); do not count swinging around in chair,
b. automanipulative - playing with parts of body or clothing, jewelry, etc. Scratching, rubbing, playing with hair, tapping foot.

3. Nonverbal frustration - (i) slamming objects, (ii) shaking head, (iii) pounding hand or fist, (iv) giving up during a task and not trying at all-measure only in terms of actual behavior, for example, if during the IP task, the subject stops writing for more than one trial.

4. Suspicious acts - (matrix game only) - (i) hand signalling or other nonverbal means of signalling group or individual choices, (ii) preventing or trying to prevent the experimenter from seeing or hearing discussion of the group. Whispering counted.

iii) Nonverbal frustration - Given that subjects might feel angry or frustrated, but be reluctant to express such sentiments verbally, some measures of nonverbal frustration were devised. Behaviors such as shaking the head, fist pounding or slamming objects were scored.

iv) Suspicious acts - This behavior was only scored during the matrix game. Since the matrix game varied in length of time played, all observational categories for the matrix game were corrected for time. Quite unexpectedly, pilot data revealed several instances of subjects performing acts which appeared to be intended to prevent the experimenter from following group deliberation during the matrix game. In such instances, the group usually tried to hand signal or whisper about their possible alternative choices until they finally made their choice and indicated as such by throwing the appropriate column switch. This behavior, plus some verbal behavior, suggested that they felt the experimenter was waiting for them to make their choice and then he was throwing his switch. This occurred even though subjects were explicity told in their instructions that the experimenter made his choice before their deliberations began for each trial. Any instances of hand signalling or other means of preventing the experimenter from following the deliberations were scored.

2. Group categories - Criteria and detailed categories are presented in Table 3.

i) Duration of silence - The amount of time in which no one was talking was recorded. Preliminary analyses had suggested that there was considerably more noise and talking in the high density groups.

ii) Verbal frustration - This was essentially a verbal analogue for

Table 3 Observational categories: Group

1. Duration of silence - Count amount of times when no one is talking.

2. Verbal frustration - verbal remarks which indicate frustration, such as swearing, saying it's impossible, I can't do it, I quit, this thing is ridiculous, forget it, etc.

3. Greater than three talking - Count number of times greater than three people are talking.

4. Hostile comments

a) Within group - remark(s) directed at someone else in the group which indicates hostility. Name calling, threats, derision.

b) Between group - remark(s) directed at the experimenter(s) from the group which indicate hostility.

5. Going to door - remarks or actions to go towards the door. Count such things as walking over to the door, references to leaving the room, references to the door directly.

6. Suspicious comments - (matrix game only) (i) references to the experimenter listening, being able to hear the subjects talking, etc., (ii) references to the experimenter cheating, questioning the procedure about who goes first.

7. Strategy remarks (matrix only) - Remarks made by group about what is happening in the game in a systematic way as opposed to guessing or choosing a column for no vocalized reasons. Comments such as take column two or no take one, would not count. A comment such as we should take column one because...was counted whether or not the strategy was valid. (ii) also counted people's remarks about the fact that the game or the experimenter had a strategy or a plan.

8. Voting (matrix only) - Counted actual voting or any attempts to reach group consensus during a particular trial. Only count once, i.e., whether or not during a particular trial voting occurred.

9. Inappropriate laughter (matrix only) - Counted number of times there was any laughter during the matrix game after the group received a minus payoff.

the nonverbal frustration measure. Pilot data indicated instances of swearing and other general remarks about frustration, such as "I can't do it," "I give up", etc.

iii) Greater than three talking - An initial impression of the pilot data was that there were more interruptions in the high density groups. This measure was an attempt to operationalize interruption by counting the number of times more than three people were talking at the same time.

iv) Hostile comments - Hostile comments was broken down into two categories: within the group and between the group and the experimenter. Stokols et al. (1973) scored the number of hostile comments made under crowded and noncrowded conditions and found no differences as a function of density level. Preliminary analysis of pilot data suggested to me that if this category was broken down as here, that comments from the group towards the experimenter in particular might be affected.

v) Going to door - Several crowded groups in the pilot tapes made remarks about leaving the room, asking whether the door was locked, etc. Thus, we decided to score this category.

vi) Suspicious comments - This category, plus the next three were scored during the matrix game only. Again, as mentioned above, all categories scored during the matrix game, whether exclusively or not, were corrected for time. Just as we had noticed in our pilot data that some groups were performing what looked like suspicious nonverbal acts, several persons also made various comments and inquiries which suggested some suspicion on their part. Many groups made remarks about the possibility that the experimenter could listen to their discussion and then make his row choice or that the experimenter could switch on the light after they made their choice.

vii) Strategy remarks - Preliminary analyses suggested that there were a group of verbal behaviors that could be subsumed under the heading of strategy remarks. Of particular interest was the possibility that if high density groups were under more stress,than perhaps they would be less likely to work together as a group and be less likely to plan and adopt a problem solving stragegy orientation towards the matrix problem. Therefore, we scored comments about trends in the groups performance or remarks about plans, strategies to the game which were posited.

viii) Voting - This index was taken in order to determine if the nature of group decision-making for the matrix game was any different under different densities. The assumption here is that voting or attempts to reach consensus would reflect group decision-making versus more indivdual dominant decision strategies.

ix) Inappropriate laughter - Some research (Stokols et al., 1973) has found that high density groups seem to have a higher 'frequency' of laughter than low density groups. Pilot data are consistent with this observation as well. Stokols suggested that perhaps this extra laughter, as it were, is a way of easing tension under the stress of crowding. We felt that one way to get a better handle on this would be to measure when laughter was occurring that was clearly inappropriate, i.e., nothing funny was said or had occurred. Thus, we measured when people laughed after a losing matrix payoff (when the payoff was negative). We originally tried to score the whole tape for this category, but it proved unsatisfactory because we could not reach consensus as to when nothing funny was said or done prior to periods of laughter.

Summary

Ten groups of subjects, ten members per group were studied in a between groups design in which the major independent variable was density level. Sex of subject was also considered as an independent variable with mixed sex groups of an equal or a four to six ratio found in each group. Density was varied placing the groups in either a normal sized laboratory room or a very small room. Dependent variables fall into four broad classes: observation, affective data based on self-report scales, performance data and physiological data. In addition, personality and background data were obtained on all subjects which will be regressed onto some of the dependent variables in order to examine the impact of individual differences on experiences of crowding.

RESULTS

The data analysis is divided into two major sections. The first section deals with the high versus the low density comparison. The second section focuses on the regression analysis of the background and personality data.

Treatment comparison

1. Manipulation check - The first question on the background questionnaire asked subjects to rate how they felt during their time in the experimental room on a nine point Likert-type scale bounded by "crowded" (+4) and "uncrowded" (-4) with a (0) neutral point. The mean rating for subjects in the low density group was -1.60 and +2.24 for the high density subjects, univariate $F(1,93) = 110.30$, $p < .0001$. This univariate value was in a cluster with 27 other dependent measures where the multivariate $F(28,66) = 6.12$, $p < .0001$. The multivariate Fs for sex and the interaction were not significant. Thus reported means are collapsed across sex, except where stated otherwise, univariate Fs are drawn from this cluster.

The MANOCOV included the three initial physiological levels as covariates and 28 dependent measures. In this cluster the semantic scales are averaged across the seven sampling points in the experiment for each person.

2. Affective measures - Six different Likert-type, nine point scales were employed at seven times throughout the experiment (See

Table 1). Table 4 illustrates the overall cell means over the seven sampling points at each level of density for each scale. "Happy-unhappy" ANOVA yielded an $F(1,93) = 1.90$, which was not significant (ns.). For the "relaxed-stressed" scale ANOVA, $F(1,93) < 1.0$. "Influenced-influential" resulted in $F(1,93) = 1.01$, ns. "Calm-excited" scales resulted in an $F(1,93) < 1.0$. "Frustrated-not frustrated" indicated a marginally signficant $F(1,93) = 2.66$, $p < .10$ and finally, "physically comfortable-physically uncomfortable" was signficant, $F(1,03) = 6.17$, $p <.01$.

These data can also be considered on an individual basis, i.e., the mean at one point in the experiment for each scale as opposed to the overall mean based upon the seven sample points throughout the experiment as reported in the above paragraph. This single scale analysis yields 42 separate means since there were seven different samplings during the experiment of the six different bi-polar scales. When included in a grouping of 60 dependent variables where the MANOVA $F(60,37) = 1.97$, $p < .01$ for density, seven out of the 42 univariate Fs calculated came out significant. The seven individual means which were significant included: "happy-unhappy" during free time period one and during the dual task situation, "influential-influenced" during free time 2, "excited-calm" during free time 2, "not frustrated-frustrated" for the single search task, and "physically comfortable-physically uncomfortable" during the past information processing task and

TABLE 4 SEMANTIC DIFFERENTIALS: ENTIRE EXPERIMENTAL MEANS

Semantic Scale	Density Low	Density High
Happy - Unhappy *	1.82	.89
Relaxed - Stressed	.96	.58
Influential - Influenced	-.05	.12
Excited - Calm	-.19	-.31
Not Frustrated - Frustrated	.37	.80
Physically Comfortable - Physically Uncomfortable	1.38	.65

*The extreme position of the underlined adjective was scored as -4 on a nine-point scale anchored at +4 and -4 .

during the matrix game. The means and levels of significance for these 42 scales are presented in Table 5 collapsed over sex.

3. Performance data - Performance data were included in the cluster with 28 variables and the three initial physiological covariates. The means for IP_1 (one number presented every 2 seconds) and IP_2 (one number presented every 1 second) are presented in Table 6. ANOVA indicated that IP_1 was not significantly effected by crowding, $F(1,93) = 1.53$, ns. IP_2 on the other hand was significantly effected, $F(1,93) = 2.80$, $p < .08$.

Means for Story 1 and Story 2 sorting times (primary task) and recognition scores (secondary task) are presented in Table 7 ANOVAS revealed that none of the search times i.e., primary tasks, were significantly effected by crowding. Story 1 recognition was not significantly effected by crowding, $F(1,93) < 1.0$ whereas Story 2 recognition errors was, $F(1,93) = 3.92$, $p < .05$.

Trials to criterion[2] for the matrix game was calculated on the basis of the group and thus had to be analyzed separately. The mean trials to criterion for low density groups was 16.4 and 26.6 for the high density groups; $t_8 = 2.08$, $p < .025$. As a measure of group conformity the percentage of individual choices which were the same as the group choice was calculated for each subject. No significant differences were found as a function of crowding,

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[2] The number of trials played before getting five in a row correct according to the minimax criterion.

TABLE 5 SEMANTIC DIFFERENTIALS: INDIVIDUAL SCALE MEANS

Collapsed Across Sex

	Density		Sig. Level
Happy-Unhappy	Low	High	
Free Time One (FT_1)	2.40	1.00	< .04
Information Processing One (IP_1)	.66	.06	NS
Information Processing Two (IP_2)	1.04	-.20	NS
Sort One (S_1)	1.93	.86	NS
Sort Two (S_2)	2.00	.64	< .10
Free Time Two (FT_2)	1.58	1.68	NS
Matrix Game (MTX)	3.10	2.14	NS
Relaxed - Stressed			
FT_1	2.40	1.82	NS
IP_1	-.50	-1.14	NS
IP_2	-.70	-1.86	NS
S_1	.34	.38	NS
S_2	.72	.24	NS
FT_2	2.12	2.24	NS
MTX	2.30	1.54	NS
Influential - Influenced			
FT_1	-.16	-.04	NS
IP_1	-.50	-.32	NS
IP_2	-.86	-.38	NS
S_1	.00	.48	NS
S_2	-.28	-.26	NS
FT_2	.16	.66	< .04
MTX	1.28	.66	NS

TABLE 5 Continued

Collapsed Across Sex

Excited - Calm	Density Low	Density High	Sig. Level
FT_1	-1.26	-.96	NS
IP_1	.32	.68	NS
IP_2	.94	.68	NS
S_1	.30	.36	NS
S_2	.32	-.22	NS
FT_2	-1.34	-1.94	<.08
MTX	-.64	-.76	NS
Not Frustrated - Frustrated			
FT_1	1.48	1.92	NS
IP_1	-.84	-.54	NS
IP_2	-1.70	-1.38	NS
S_1	.58	1.58	<.03
S_2	.62	.92	NS
FT_2	1.02	1.74	NS
MTX	1.42	1.36	NS
Physically Comfortable - Physically Uncomfortable			
FT_1	1.58	1.20	NS
IP_1	.72	.32	NS
IP_2	.50	-.34	<.07
S_1	1.86	1.22	NS
S_2	.90	.40	NS
FT_2	1.78	1.14	NS
MTX	2.22	.60	<.0006

TABLE 6 PERFORMANCE DATA: INFORMATION PROCESSING TASK

	Density	
	Low	High
Information Processing One (One Number/ Two Sec)	27.50	29.50
Information Processing Two (One Number/One Sec)	77.50	89.00

TABLE 7 PERFORMANCE DATA: SEARCH TASKS

	Density		
	Low	High	
Search One Simple (Clear)	33.15	31.94	Primary Task Only
Search One Complex (Filled)	35.74	35.21	
Search Two Simple (Clear)	28.12	29.21	Primary Task Plus Secondary
Recognition Story 1 (No Errors)	2.54	2.60	
Search Two Complex (Filled)	31.06	33.74	
Recognition Story 2 (No Errors)	2.36	2.92	

$F(1,93) < 1.0$ (See Table 8).

The aftereffect data are presented in Table 9. For the first adaptation task A_1 there was a highly significant effect of density, $F(1,93) = 16.68$, $p < .0001$ and for the second tracing task, A_2, $F(1,93) < 1.0$.

4. Physiological data - Means are presented in Table 10. ANOVAs indicated that terminal systolic blood pressure and terminal diastolic blood pressure were both significantly effected by crowding, $F(1,93) = 3.58$, $p < .05$; $F(1,93) = 9.40$, $p < .002$, respectively. Terminal heart rate yielded a significant F as well, $F(1,93) = 10.14$, $p < .002$.

5. Other scales - The Subjective Stress Scale and the Hostility Scale were both significantly effected by crowding levels, $F(1,93) = 3.41$, $p < .05$, $F(1,93) = 7.01$, $p < .009$, respectively. The means are presented in Table 11. Responses to the information rate scale were not significant, $F(1,93) = 2.05$ ns. (See Table 11).

Means responses to the four questions of interest on the disguised departmental research inventory are tabulated in 11. Question 5 concerning the adequacy of the facilities was the only scale significantly effected by crowding, $F(1,93) = 11.92$, $p < .0009$.

6. Observational data - Observational data were analyzed across all tasks for the entire experiment with the exception of the

TABLE 8 MATRIX GAME: CONFORMITY

	Density	
	Low	High
Matrix Conformity (% of Indiv. Agreement W/GRP)	.67	.70

TABLE 9 PERFORMANCE DATA: AFTEREFFECT TRACINGS

	Density	
	Low	High
Aftereffect One	9.26	3.08
Aftereffect Two	15.16	18.76

TABLE 10 PHYSIOLOGICAL DATA

	Density	
	Low	High
Systolic Blood Pressure	119.12	127.50
Diastolic Blood Pressure	75.60	83.62
Heart Rate	71.76	78.02

TABLE 11 OTHER SCALES

	Density	
	Low	High
Subjective Stress Scale	27.06	31.86
Hostility Scale	13.06	19.58
Information Rate	4.60	7.08
Departmental Research Questionnaire		
Adequate Facilities? (Excellent +4 - Poor -4)	3.10	1.98
Experimenter Care About Sub? (Concerned +4 - Unconcerned -4)	2.20	1.82
Overall Competency of E (Excellent +4 - Poor -4)	2.92	2.96
Feelings About E (Like +4 - Dislike -4)	2.82	2.56

sorting tasks. Analysis was also performed on an individual task level basis. As discussed in the method section, some data were calculated on the basis of the group as a whole and other data were based on individuals.

a. Reliability data - Interobserver reliability was assessed by calculating the percentage of agreement between two observers who independently scored one particular group tape. All data were checked for reliability since two observers scored each tape completely. Table 12 displays the mean overall observer percent of agreement on each category scored based upon 20 observers (10 tapes, 2 observers per tape). It should be noted that in no case did any pair drop below .70 agreement.

b. Group data - The MANOVA for the six group observational data was not significant, $F(6,3) = 3.26$, $p < .18$. Of the six ANOVAs (i.e., Duration of Silence, Verbal Frustration, Hostile Remarks within the Group, Hostile Remarks between the Group and the Experimenter, Remarks about the Door and Greater than 3 Talking), only Remarks about the Door was significant, $F(1,8) = 7.32$, $p < .03$. Table 13 presents the means for group observational data. Sex was not treated as an independent variable for any observational analysis.

c. Individual data - MANOVA revealed a marginally significant $F(4,45) = 2.43$, $p < .06$. Defensive Postures was significantly different as a function of crowding, $F(1,48) = 4.07$, $p < .05$. ANOVAs for Object

TABLE 12: MEAN INTEROBSERVER RELIABILITY FOR EACH OBSERVATIONAL CATEGORY

Observational Category	Interobserver Reliability
Duration of Silence	.88
Greater Than 3 Talking	.97
Verbal Frustration	.91
Hostile Remarks Within Group	.93
Hostile Remarks Between Group and Experimenter	.98
Remarks About Door	.96
Defensive Postures	.88
Object Play	.87
Atomanipulative	.89
Nonverbal Frustration	.89

TABLE 13 OBSERVATIONAL DATA: OVERALL GROUP MEANS

	Density	
	Low	High
Duration of Silence	505.24	474.24
Verbal Frustration	6.92	20.40
Hostile Remarks within the Group	.96	3.36
Hostile Remarks Between the Group and the Experimenter	.80	3.02
Remarks about the Door	.00	6.30
Greater Than 3 Talking	15.14	7.96

Play, Automanipulative Behavior and Nonverbal Frustration were not significant. Table 14 illustrates the means for the individual observational data.

d. Additional observational data from the matrix game - In addition to the above data, some additional group and individual variables were measured during the matrix game only. These data included one individual category (Suspicious Acts) and four group categories: (Suspicious Comments, Strategy Remarks, Voting and Inappropriate Laughter). Suspicious Acts ANOVA was not significant. See Table 15 for means.

Strategy remarks and voting were considered in a multivariate cluster, with two other group observational categories, MANOVA $F(4,5) < .1.0$. Neither univariate F for strategy remarks or voting was significant. Suspicious Comments were considered in a multivariate cluster with three other group categories $F(4,5) = 8.82$, $p < .03$. Neither univariate F for inappropriate laughter or suspicious comments was significant.[3] See Table 15 for the means. Table 15 also includes intraobserver reliability data for the matrix observational categories.

Table 16 is a summary table of significant between groups comparisons.

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[3]These clusters were analyzed in different arrangements, i.e., with different group categories with no significant shifts in the results of the MANOVAs.

TABLE 14 OBSERVATIONAL DATA: INDIVIDUAL MEANS

	Density	
	Low	High
Defensive Postures	23.52	17.56
Object Play	18.28	20.60
Automanipulative	39.16	36.80
Nonverbal Frustration	4.92	7.68

TABLE 15 ADDITIONAL MATRIX OBSERVATIONAL DATA

Category	Density Low	Density High	Reliability
Suspicious Acts	.12	.06	.95
Strategy Remarks	.77	.65	.85
Voting	.23	.39	.84
Suspicious Comments	.47	.17	.85
Inappropriate Laughter	.31	.22	.95

TABLE 16 SUMMARY TABLE OF SIGNIFICANT TREATMENT EFFECTS

Collapsed Across Sex

	Density		
	Low	High	Sig. Level
Manipulation Check (Crowded - Uncrowded)	-1.60	2.24	< .001
Physically Comfortable - Physically Uncomfortable	1.36	.65	< .01
Information Processing 2	77.50	89.00	< .08
Story 2	2.36	2.92	< .05
Trials to Criterion	16.40	26.60	< .05
Adaptation 1	9.26	3.08	< .0001
Systolic Blood Pressure	119.12	127.50	< .06
Diastolic Blood Pressure	75.60	83.62	< .002
Heart Rate	71.76	78.02	< .002
Subjective Stress Scale	27.06	31.86	< .05
Hostility Scale	13.06	19.58	< .0001
Adequate Facilities	3.10	1.98	< .0009
Defensive Postures	23.52	17.56	< .05
Remarks About Door	.00	6.30	< .03

e. Observational data analyzed by task -

i) Matrix game - Table 17 presents means for both individual and group categories for the matrix game. Inspection of the means and tests of significance reveals that none of the differences are significant, MANOVA $F(6,3) < 1.0$ for individual categories. A group category cluster of Duration of Silence, Strategy Remarks, Voting and Greater than Three Talking yielded a nonsignificant Manova, $F(4,5) < 1.0$. A group category cluster of Suspicious Comments, Verbal Frustration, Inappropriate Laughter, Hostile within and Hostile between yielded a significant MANOVA, $F(4,5) = 8.82$, $p < .02$. Only Hostile comments between was significant, ANOVA $F(1,8) = 52.50$, $p < .001$.

ii) Free time two - Means for group and individual categories are presented in Table 18. Individual data for all tasks except the matrix game are in a sixteen variable cluster, MANOVA, $F(16,33) = 2.29$, $p < .02$. For free time two, object play and automanipulative ANOVA, $F(1,48) = 6.18$, and 3.76, respectively, $p < .01$, $< .05$. MANOVA for the group data was not significant, $F(6,3) = 2.15$, ns.

iii) Information processing two - Means for individual and group data are presented in Table 19. Only Defensive Postures was significant, $F(1,48) = 6.91$, $p < .01$. The MANOVA cluster for the group data was not significant.

iv) Information processing one - Means for individual and group data are in Table 20. ANOVA was significant for Defensive Behavior,

TABLE 17 MATRIX OBSERVATIONAL CATEGORIES

	Density	
	Low	High
Defensive	4.45	2.43
Object Play	2.48	2.89
Automanipulative	5.80	5.66
Nonverbal Frustration	.42	.49
Duration of Silence	5.45	7.64
Greater Than 3 Talking	1.67	.36
Verbal Frustration	.35	.20
Hostile Within	.14	.08
Hostile Between	.19	.02
Remarks About Door	0.00	.02

TABLE 18 FREE-TIME 2 OBSERVATIONAL DATA

	Density	
	Low	High
Defensive	4.24	4.68
Object Play	3.96	6.20
Automanipulative	4.16	5.68
Nonverbal Frustration	.20	.60
Duration of Silence	57.83	83.40
Verbal Frustration	0.00	3.40
Hostile Within	0.00	1.80
Hostile Between	0.00	1.20
Remarks About Door	0.00	2.40
Greater Than 3 Talking	5.20	1.80

TABLE 19 INFORMATION PROCESSING$_2$ OBSERVATIONAL DATA

	Density	
	Low	High
Defensive	6.12	3.08
Object Play	4.72	5.08
Automanipulative	13.12	12.80
Nonverbal Frustration	3.72	4.80
Duration of Silence	164.00	136.40
Verbal Frustration	4.80	10.00
Hostile Within	.40	1.20
Hostile Between	.20	1.20
Remarks About Door	0.00	.20
Greater Than 3 Talking	4.00	3.40

TABLE 20 INFORMATION PROCESSING$_1$: OBSERVATIONAL DATA

	Density	
	Low	High
Defensive	3.60	.80
Object Play	4.44	3.96
Automanipulative	4.21	3.88
Nonverbal Frustration	.43	.41
Duration of Silence	215.20	188.80
Verbal Frustration	1.40	7.00
Hostile Within	.20	.80
Hostile Between	.20	.40
Remarks About Door	0.00	1.80
Greater Than 3 Talking	4.60	.20

$F(1,48) = 4.06$, $p < .05$. The MANOVA for the group data was not significant.

v) Free time one - Mean data are in Table 21. Nonverbal Frustration was significnatly effected by crowding, $F(1,48) = 8.85$, $p < .004$. The MANOVA for group data was not significant.

Individual difference data

A paralellism test was conducted in order to determine if the regression equations for high density were parallel to those for low density. The analysis revealed that we could not reject the null hypothesis that the two sets of equations were parallel, $F(378,305) < 1.0$. This means that the predictors for the high density condition are not unique with respect to high density conditions only. Thus data for both high and low density were combined for subsequent regression analysis. The personality and background variables then will predict equally well for one's behavior under high or low density. For the combined analysis, see Appendix VI.

TABLE 21 FREE TIME ONE: OBSERVATIONAL DATA

	Density	
	Low	High
Defensive	5.12	5.04
Object Play	3.40	4.24
Automanipulative	5.76	5.44
Nonverbal Frustration	0.00	.64
Duration of Silence	62.80	87.60
Verbal Frustration	.40	.40
Hostile Within	.20	.00
Hostile Between	.20	.20
Remarks About Door	0.00	1.20
Greater Than 3 Talking	3.20	2.80

DISCUSSION

The major hypothesis of this study was that crowding is a stressful experience mediated by heightened arousal. We expected to find more errors in the increased observational and physiological indices of arousal in the crowded conditions as compared to the uncrowded conditions.

Secondly, a subsidiary hypothesis based upon the stress construct was that some aftereffects of the crowding experience would be reflected in a reduced tolerance for frustration as measured in a problem solving task. Third, several individual differences in personality and background experiences were expected to ameliorate the effects of crowding on individual's behavior. In particular, persons who are more externally oriented, dominant, aggressive and less aesthetically sensitive, arousal-seeking and gifted in imagery ability, would react more negatively to the crowded environment. Fourth, an argument was made for the utility of some non-hypothetical, exploratory analysis.

Because of the voluminous amount of data generated by this program of research, considerable data reduction and summary overviews will be necessary.

Before proceeding any further with a discussion of the data, the results of the manipulation check need to be examined. Subjects rated the high density environment as significantly more crowded than the less dense condition. Thus, in light of Stokols (1972a) distinction between crowding and density, subjects overall in this study perceived the high density environment as significantly more crowded than subjects in the low density environment.

1. Crowding and the stress/arousal hypothesis

The hypothesis that crowding is a stressor mediated by over-arousal received generally supportive evidence, although a few contradictory findings need to be explained. Several affective measures indicated that subjects felt more stressed when crowded. Persons who were crowded felt significantly more physically uncomfortable overall (see Table 4) and rated their overall experience on the Subjective Stress Scale as more stressful (see Table 11). On the other hand, subjects did not feel more relaxed nor did they feel more calm under the uncrowded condition as opposed to the crowded condition (Table 4). If subjects were at higher arousal levels in the crowded condition, it seems reasonable that this state would be reflected by greater feelings of excitement and stress. The calm-excited scale in particular has been found to load most highly on an arousal factor in Mehrabian and Russell's (1974) research on individual's affective responses to various environments. Examination of the calm-excited means in Table 4 reveals that subjects typically checked the zero point on the scale which may mean that they felt that this scale was not applicable to the situation. Both of these scales, although validated against other semantic situations by Mehrabian and Russell (1974), have not been validated against a real world, i.e., live experience. Perhpas their construct validity is lacking, but in any case they do not suggest either greater self-reported excitement or stress in the crowded conditions.

Some support for arousal as a mediator of the effects of crowding can be found in the performance data. Complex tasks have been found to be more sensitive to manipulations of arousal level and thus, ought to be more interferred with by crowding than simple tasks. The Yerkes-Dodson task performance clearly need to be tempered. In order to more adequately compare the Freedman studies with this one, it is useful to note the varying densities employed. In this study, the high density condition provided 9.6 square feet per person as compared to 3.9 and 6.3 in Freedman's two studies. Low density here was 60 square feet per person as compared to 32 and 18 for the Freedman studies.

The physiological data are consistent in their support for the increased arousal mechanism of crowding. Subjects had significant increases in all three physiological indicators. In addition to the Epstein and Karlin (in press) findings that crowding increased skin conductance, Henry et al. (1967) have also reported significant increases in blood pressure when mice were subjected to high density living conditions. The physiological damage reported in rodents after high density experience (Christian et al., 1962, 1964) are also in accord with the increase found here in heart rate and blood pressure.

One can also build a case that crowding increases arousal from a series of studies done with children under different conditions by the Hutts. Hutt and Vaizey (1966) varied the number of children aged 6-9 years in a constant area. Less than six, seven to eleven and greater than eleven children were observed in an area 27x17.5 feet during periods of free play. Of interest from an arousal point of view is that they found different results dependent on the arousal states of the children. Children who were brain damaged (generalized lesions of the brain) had more actue reactions to being crowded (as measured by observer time spent in aggression or destructive behavior) than normal or autistic children. The latter had no such increase, while the normal children did, but not to the extent that the brain damaged children did. Only the normal children reflected a significant drop in social interaction with increased crowding (a tendency that has been found in other crowding studies with children as well (Loo, 1973). Furthermore, the autistic children exhibited significantly increased withdrawal (measured by the time spent on the peripthery of the room).

Of particular interest to us here, is the fact that autistic children have abnormally high arousal levels as evidenced by electroencephlagraph recording (Hutt and Hutt, 1970). In addition, brain damaged children, in comparison to normal children, have the exact opposite pattern of EEGs. Presumably extreme withdrawal versus increasing aggressive activity could reflect attempts to decrease or increase arousal levels, respectively.

Hutt and Hutt (1970) have also acquired evidence that the common stereotypical behavior patterns found in autistic children are employed as an arousal reducing mechanism. Stereotyped behavior can be defined as repetitive movement in invariant patterns which appear to have no goal. Considerable findings, as reported by the Hutts, indicate that in conditions where arousal is known to increase, autistic children's stereotypical behavior also increases. Thus, stereotypies have been found to increase when novel objects or persons are interjected into the autistic's immediate environment, or when the complexity of the immediate environment is increased. More convincing evidence of the tie between stereotypies and arousal reduction comes from the finding that immediately prior to bouts of stereotypies telemetrized EEG readings indicate high arousal. Slowly as the stereotypies continue, the EEG begins to return to a more normal state and eventually does so. At or close to this point where the EEG is normal, the stereotypies cease.

Two observational measures of stereotypical behaviors were included here; object play and automanipulative behavior. The overall results were disappointing in that neither measure was significantly greater in the crowded condition. When the results are broken down into different activity sessions of the experiment, one noteworthy exception is apparent. During the second free time period, which occurred approximately three hours into the experiment, there was significantly more object play and slightly more automanipulative behavior in the crowded condition (see Table 18). One reason why these dependent measures may not have been sensitive to the effects of crowding during other parts of the experiment is because only during the free time periods was the subject's time unstructured. During the other task oriented sessions, subjects had little opportunity to engage in stereotypical behavior,since they were busy with the tasks at hand. The lack of a significant difference during the first free time period could be because of the early time in the experiment. Subjects at this point had only been crowded for about ten minutes into the experiment.

Two other lines of research may have some bearing on the arousal argument. First, several lines of work indicate that eye contact heightens arousal (Nichols and Champness, 1971; Coss, 1970). Nichols and Champness found that both the frequency and amplitude of GSRs increased with eye contact in adults. Coss (1970) has found that the eye spot pattern, geometric configurations is itself an important contributer to arousal.

Arousal increased significantly when persons look at different stimulus configurations that approached the normal, horizontal placement of two concentric circles.

Work with autistic children indicates several interesting facts with regards to eye contact behavior. First, the avoidance of eye contact is considered a primary symptom of childhood autism by clinicians and researchers alike (Hutt and Ounsted, 1970). Hutt and Ounsted (1970) have suggested that the extreme avoidance of eye contact among autistic children (who you will recall are at abnormally high levels of arousal) functions as to cut down arousal since, as argued above, eye contact can be an arousal increasing experience. This argument is consistent with Chance's (1962) classical paper on the 'cut off' hypothesis. Briefly, Chance argued in his review of numerous agnostic postures and displays in many different animals, that these displays and postures typically involved various maneuvers designed to cut off aggression which would be elicited by particular signs at close range. One particularly salient aggression-inducing sign or threat display among animals reported by Chance was the eye gaze. When close up, many animals would behave in such a way as to avoid eye contact ritualistically.

Two areas of human spatial research can also be brought to bear upon the position taken here vis-a-vis the possible relationship between eye contact and arousal. If it is correct that a spatial impingment heightens arousal and that eye contact also heightens arousal, then given the normally preferred moderate level of arousal, persons should seek to avoid eye contact more under conditions of spatial impingment. Consistent with this idea, several personal space studies have found that there is an inverse relationship between amount of eye contact and interpersonal distance (Evans and Howard, 1973). Furthermore, Ross, Layton, Erikson and Schopler, (1973) have reported that males in an all male group looked less at the faces of other males under crowded conditions. This relationship was reversed, however, for females. This sex difference could be due to the fact that either females characteristically have lower arousal states than males or that females are less negatively affected by crowding. Several researchers have reported that all female groups responded less negatively to crowding than all male groups (Epstein and Karlin, in press).

A serious methodological problem exists, however, in the measurement of eye contact. Earlier research which claimed that observers could reliably gauge when eye contact was being made have been challenged by recent research (Lord and Haith, 1974; Stephenson and Rutter, 1970). We tried to observe eye contact in our pilot studies, but found that it was extremely hard to get satisfactory inter-observer reliability. The overall impression that one gets when looking at the video tapes is of more avoidance of eye contact and general orienting away from the group in the crowded sessions. Subjects seemed to turn their chairs on an angle to the group and look away from the group. All of this, however, is clearly speculative. We simply were not able to establish satisfactory reliability to tabulate eye behavior.

A second thread of indirect evidence that may bear on the arousal argument, are data which indicate that introverts characteristically have higher arousal levels than extraverts (Berlyne, 1971). Data also suggests consistently that less dominant animals in a social hierarchy have greater arousal levels (Welsh, 1964). A clear finding, as discussed in the animal section of the introduction, is that subordinate animals suffer more maleffects from crowding than do more dominant animals (Christian et al., 1961, 1964; Thiessen, 1961, 1964). If crowding increases arousal and if subordinate animals are already at high levels of arousal, then it makes sense that less dominate animals would react more negatively to crowding given the medium, optimal arousal hypothesis. One can argue, of course, that more dominant animals handle high density more effectively, simply because they can command more space and other resources and thus be less effected by some of the negative aspects of high density. On the other hand, one might argue that more dominant persons who are used to being in control when placed in a situation where there is some behavioral restraint operating might react more negatively, given the greater discrepancy between their usual mode of operation and their present behavioral options.

The present findings have little to say concerning either prediction - individual's dominance and their reaction to crowding is not clear from the data,since any relationships found among the predictor variables and the various criterion variables are not unique to the high density situation because the parallelism test revealed that the regression line for the crowded condition was essentially parallel to that of the non-crowded condition.

Perhaps more directly bearing upon the arousal argument is arousal-seeking tendency. The prediction again here was that persons who seek high arousal levels should react less negatively to the crowded conditions. Presumably such persons are typically at a lower arousal levels and thus seek more arousal to increase their arousal levels up to the more moderate, optimal level. Again the evidence is equivocal because of the parallelism test findings.

Hebb (1972) and Berlyne (1960, 1971) have disucssed some of the hypothesized underlying physiological mechanisms and operations governing arousal. Arousal is seen as a nonspecific dimension of ascending excitation which provides a general freshening or toning up of the cortex. This nonspecific activation manifests itself in terms of how wide awake, alert or excited the individual feels. This ergotropic system is believed to be located in the brain stem reticular formation. The evidence for the physiological basis of arousal is based primarily on electrical stimulation and/or removal of selective parts of this area in various animals. Hypothalamic and thalamic input are also indicated in arousal functioning. Interestingly, there is also support for a descending, reticular inhibiting process which appears to be cortically mediated. Given the argument that a medium range of arousal seems to be optimal for a variety of human behaviors, it makes sense that the arousal system has some built in leveler, as it were, to inhibit arousal. The need for periods of rest and sleep also demand some arousal reducing mechanisms. For a more detailed treatment of physiological bases of arousal, see Malmo (1959).

The construct of arousal is by no means clear-cut. Broadbent (1971) and Kahneman (1973) both present summaries of the conflicting evidence. Data based on drug stimulants, circadian rhythms and the introvert-extravert dimensions all suggest the need for at least a dual function arousal mechanism. Arousal as discussed here has been treated as if it were a unitary dimension. One might argue, however, that there are qualitative differences in arousal depending in part upon varying affective inputs or general cortical conditions.

There is also dispute over the measurement of arousal. Hebb (1972) argues that EEG is probably the most effective and accurate psycho-physiological indicator of arousal whereas Bloch and Bonvallet (1960) argue for the use of the electrodermal response. Berlyne (1960, 1971) and others argue that both of these measures, plus heart rate and blood pressure are adequate measures. Lacey (1967), however, has argued that based on discrepancies among various arousal indicators, the construct itself should not be considered as a undimensional idea. Based on the evidence presented, it would appear that skin conductance is probably the most direct correlate of arousal level with EEG a close second. Again these measures were not employed here because of the lack of suitable equipment to monitor ten people at a time.

In summary, the line of argument suggested here is that crowding is a stressor which is mediated by high arousal. This high level of arousal becomes debilitating only when the organism is pushed close to its information processing capacities by more complex task demands during short, acute periods of high density. The evidence, although clearly not overwhelming and not without some inconsistencies, does support this argument.[5] Physiological data and complex task performance indicate patterns of stress mediated by high arousal.

2. Stress and aftereffects

The pioneering work of Glass and Singer (1972) which was discussed

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[5] Nonetheless, all of the MANOVA findings reported above are conservative because of the small ratio of nonverbal observation (n=100) to dependent variables (27) in the multivariate cluster.

briefly in the introduction has indicated that while the effects of various stressors (primarily noise) are quite small on simultaneously analyzed simple tasks, there may be considerable aftereffects on later behavior as a result of those stressors. These findings are consistent with the theoretical work of Dubos (1965) and the physiological analyses of Selye (1956) in which it is argued that humans are quite adaptable in that they can respond to and deal with a great deal of stress at the time that it is occurring. It is afterward in the long run in response to chronic stress in Dubos' analysis or after more acute, short term stressors according to Selye that we begin to exhibit signs of exhaustion, fatigue or even injury and death. Inspection of Table 9 and ANOVA results indicated a pattern of results quite consistent with Glass and Singer's findings. Immediately after the experimental condition, subjects who had previously been crowded attempted to solve the first impossible figure significantly fewer times than the previously uncrowded subjects. As in Glass and Singer's work, only the first impossible puzzle reflects the stressor's effects.[6] Recent work by Dru Sherrod (1975) has found similar results. Previously crowded subjects, as opposed to uncrowded subjects, attempted fewer tries to solve the first impossible figure and again did not differ significantly on the second puzzle. Sherrod also introduced an additional independent variable which has been shown to be important in mediating the effects of stress upon human behavior. In addition to a crowded-uncrowded condition, Sherrod also had a condition of crowding with perceived control where subjects

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6 Glass and Singer (1972) have not been able to explain why only the first puzzle is effected by previous stress. It's probably related to the fact that after giving up on the first impossible puzzle, Ss usually meet immediate success on the next puzzle and then persist a lot more on the second impossible puzzle.

felt that they could leave the situation if they wanted to. Consistent with most of the research on perceived control and stress, he found that this variable ameleiorated some of the effects of the crowding experience.

This finding concerning perceived control is important for at least two reasons. First, in light of the theoretical position of behavioral restraint enunciated earlier, this result is clearly in support of the perspective which argues that the indivdual's perception of restraints on behavioral options which are encountered under a situation of high density are an important contributor to the person's response to the situation at hand.

Second, much of the research which has found little or no effects of crowding on task performance may have confounded conditions of varying perceived control. Freedman's research is particularly susceptible to this criticism, in that subjects could walk around the room, get a drink of water, etc. In some sense all psychological research carries the implication, explicit or not, that subjects can leave the experiment if they want to in order to conform to HEW guidelines for human subjects. This trend may have the result of weakening many of the effects found in the crowding research and, unfortunately, decrease the ecological validity of the experimental experience of crowding, in that crowding outside of the laboratory is often experienced with little or no perceived control options.

Epstein and Karlin (in press) in a series of studies have systematically examined the aftereffects of crowding on various human behaviors. They argue that the use of tasks during the crowding experience reduces the effects of crowding because the tasks provide subjects with distractants which allow them to more or less ignore the close presence of others. Thus, they placed subjects in either high or low density conditions for thirty minutes and gave no tasks to perform. Afterward subjects behaviors on a variety of tasks and situations were assessed, indicating several negative aftereffects as a function of crowding.

Dooley (1975) has also recently reported aftereffects in a crowding experiment which significantly interacted with independent measures of subjects' personal sapce zones. Although all persons who had previously been crowded performed more poorly on a proofreading task, persons who had "far" personal space zones were particularly affected.

The findings that crowding seems to precipitate aftereffects becomes problematic when one attempts an explanation of the effect. Glass and Singer (1972) have attempted to examine in some detail Dubos (1965) theory that one pays some psychic and/or physical cost in his adaptation to stressful conditions and in the process, depletes his reserve capacity to deal with subsequent challenges or stressors. Employing several internal analyses of existing data, plus manipulating degree of adaptation, Glass and Singer have found little support for the psychic cost hypothesis in terms of short, acute stress exposure.[7] At the present, the only explanation offered is simply that behavioral aftereffects indicate some behavioral residue from the original stressor.

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[7] This research has involved noise almost exclusively. To be fair to Dubos (1965), his conceptualization of psychic cost was in reference to more long term, chronic stressors than those employed by Glass and Singer.

Therefore, while we may be moving toward a possible explanation of the mechanisms of crowding, i.e., it is a stressor which is mediated by high arousal; this explanation in itself does take us all that much further. Attempts to explain the effects of overarousal in terms of attention focusing, for example, have not been all that successful and currently remain largely unexplained.

3. Individual difference data

A series of multivariate multiple regression equations were derived in order to examine what contributions a set of eleven personality and background variables made to various criterion variables. The personality variables involved were locus of control, aggression, aesthetic sensitivity, arousal-seeking tendency and imagery ability. As discussed above, a parallelism test was conducted to determine if the particular contribution of the set of predictor variables was unique to one cell of the design, i.e., the crowded condition. This test was derived from Finn (1974) to deal with one of the inherent weaknesses of regression analysis. Namely, when researchers derive a particular equation or set of equations to explain variability in dependent variables, those relationships are discussed as if they applied exclusively or in some unique way to that particular independent condition. The parallelism test provides a check on this assumption by determining if the particular set of equations for the crowded condition is parallel or not to the same set of equations for the uncrowded condition. Since we could not reject the null hypothesis that the two sets of equations were parallel, we have to assume for purpose of analysis and interpretation that the two sets of equations are parallel.

The parallelism test provides us with a statistical test for the trait by situation interaction position advocated by Bowers (1973). Bowers' analysis suggests that while neither traits nor situations alone can account for substantial proportions of variability in human behavior, the interaction of trait and situation provides a considerably more powerful behavioral indicator. Our data suggests that this interactionist position may also be weak. There was no trait by situation interaction as indicated by the parallelism test findings. Knowing a constellation of background and personality data does not predict differentially how individuals will react in a crowded environment versus how they will react in an uncrowded environment.

Two possible objections to this observation are apparent. First, perhaps the present selection of personality and background variables was inappropriate to the crowding context. A review of the justifications and predictions made for the variables used here (see Introduction) disputes this objection.

Second, one could argue that several of the predictor variables may have insufficient variability given the limited scope of the sample, i.e., college students. Inspection of the means and standard deviations of the predictor variables in Appendix VI suggests, however, that considerable variability is present in the predictor variables from our sample.

In addition to the trait by situation issue, the similarity of the two sets of regression functions bears upon the claims of several researchers (see Wohlwill, 1974, for example) that an individual's past experiences help shape their present responses to particular environmental conditions, such as crowded environments. Such claims need to be tempered by the

the realization that while such relationships may hold, they may not be unique to a particular situation, such as a crowded environment.

4. Other data and some further analyses

a. Affective measures - In addition to the "relaxed-stressed," "calm-excited," and "physically comfortable-physically uncomfortable" scales, subjects also responded on a "happy-unhappy" dimension,"influenced-influential" and "frustrated-not frustrated" scales. Inspection of the means (Table 4)and ANOVAs indicated no significant overall differences. The "frustrated-not frustrated" result, although not significant, is in the opposite predicted direction from that which the behavioral restraint perspective would predict. Behavioral restraint theories of crowding argue that the frustration of goal attainment as a result of interference by the presence of other persons in too small a space is a prime cause of the stresses of overcrowding. Yet, here there was a slight reversal with more crowded subjects feeling less "frustrated." One might also suspect as a corollary of the behavioral restraint position that persons under crowded conditions would be more likely to feel influenced by their surroundings, other persons, etc.,rather than feel that they could influence their environment. Again, there was no support for this position, in that there was no more "influence" reported by the crowded persons. "Happy-unhappy" also was unaffected by crowding.

b. Performance data - The only performance variable left to discuss is the group conformity measure where the percentage of individual's agreement with the group choice was calculated for each trial of the matrix game and then combined to form a mean, individual conformity score. Subjects indicated their own personal choice on their answer sheets after the group discussion and choice had been indicated, but prior to the payoff value determination. Statistical analysis suggest (Table 8) there was no significant differences between crowded and uncrowded groups in their conformity to group decisions on the matrix task.

Epstein and Karlin (in press) reported a significant sex by crowding effect where they found that men were less cohesive and more apt to assume a competitive stance on a group task than women when crowded. Cohesiveness was operationalized by these investigators by the Tajfel task in which individuals make choices about the allocation of points between a member of their own group versus a member of a different group. This type of cohesiveness, while not identical to group comformity, presumably would correlate highly with group norm compliance. Epstein and Karlin used sexually homogenous groups, whereas in the present study, I employed mixed sex groups. Since the interaction terms here for sex and crowding were not significant, it may be that sex effects are washed out altogether in mixed sex groups.

c. Other scales - The combination of results that crowded persons rated others in the room as more hostile and found the facilities more inadequate (Table 11) is interesting for two reasons. First, these findings are consistent with the assertion that crowding is a stressful experience which may cause some discomfort. Secondly, these data tap into an interesting issue raised by Loo (1973). Loo suggests that an important dimension in defining the crowding experience is the particular cause of the spatial restraint. She argued that when one's space is reduced because of too many people (social crowding) or because the physical space is not large enough (spatial crowding), then reactions to those conditions may vary. That is, if numbers are held constant, but room size is changed, one is more apt to put the blame for his circumstances on the physical environment; whereas if room size is held constant and persons are added, then perhaps some of the individual's discomfort in such a situation will be blamed on the other persons present.

Clearly here subjects are attributing some of their dissatisfaction to both sources, i.e., the facilities are less adequate and the others in the room are rated more negatively when persons were crowded. In some sense both of these reactions are irrational, in that the experimenter was the one who was placing people in the situation they found themselves. Yet subjects did not project any feelings of hostility or judge the experimenter as any less competent when they were crowded (see Table 20). This is an area of study which warrants further concern. When and why do persons perceive the cause of their stress in an adversive environmental condition and how is the placement of blame in such a situation related to actual versus perceived sources of the original environmental stressor(s)?

The information rate scale designed by Mehrabian and Russell (1974) to assess the amount of information present in an environment failed to discriminate between the two conditions. This result may suggest no support for the sensory overload argument position taken by Mehrabian and Russell (1974) and others in which the mechanism of crowding's stressful effects is said to be the presence of too much stimulation, which in turn overloads the human information processing capacities. It could be argued, on the other hand, that this was not a fair test of the overload argument because the instrument itself may have been faulty. Two lines of evidence suggest that this may be the case. First, Mehrabian and

Russell's validation of the scale employed the use of verbal descriptions of various situations in which the overall mean for the scale was -2.2 (p. 220, Mehrabian and Russell, 1974); whereas here the means for either condition are considerably higher than their verbal workup mean. Whether one can adequately assess such a complex dimension as information rate on a verbal scale is surely a matter of considerable argument, irrespective of the additional serious objection that information rate assessment in complex environments has proven to be a futile task so far.

Second, Merhrabian and Russell (1974) posited a function which indicated that arousal was a direct correlate of information rate. However, here there is no overall effect on information rate, yet some evidence do suggest an overall arousal difference as a function of crowding. I would argue that the information rate scale itself needs further validation before any hypothesis testing can be dome employing it as a dependent variable as suggested by Mehrabian and Russell (1974).

d. Observational data - As indicated in Tables 12 and 15, all categories scored were of satisfactoryly high levels of inter-observer reliability, the lowest category having .84 agreement. Categories which did not reach at least .70 in pilot testing were eliminated. Observational data not already discussed will be outlined below under the two sub-headings: individual and group categories.

i) Individual categories - Individual categories scored were: defensive postures, object play, automanipulative and nonverbal frustration. Object play and automanipulative behavior have already been discussed in some detail above in light of the arousal hypothesis. The discussion here focuses on defensive postures and nonverbal frustration. First, it must be remembered that the MANOVA for individual categories scored, overall, was only marginally significant (< .06).[8] ANOVA revealed that only defensive postures was significantly different overall, but inspection of Table 14 indicated that the means were not in the predicted direction, i.e., there were more defensive postures in the uncrowded groups. This finding contradicts a recent finding by Kutner (1974) who found that subjects showed significantly more body protection in more dense groups, but especially when subjects faced one another as opposed to sitting back to back. In the present groups some subject faced one another, whereas others had their backs to the group. Although this mixture might explain the lack of significant sex difference as a function of crowding given Kutner' data, such seating placements cannot explain the significanct reversal of the finding. Body protection as scored by Kutner (1974) was quite similar to defensive postures as scored here. One possible explanation of the difference may be the fact that Kutner used all male groups, whereas here the groups were mixed. His groups were also smaller, i.e., two versus four persons. Again we may have a case of sex differences being washed out although this still cannot explain the reversal. When the defensive postures data are broken down into the individual task periods, we find significant differences only during the two information processing tasks, again, both in the opposite-predicted direction. One possible explanation is that observers could see more occassions of the observed categories in the uncrowded groups because people were more

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8 The MANOVA for group observational data are also highly conservative with a small number of observations (n=10 for group categories) and six dependent variables. Since there were four individual observational categories and fifty observations, the conservative limitation does not apply to the individual observation findings.

spread out. If this bias was operating during our observations, it makes all of the observation results conservative since the predictions in all cases were for greater frequencies of the particular observation measure in the crowded groups. Clearly, some methodological research is in order to answer this question.

Nonverbal frustration overall was not significant. Within each of the free time periods, however, nonverbal frustration was significantly greater in the crowded conditions, for the free time one ($p < .01$) and ($p < .10$) for free time two. This finding lends further support to Loo's (1973) and Epstein and Karlin's (in press) arguments that the degree of experimental structure created in part by the use of potentially distracting tasks is an important variable in crowding research because it may allow subjects to focus in, as it were, on other aspects of the situation, ignoring the close presence of others. The issue touches on the larger concern of using experimental versus more field oriented approaches to research in crowding. It is worth noting again that both of the stereotypical behaviors in addition to the nonverbal frustration measures only proved significant during a free time period.

Suspicious acts was also scored as an individual category, but only during the matrix game. No significant differences were found (see Table 15).

ii) Group categories - The group categories scored overall included: duration of silence, verbal frustration, hostile remarks within and between the group and the experimenter, remarks about the door and greater than three talking. Although the multivariate cluster was not significant for the overall analysis, remarks about the door was clearly significant and inspection of Table 12 indicated a considerable spread between the two conditions of crowded-uncrowded. While none of the other overall group mean ANOVAs were significant, verbal frustration and both types of hostile remarks are clearly in the originally predicted direction, i.e., more of each under more crowded conditions. The lack of significant differences for hostile remarks replicates an earlier finding by Stokols et al. (1973) although he did not break down his category into hostile within and between, but had an overall hostility score instead. None of the ANOVAs for verbal frustration came out significant when taken on a task by task situation.

Hostile within was marginally significant, $F(1,8) = 3.86$, $p < .08$ for free time two although the multivariate cluster for free time two was not significant. The means (see Table 18) indicated greater hostility in the crowded groups. Hostile comments between the group and the experimenter during the matrix game were significantly greater in the uncrowded condition, $F(1,8) = 52.50$, $p < .0001$, (see Table 17) which was clustered in a significant multivariate analysis for matrix game group tasks. Hostile remarks between were not significant on any other ANOVA for the other task periods.

Remarks about the door which was the only overall significant groups category was significantly greater under the crowded conditions in free times one and two with the remaining task period means not significant, but all in the expercted direction.

Duration of silence and greater than three people talking at once, which were not significant overall, were not significantly affected by crowding during any of the task periods.

In addition, during the matrix game, four additional group categories were scored: strategy remarks, voting, suspicious comments, and inappropriate laughter. As indicated in the Results section, none of these categories proved to be significantly different as a function of crowding (see Table 15). The lack of support for inappropriate laughter seems to contradict a hypothesis of Stokols et al. (1973) that the reason people laughed more under crowded conditions, especially when under a competitive versus a cooperative task set, was to relieve tension. Such laughter was viewed as a possible coping mechanism. Our data indicate no support for this position since we made an attempt to partial out laughter which was clearly not tied to funny behavior or remarks. You may recall that inapporpriate laughter was operationalized as occurring only after the group lost points during the matrix game, and thus, as a result decreased their chances or winning the monetary reward for most points scored in the game. On the other hand, one could argue that such a situation might not create the kind of tension which would elicit tension coping behavior, such as inappropriate laughter.

The results for suspicious remarks and acts, while not counter-initutive, are nonetheless disappointing. During pilot testing, there were significantly greater occurrence of each of these measures in crowded groups. At this time no explanations for this failure of replication come to mind.

Pilot testing also indicated a marginally significant spread on strategy remarks again in the same direction here with more in the uncrowded groups. One possible reason why this category may not be working out, besides the obvious possibility that there are no effects of crowding on the category, is that in order to reliably score this category, we had to restrict our criteria quite narrowly as to what was a strategy remark.

Finally, the lack of support for any differences in the amount of voting as a function of crowding may serve to counter the oft-made extreme claims of Le Bon (1895) and others who see individuals in crowded conditions as a mass collection of automatons ready to imprint upon the polemics of the first despot who comes along. Whether people were crowded or not, in this experiment they tended to make group decisions by voting about half the time.

5. Summary and further speculations and future directions

One way in which to gain an overall summary of the data in this research project is to examine Table 16 which includes significant overall treatment effects,except for the observational data which is broken down into specific task periods (Tables 17-21). One of the stated purposes of this project was to determine what types of activities or behaviors are most susceptible to the effects of crowding. This can be operationalized in part by asking which of the array of dependent measures used here maximally discriminates between the two groups. Cooley and Lohmes (1971) have discussed a method called multiple discriminant analysis, which can be described as a best reduced-rank model for parsimoniously describing the actual measured differences of the independent groups under consideration. Briefly, this technique derives a model which extracts orthogonal factors of the measurement battery for the task of displaying and capitalizing upon differences among the criterion groups. In other words, the model derives those components which best separate the groups.

The procedure available here (SPSS) enabled me to use a stepwise procedure wherein the best discriminant function is first extracted, i.e., the one which maximizes the measured differences between my groups; the program then pulls out a second factor, orthogonal to the first which maximizes the differences between my groups given that the first orthogonal factor has been removed and so on. To go beyond two or three factors is meaningless for reasons too complex to be discussed here (see Cooley and Lohmes, 1971).

The best three weights in descending order were first, the adaptation task; second systolic blood pressure and third the physically comfortable-physically uncomfortable semantic differential scale for the matrix game. Table 22 depicts the entire set of discriminant weights. One interpretation of these results is that the most sensitive indicators of the effects of crowding are indicators of a) the aftereffects of the experience and b) physiological and c) measures affected during a complex, group task. The finding that the aftereffects measure is a strong discriminant is in line with the view that crowding operates as a stressor which may be coped with in large part over short periods of time, but that crowding may create some distress and problems later on after the experience has passed. On the other hand, the complex task decrements and physiological data do suggest some current effects of the stressor as well. Again it seems cogent to view the human organism as a remarkably adaptable organism which is quite capable of dealing with a large amount of stress. It may take extremely

TABLE 22

D I S C R I M I N A N T   A N A L Y S I S

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F TO ENTER OR REMOVE	NUMBER INCLUDED	WILKS LAMBDA	SIG.	RAOS V	CHANGE IN RAOS V	SIG.
1	VAR051 Aftereffect 1		17.33670	1	.84969	.000	17.33670	17.33670	.000
2	VAR053 Systolic		11.68314	2	.75835	.000	31.22840	13.89170	.000
3	VAR042 Physc. Comf-uncomf MTX		13.09845	3	.66730	.000	48.86061	17.63221	.000
4	VAR027 STR-Relax S_2		5.74394	4	.62925	.000	57.74017	8.87956	.003
5	VAR048 Hostility		5.77923	5	.59281	.000	67.31534	9.57517	.002
6	VAR049 Info. Rate		6.70608	6	.55294	.000	79.23598	11.92063	.001
7	VAR014 STR-Relax MTX		2.28094	7	.53956	.000	83.63016	4.39413	.036
8	VAR001 Hap-Unhpy FT_1		10.53306	8	.48358	.000	104.65347	21.02331	.000
9	VAR011 STR-Relax S_1		6.45860	9	.45120	.000	119.19633	14.54286	.000
10	VAR020 Influ. FT_2		3.36491	10	.43477	.000	127.40810	8.21177	.004
11	VAR033 Frus-NFR S_2		2.61885	11	.42220	.000	134.11617	6.70807	.010
12	VAR046 Story 2		3.75511	12	.40473	.000	144.13482	10.01865	.002
13	VAR041 Physc. Comf-Uncomf. FT_2		2.01977	13	.39545	.000	149.82152	5.68670	.017
14	VAR010 STR-Relax $1P_2$		2.06114	14	.38608	.000	155.83087	6.00935	.014
15	VAR037 Physc. Comf-Uncomf. $1P_1$		2.11847	15	.37659	.000	162.23244	6.40157	.011
16	VAR032 Frus.-NFR S_1		1.95430	16	.36792	.000	168.35983	6.12739	.013
17	VAR031 Frus.-NFR $1P_2$		1.33004	17	.36205	.000	172.68020	4.32037	.038
18	VAR022 Calm-Excit. FT_1		1.33051	18	.35620	.000	177.12640	4.44620	.035
19	VAR017 Influ. $1P_2$		.91061	19	.35219	.000	180.25805	3.13165	.077
20	VAR005 Hap-Unhpy S_2		1.08110	20	.34744	.000	184.06594	3.80789	.051
21	VAR007 Hap-Unhpy MTX		1.86260	21	.33933	.000	190.80152	6.73557	.009
22	VAR021 Influ. MTX		1.76958	22	.33171	.000	197.43864	6.63713	.010
23	VAR006 Hap-Unhpy FT_2		1.34840	23	.32593	.000	202.68033	5.24169	.022
24	VAR002 Hap-Unhpy IP_1		1.14681	24	.32102	.000	207.27799	4.59766	.032
25	VAR030 Frus.-NFR IP_1		1.30812	25	.31544	.000	212.67448	5.39649	.020
26	VAR029 STR-Relax FT_1		.83888	26	.31186	.000	216.24461	3.57013	.059
27	VAR003 Frus. NFR MTX		1.12201	27	.30707	.000	221.14163	4.89702	.027
28	VAR035 STR-Relax FT_1		1.03735	28	.30265	.000	225.80446	4.66283	.031
29	VAR012 STR-Relax S_2		1.19302	29	.29758	.000	231.32310	5.51864	.019
30	VAR018 Influ. S1		1.09949	30	.29291	.000	236.57073	5.24763	.022
31	VAR024 Calm-Excit. $1P_2$		.86559	31	.28923	.000	240.82960	4.25886	.039
32	VAR019 Influ. S_2		.71980	32	.28616	.000	244.46974	3.64014	.056
33	VAR045 Story 1		.78314	33	.28280	.000	248.53341	4.06367	.044
34		VAR017 Influ. S_2	.00349	32	.28282	.000	248.51509	-.01832	1.000
35	VAR044 IP_2 Errors		.65370	33	.28004	.000	251.94716	3.43206	.064
36		VAR037 Physc. Comf-Un-comf $1P_1$	.00396	32	.28006	.000	251.92616	-.02100	1.000
37	VAR043 $1P_1$ Errors		.64023	33	.27737	.000	255.32061	3.39446	.065
38	VAR025 Calm-Excit. S_1		.58816	34	.27488	.000	258.51767	3.19706	.074
39	VAR028 Calm-Excit. MTX		.61276	35	.27227	.000	261.93109	3.41342	.065
40	VAR026 Calm-Excit. S_2		.24038	36	.27124	.000	263.30444	1.37335	.241
41	VAR056 Exp. 5		.15448	37	.27057	.000	264.20469	.90025	.343
42	VAR013 STR-Relax FT_2		.15313	38	.26989	.000	265.11395	.90927	.340
43	VAR054 Diastolic		.13444	39	.26928	.000	265.92758	.81363	.367
44	VAR055 Heart Rate		.31726	40	.26784	.000	267.88450	1.95692	.162
45	VAR050 After. 2		.16292	41	.26709	.000	268.91225	1.02775	.311

46	VAR052 Matrix	.11204	42	.26657	.000	269.63346	.72121	.396
47	VAR003 Hap-Unhpy $1P_2$	.10465	43	.26607	.000	270.32046	.68700	.407
48	VAR038 Physc. Comf-Uncomf $1P_2$	.03538	44	.26590	.000	270.55738	.23692	.626
49	VAR023 Calm-Excit. IP_1	.05572	45	.26563	.000	270.93765	.38027	.537
50	VAR037 Physc. Comf-Uncomf $1P_1$	.03509	46	.26545	.000	271.18188	.24424	.621
51	VAR056	.00409	45	.26547	.000	271.15342	-.02846	1.000
52	VAR009 STR-Relax $1P_1$	.03118	46	.26532	.000	271.37057	.21715	.641
53	VAR040 Physc. Comf-Uncomf S_2	.02453	47	.26519	.000	271.54480	.17423	.676
54	VAR039Physc. Comf-Uncomf. S_1	.02140	48	.26508	.000	271.69990	.15510	.694
55	VAR016 Influ. $1P_1$	.02646	49	.26494	.000	271.89550	.19561	.658
56	VAR034 Frus.-NFR FT_2	.02903	50	.26478	.000	272.11466	.21915	.640
57	VAR015 Influ. FT_1	.01132	51	.26472	.001	272.20195	.08729	.768

NUMBER REMOVED	EIGENVALUE	CANONICAL CORRELATION	PERCENT OF TRACE	WILKS LAMBDA	CHI-SQUARE	D.F.	SIGNIFICANCE
0	2.77757	.85748	100.0	.26472	97.68747	51	.000

ORTHOGONAL DISCRIMINANT FUNCTION COEFFICIENTS

	1
VAR001	-.44278
VAR002	.32213
VAR003	.03959
VAR005	-.39010
VAR006	.21211
VAR007	.33005
VAR008	-.12088
VAR009	-.04085
VAR010	-.22871
VAR011	.31154
VAR012	-.19622
VAR013	.08607
VAR014	.21927
VAR015	-.01332
VAR016	.02898
VAR018	-.18504
VAR019	.18352
VAR020	.31481
VAR021	-.15764
VAR022	.14411
VAR023	.02083
VAR024	-.06915
VAR025	.15606
VAR026	-.06355
VAR027	-.28344
VAR028	-.06624
VAR029	.18034
VAR030	-.20254
VAR031	.15078
VAR032	-.08032
VAR033	.44484

VAR034	.02909
VAR035	-.13349
VAR037	.01295
VAR038	-.02356
VAR039	-.01974
VAR040	.02871
VAR041	-.26890
VAR042	-.15122
VAR043	-.00631
VAR044	.00939
VAR045	.20227
VAR046	.01874
VAR048	.03717
VAR049	.05369
VAR050	.00307
VAR051	-.03533
VAR052	.36089
VAR053	-.61946
VAR054	-.07334
VAR055	.14934

sensitive dependent measures in order to pick up any immediate effects from most stressors on human task performance. Further, while there may be some evidence from affective scales and the like plus physiological evidence of some reaction to the stressor occurring, probably a good deal of the effects of stressors normally encountered come after the actual stressful experience.

The claim that group task behavior is also sensitive to the effects of crowding makes intuitive sense in that such tasks are quite likely to demand considerable cooperation and attention to interpersonal interactions which among other things would heighten the saliency of the perception of persons close by and feelings of interruption. Both of these interpretations concerning aftereffects and group task behavior are speculative and need further examination, but given the exploratory goals of this study, they are useful and a step in the direction of further exploration and understanding of the underlying dynamics of human crowding.

The non-significant sex x crowding interaction terms throughout the analyses suggest that previous sex differences reported in the crowding literature may be limited to like-sex groups only since when the sexes are combined, as in this experiment, most sex differences appear to be absent. Given the greater generalizability of a mixed sex design such as this one to the natural condition of mixed sex groupings in society, it seems cogent for other researchers to reconsider their generalizations concerning the reactions of males versus females to crowding.

Priorities for research should go into three different areas in my opinion. First, further exploration is needed into the stress, over-arousal hypothesis. The data on complex task performance are not clearcut and warrant more detailed exploration. Further the questions raised by Broadbent (1971), Kahneman (1973) and Lacey (1967) as to precisely why over-arousal causes decrements in task performance and whether or not arousal à viable construct have not been answered fully. It would improve the experiment considerably if more frequent measures of arousal level and perceived crowding levels could be assessed. If arousal increased during the experiment, feelings of crowding should go up accompanied by various stress indicators.

A second direction for future research would be to examine how crowding interacts with other potential stressors. Cohen (1975) has suggested that a cogent way to view the relationship between the human and his physical environment is in terms of the effects of environmental load on the allocation of attention and its subsequent effects on information processing. He suggests that various environmental stimuli can be viewed on a linear informational continuum much in line with Mehrabian and Russell's analyses of information rate and the environment (1974). If humans can only allocate attention to a limited amount of input, then it behooves us to consider how different levels of information from the environment may become stressful acting alone or in conjunction with other sources of information load to create an overload condition wherein processing capacities are pushed beyond their limits. Such an analysis makes the important assumption than when environmental load is too great that the system becomes overloaded and stress resluts. This analysis presupposes first that overload is stressful and suggests secondly that perhaps different environmental loads can be combined in some sort of additive fashion. Certainly both of these assumptions demand further clarification and documentation.

Finally, it seems that our reactance to andpreference for physical or natural environments in which we find ourselves may be partially contingent upon our current situation vis-a-vis dealing with sources of social and physiological stress. Zimring, Evans and Zube (1975), for example, have proposed a preliminary theoretical schema for the relationship among proxemic behaviors and physical design. For example, if it is correct that crowding heightens arousal and that persons prefer moderate amounts of arousal, then persons who are crowded should be provided designed environments which minimize arousal.

Some additional criticisms and possible areas of future research include the following:

a) What effects does crowding have on helping behavior during the crowding experience as well as afterwards?

b) Does crowding have any effects on eye contact behavior?

c) For the information processing tasks, it's not clear that IP_1 where numbers were presented one every two seconds was a simple enough baseline measure for the comparison of simple to complex tasks where complexity was operationalized in terms of stimulus signal rate. It would be an improvement to include a 1/3 signal rate condition.

d) The order of tasks is clearly confounded in the present design with effects of time during crowding. Perhaps the matrix game was a sensitive measure because it came late in the experiment rather than because it was a task which demanded a high degree of interpersonal skill and coordination. Given enough time and subjects a larger design could be employed where task order is counterbalanced.

e) Some of the potential interactions of personal space and crowding could be investigated in future research. For example, through the use of confederates we could deliberately violate the personal space of some individuals to determine if this heightens their perceptions of crowding. Furthermore, while recent research (Cozby, 1973) has found that persons with larger personal space zones tend to feel more crowded at a given density, it would be interesting to examine what effects a crowding experience has on personal space behavior.

f) How do persons' expectations of a spatial situation influence their reactions to it? For example, do we feel less negatively in a crowded situation such as on a rush-hour subway where we expected to be crowded?

g) The possible biases in observation mentioned above where it may have been harder to see behaviors in the crowded groups could be reduced by using two or more cameras. This would also enable me to score the whole group rather than just the middle five.

Hall in 1966 was able to describe the study of human spatial behavior in terms of a 'hidden dimension' which he compared to the subject of sex during the previous 10 years in that it was something everyone was aware of and intimately involved with; yet it was not systematically investigated or analyzed by researchers or laymen. It has been nearly 10 years since Ned Hall's book on the field of proxemics and the study of human spatial behavior has experienced a literal population explosion, if you will pardon the term, to the extent where there are no less than 10 books out or in press on the topic, discussion of a journal related to spatial behavior and several 100 investigators in the area. While this surge of interest and exploration in the areas of personal space, human crowding and human territoriality has certainly revealed the hidden dimension, we are still a long way from understanding human spatial behavior.

I would like to thank each of you for your support and interest in me as a person and as a colleague. I thank Dalton for being a good listener and teaching me the wisdom of being an observer. I thank Swami for helping me to see the value of doing statistical analyses in a broad and thorough manner. I thank Ken for giving me the chance to learn from him and pick up some wisdom from the leader of the field of environmental psychology. I thank Erv for being a close friend and advisor who also made me feel at home as a colleague at the Institute of Man and Environment. Finally, I thank Bill who has been incredibly generous with his time and always gave me the freedom to follow up my ideas and had the patience and wisdom to tell me when I was going down a blind alley or to encourage me when he thought I was on to something.

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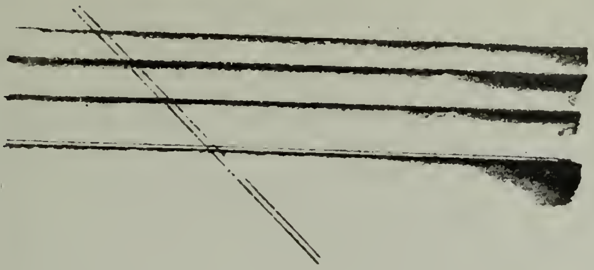
Appendix I Personality Scales

E.g. From Baron-Welsh Art Scale



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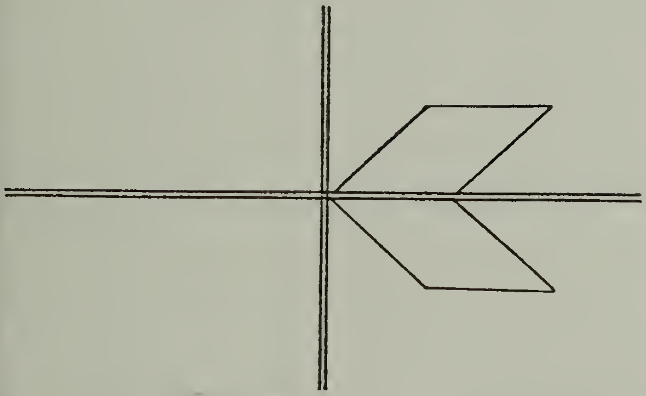

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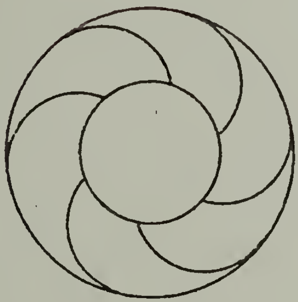

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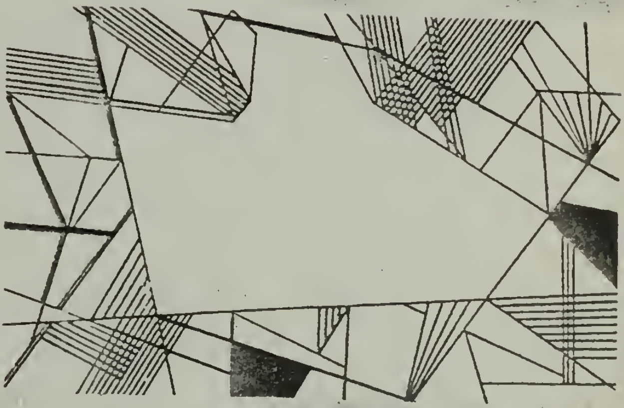

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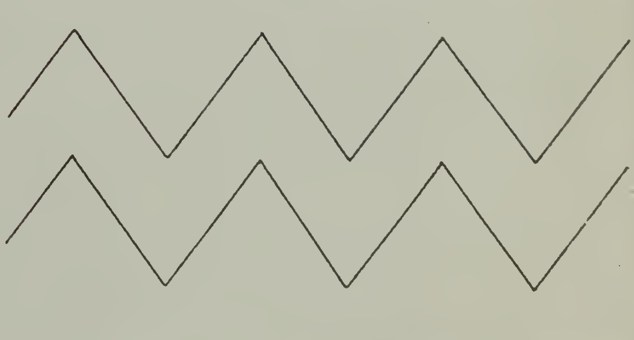

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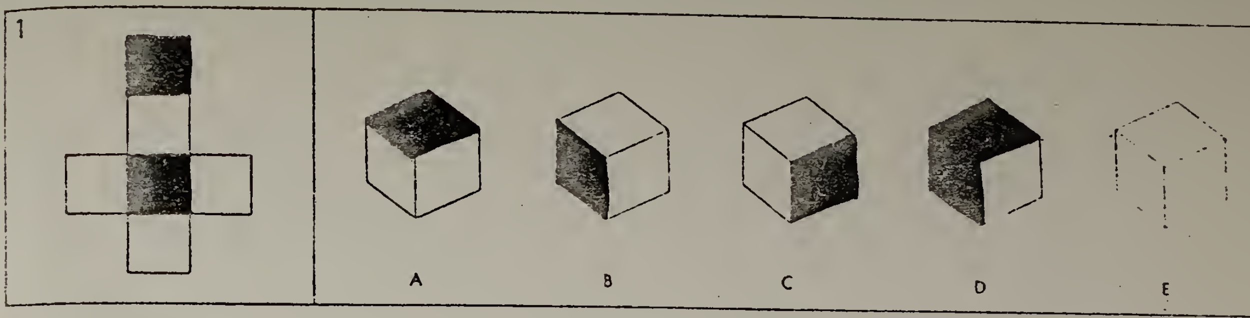
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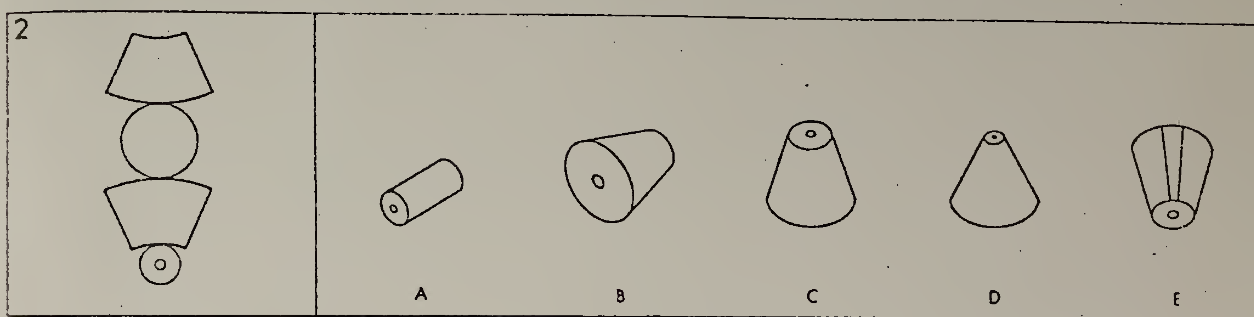
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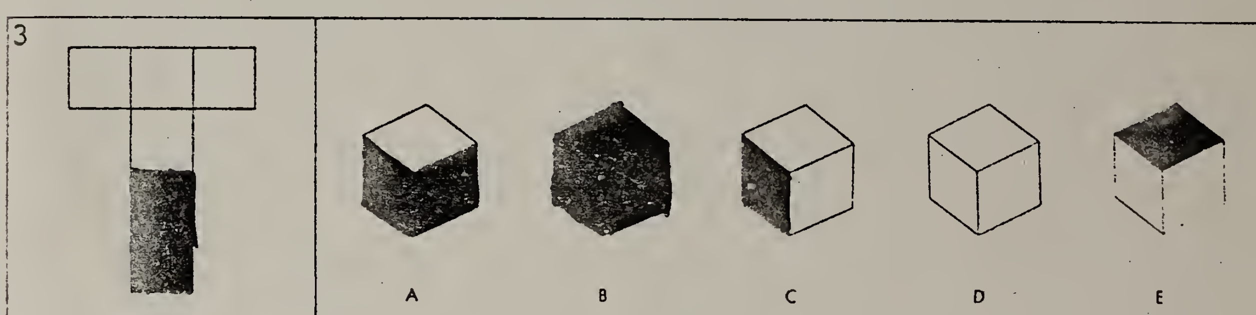
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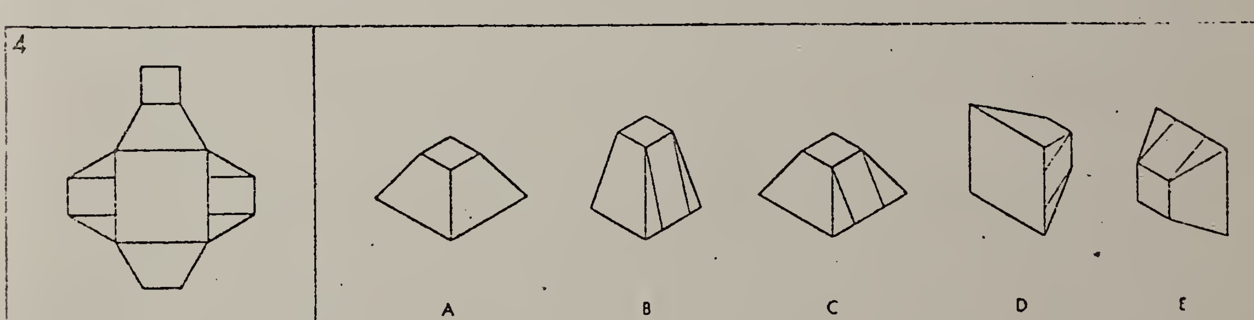
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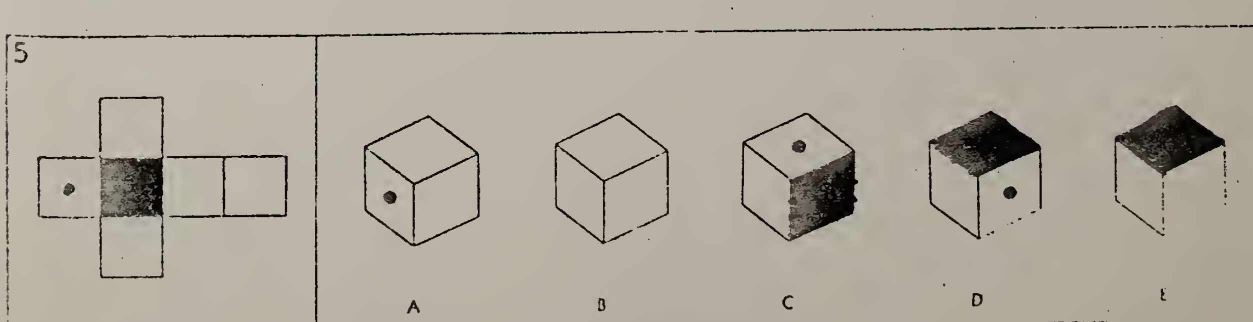
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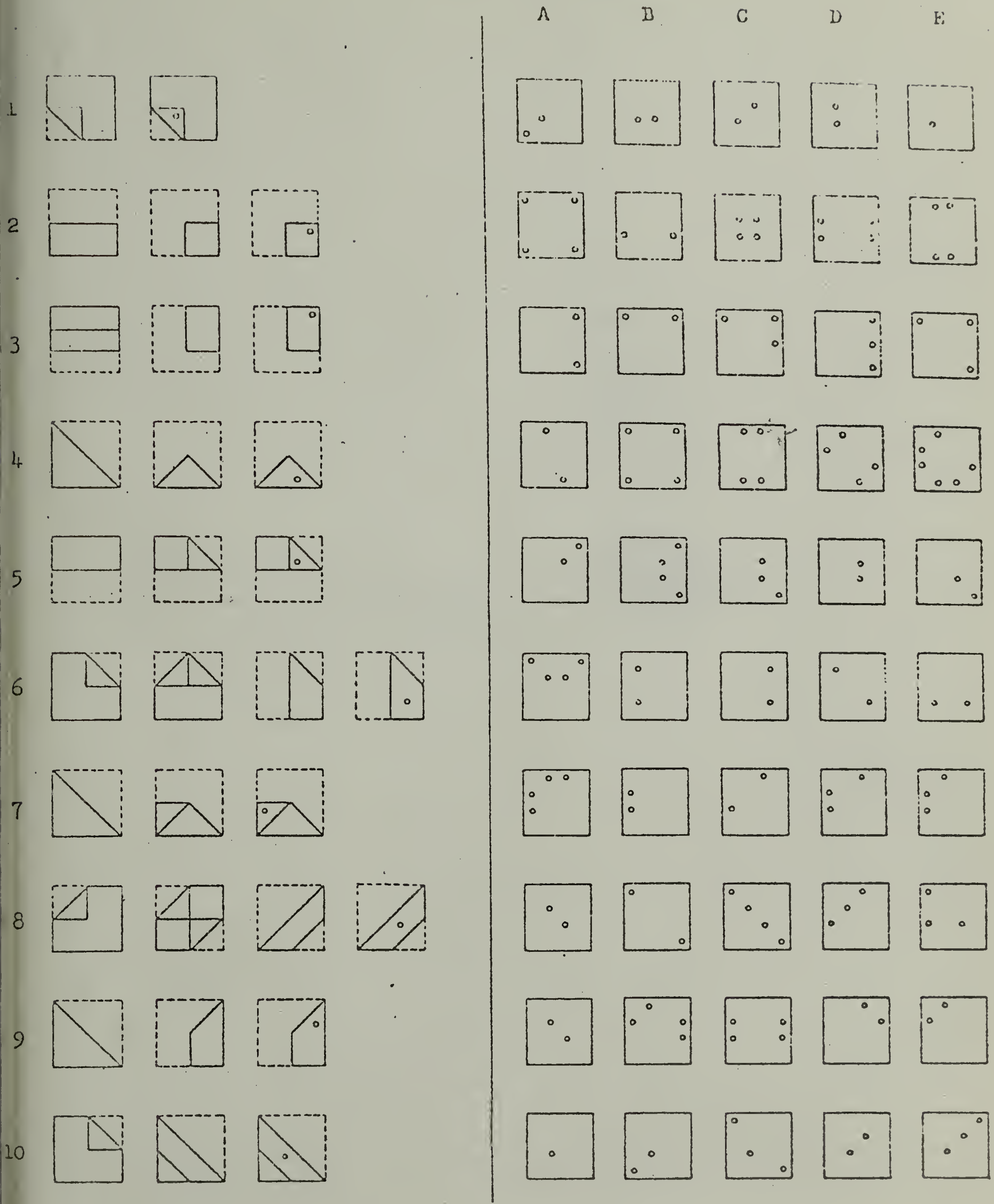

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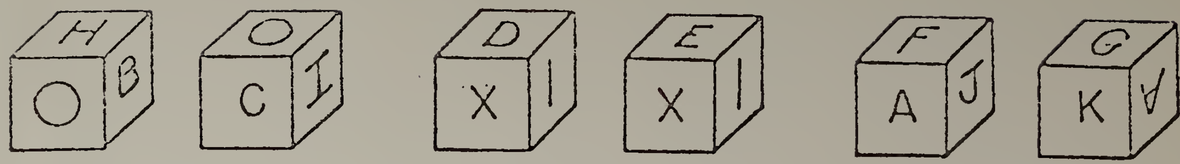
Page 2

Part 1 (3 minutes)



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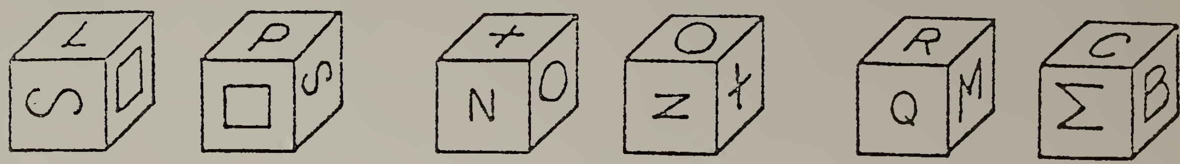

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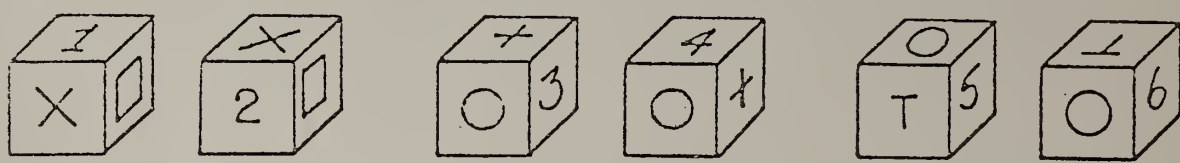

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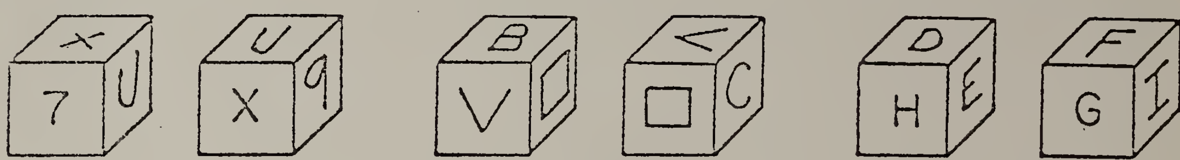
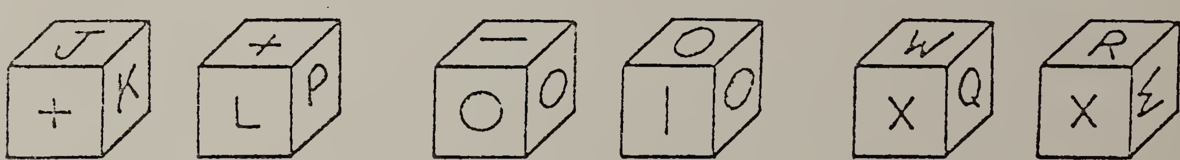
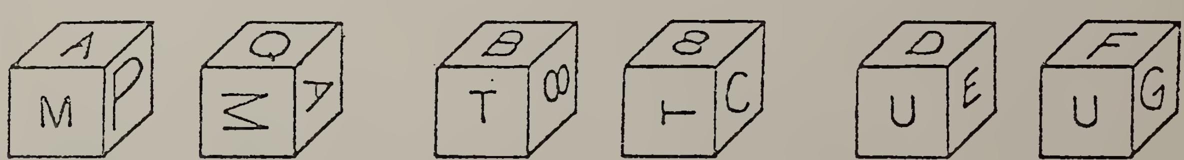


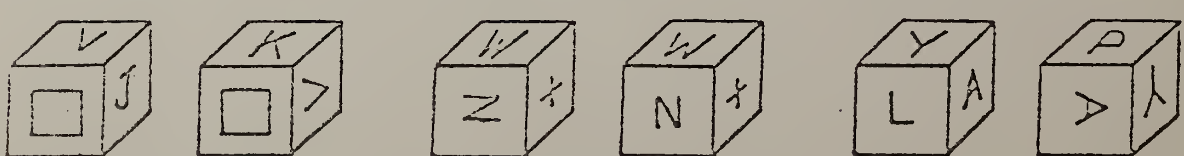
10. S ☐ D ☐ 11. S ☐ D ☐ 12. S ☐ D ☐



13. S ☐ D ☐ 14. S ☐ D ☐ 15. S ☐ D ☐



16. S ☐ D ☐ 17. S ☐ D ☐ 18. S ☐ D ☐



19. S ☐ D ☐ 20. S ☐ D ☐ 21. S ☐ D ☐

DO NOT GO ON TO THE NEXT PAGE UNTIL ASKED TO DO SO.

DOMINANCE SUBSCALE

I doubt whether I would make a good leader.

I think I would enjoy having authority over other people.

I find it hard to keep my mind on a task or job.

I have sometimes stayed away from another person because I feared doing or saying something that I might regret afterwards.

When in a group of people I have trouble thinking of the right things to talk about.

School teachers complain a lot about their pay, but it seems to me that they get as much as they deserve.

E.G. FROM BUSS-DURKEE SCALE

Once in a while I cannot control my urge to harm others.

I get into fights about as often as the next person.

I sometimes spread gossip about people I don't like.

I never play practical jokes.

I sometimes pout when I don't get my own way.

I sometimes show my anger by banging on the table.

I am always patient with others.

AROUSAL SEEKING TENDENCY SCALE

Instructions to Subjects:

Please use the following scale to indicate the degree of your agreement or disagreement with each of the statements on the following pages. Record your answers on the answer sheet A.S.T. DO NOT WRITE IN TEST BOOKLET.

+4 = very strong agreement
+3 = strong agreement
+2 = moderate agreement
+1 = slight agreement
0 = neither agreement nor disagreement
-1 = slight disagreement
-2 = moderate agreement
-3 = strong disagreement
-4 = very strong disagreement

1. Designs or patterns should be bold and exciting.
2. I feel best when I am safe and secure.
3. I would like the job of a foreign correspondent for a newspaper.
4. I don't pay much attention to my surroundings.
5. I don't like the feeling of wind in my hair.
6. I prefer an unpredictable life that is full of change to a more routine one.
7. I wouldn't like to try the new group-therapy techniques involving strange body sensations.
8. Sometimes I really stir up excitement.
9. I never notice textures.
10. I like surprises.
11. My ideal home would be peaceful and quiet.
12. I eat the same kind of food most of the time.
13. As a child I often imagined leaving home, just to explore the world.
14. I don't like to have lots of activity around me.
15. I am interested only in what I need to know.
16. I like meeting people who give me new ideas.
17. I would be content to live in the same town for the rest of my life.
18. I like continually changing activities.
19. I like a job that offers change, variety, and travel, even if it involves some danger.
20. I avoid busy, noisy places.
21. I like to look at pictures that are puzzling in some way.
22. I wouldn't enjoy dangerous sports such as mountain climbing, airplane flying, or sky diving.
23. I like to experience novelty and change in my daily routine.
24. Shops with thousands of exotic herbs and fragrances fascinate me.
25. I much prefer familiar people and places.
26. When things get boring, I like to find some new and unfamiliar experience.
27. I like to touch and feel a sculpture.
28. I don't enjoy doing daring, foolhardy things just for fun.
29. I prefer a routine way of life to an unpredictable one full of change.
30. I like to go somewhere different nearly every day.

Arousal Seeking Tendency Scale Continued

31. I seldom change the decor and furniture arrangement at my place.
32. People view me as a quite unpredictable person.
33. I like to run through heaps of fallen leaves.
34. I sometimes like to do things that are a little frightening.
35. I prefer friends who are reliable and predictable to those who are excitingly unpredictable.
36. I am interested in new and varied interpretations of different art forms.
37. I seldom change the pictures on my walls.
38. I am not interested in poetry.
39. It's unpleasant seeing people in strange, wierd clothes.
40. I am continually seeking new ideas and experiences.

***<u>DO NOT WRITE IN TEST BOOKLET</u> ***

E.G. FROM ROTTER'S LOCUS OF CONTROL SCALE

a. Children get into trouble because their parents punish them too much.

b. The trouble with most children nowadays is that their parents are too easy with them.

a. Many of the unhappy things in peoples lives are partly due to bad luck.

b. People's misfortunes result from the mistakes that they make.

a. One of the major reasons why we have wars is because people don't take enough interest in politics.

b. There will always be wars, no matter how hard people try to prevent them.

a. In the long run people get the respect they deserve in this world.

b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

a. The idea that teachers are unfair to students is nonsense.

b. Most students don't realize to which their grades are influenced by accidental happenings.

a. Without the right breaks one cannot be an effective leader.

b. Capable people who fail to become leaders have not taken advantage of their opportunities.

APPENDIX II

BACKGROUND QUESTIONNAIRE

NAME ____ SUBJECT NO. ________

CAMPUS PHONE ______________________ CAMPUS ADDRESS ________________________

AGE ________

SEX ________

BLOOD PRESSURE READINGS   INITIAL   TERMINAL

Systolic

Dystolic

HEART RATE

PLEASE ANSWER ALL QUESTIONS. MARK ONLY ONE ALTERNATIVE. IF YOU HAVE ANY QUESTIONS, PLEASE ASK THE EXPERIMENTER.

1. Please rate how you felt during your time in the room where the experiment was conducted.

Uncrowded ___; ___; ___; ___; ___; ___; ___; ___; ___; Crowded

2. How many people per room was there in the home you grew up in. (Spent the majority of your years in).

	CHECK ONE ONLY
For each person, there were greater than 4 rooms	___
For each person, there were 4 rooms	___
For each person, there were 3 rooms	___
For each person, there were 2 rooms	___
For each person, there was 1 room (one person per room)	___
2 persons per room	___
3 persons per room	___
4 persons per room	___
Greater than 4 persons per room	___

3. How many siblings (brothers and sisters) did your mother have? Circle one.

a) 0 b) 1 c) 2 d) 3 e) 4 f) 5 g) 6 h) 7 i) Greater than 7

4. Please indicate your family's income level. Circle one.

a) Greater than $40,000 b) $35,000-$40,000 c) $30,000-$35,000

d) $25,000-$30,000 e) $20,000-$25,000 f) $15,000-$20,000

g) $10,000-$15,000 h) $5,000-$10,000 i) Less than $5,000

5. Please indicate the highest grade level that either (not both) of your parents achieved. Circle one.

a) Greater than 6 years of college (academic years or grades).
b) 5-6 years of college
c) 3-4 years of college
d) 1-2 years of college
e) 11-12 years of school
f) 9-10 years of school
g) 7-8 years of school
h) 5-6 years of school
i) Less than 5 years of school

6. Please indicate how crowded your present living environment is.

Crowded ___; ___; ___; ___; ___; ___; ___; ___; ___; Uncrowded

APPENDIX III

SEMANTIC SCALES

Subject Number ______

happy	___: ___: ___: ___: ___: ___: ___: ___: ___:	unhappy
stressed	___: ___: ___: ___: ___: ___: ___: ___: ___:	relaxed
influential	___: ___: ___: ___: ___: ___: ___: ___: ___:	influenced
calm	___: ___: ___: ___: ___: ___: ___: ___: ___:	excited
frustrated	___: ___: ___: ___: ___: ___: ___: ___: ___:	not frustrated
physically comfortable	___: ___: ___: ___: ___: ___: ___: ___: ___:	physically uncomfortable

Task FT_2

Appendix IV Performance Tasks

Subject No.____

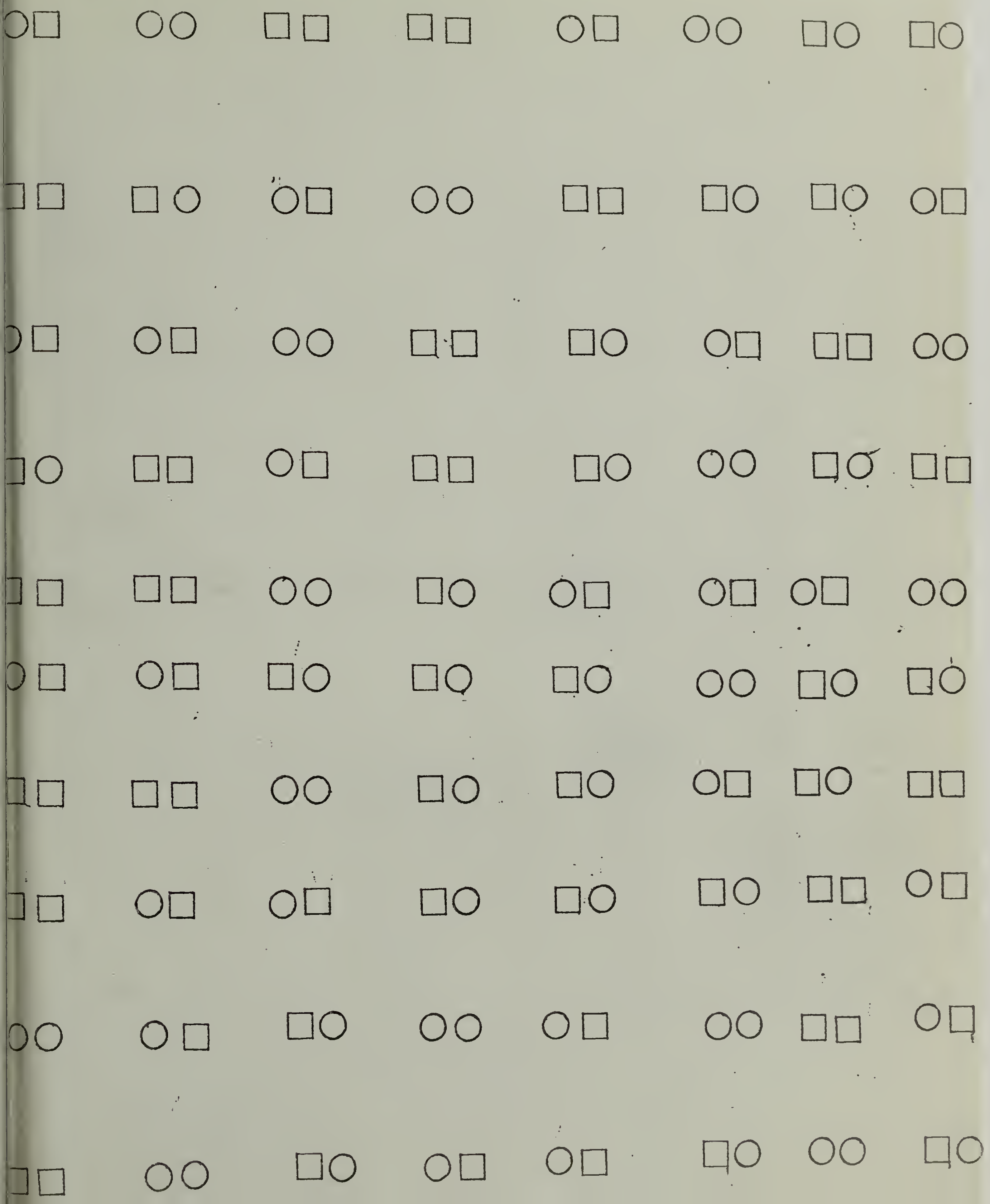
IP$_1$ ANSWER SHEET

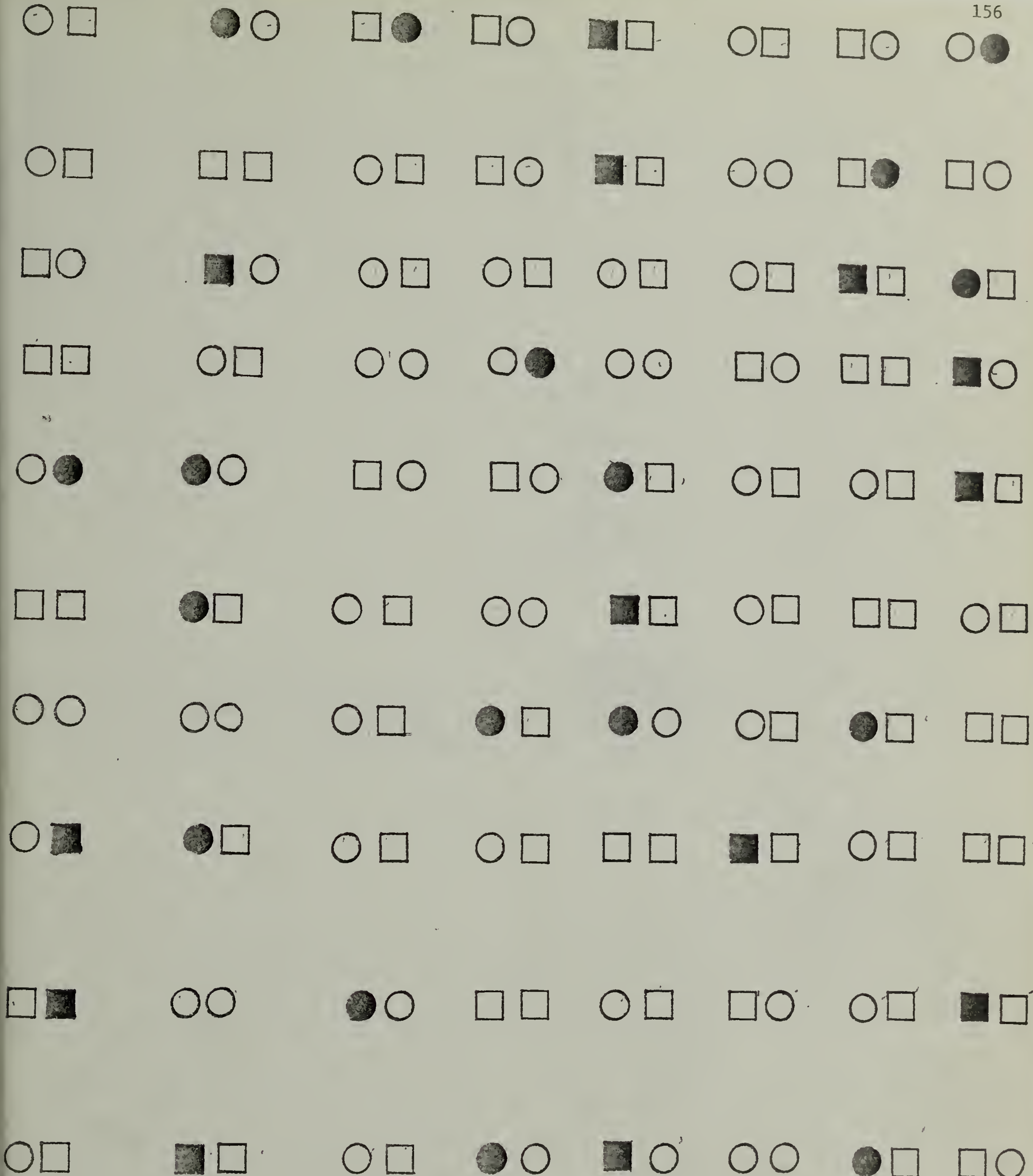
(Read Down)

Practice

H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E
H O	H O	H O	H O	H O	H O	H O	H O	H O	H O	H O
L E	L E	L E	L E	L E	L E	L E	L E	L E	L E	L E

SUBJECT NO ______





SUBJECT NO ___

Story 1

The debate over amnesty for Vietnam draft evaders recalls the 21 American prisoners of war who refused to be repatriated after the Korean war. They chose instead to remain with the Communists, taking up new lives in China.

None of them remain there. One died in an auto accident; another, a Belgian national went back to Europe, and the 19 others have all returned to the United States. Some returned by circuitous routes through Iron Curtain countries.

Most of them stayed in China more than 10 years . At least one made propaganda broadcasts over Hanoi Radio during the Vietnam war. But a Pentagon spokesman said that none have been prosecuted since returning.

Story 2

A dental expert has linked teeth marks found on the hand of 73-year old Dorris Green to a zoo-keeper. The zoo-keeper, Walter Marks, is on trial for her murder. It was believed to be the first time in California court history that teeth marks were allowed as identifying evidence in a murder case. Mr. Marks is accused of strangling Mrs. Green, from whom he rented a room. Dr. Wood, an authority on dental identification, had a plaster impression made of Mrs. Green's hand which still bore the deep teeth marks. A plaster impression of Mr. Marks teeth was also made. Then, using electron tracing, Dr. Wood compared the two plaster impressions. He reached the conclusion that the bite marks had been made by Mr. Marks.

Subject No. ___

Session No.___

Story I: Choose one alternative only for each question. Circle the number. Put a check mark next to any answer that is a guess. Do not look back and forth through the answers. Do the questions in order and do not go back and change any after marking them.

1. What was the article about?

a. the birth of triplets
b. amnesty to draft evaders
c. international radio
d. a bus terminal
e. newspaper reporting

2. Where did the men choose to live?

a. Brazil
b. Russia
c. Italy
d. China
e. Greenland

3. How long did most of the men stay away from the U.S.?

a. 2 years
b. 10 years
c. several months
d. Most never returned
e. Until the end of the war

4. What war did this article involve?

a. boxer rebellion
b. Korean war
c. World War I
d. World War II
e. War of 1812

5. How many remained behind?

a. none
b. 9 of the men
c. all
d. most of the men
e. 3

6. How did the one man die?

a. he was shot in the war
b. he was stabbed
c. he was hung
d. an auto accident
e. accidental death from drowning

7. How many of these men have been prosecuted by the U.S.?

a. all who returned
b. 5
c. None
d. 15
e. 2

8. What role did the iron curtain countries play with these men?

a. provided circuitous routes back to the U.S.
b. they persecuted them
c. they imprisoned them
d. did not mention in the story
e. sold them cheap land

Remember to check any answer that is a guess totally.

Subject No. ___ Session No.___

Story II: Choose one answer to each question. If it is a guess than put a check next to it. Do not look back and forth thru the questions. Do them in order and do not go back to answer any.

1. The article was about?

a. an auction
b. a birthday party
c. a doctor's office
d. a dentist
e. a prizefighter

2. Mr. Walter's was accused of?

a. strangling a woman
b. strangling a man
c. molesting children
d. stealing cars
e. none of the above

3. Where were the teeth marks made?

a. the victim's hand
b. the victim's nose
c. the victim's foot
d. the victim's leg
e. the victim's throat

4. What was the relationship between Mr. Marks and the victim?

a. owner and tenant
b. friends
c. siblings
d. strangers
e. not mentioned in the story

5. What was the setting?

a. New Jersey
b. New Hampshire
c. Connecticut
d. California
e. Oregon

6. Did the impressions match?

a. no
b. uncertain
c. yes
d. did not say
e. further analysis necessary

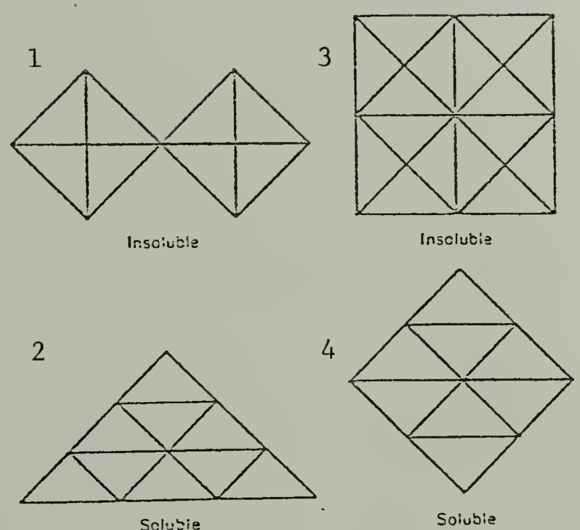
7. What was Walter's occupation?

a. barber
b. street cleaner
c. zookeeper
d. businessman
e. teacher

8. How common has this procedure been?

a. fairly uncommon because unsuccessful
b. fairly common
c. standard procedure
d. this instance was unique
e. occasional when appropriate

AFTEREFFECT TRACING TASK



Appendix V Other Scales

Subject No. ___

OVERALL FEELINGS (SUBJECTIVE STRESS SCALE)

Please circle the one phrase describing your overall feelings during the time in this room so far.

WORRIED

INDIFFERENT

UNSAFE

DIDN'T BOTHER ME

FINE

PANICKY

WONDERFUL

NERVOUS

STEADY

SCARED STIFF

COMFORTABLE

TIMID

FRIGHTENED

UNSTEADY

Subject No. ___

INFORMATION RATE SCALE

Instructions to Subjects:

Please use the following adjective pairs to describe the situation you are in. Each of the following adjective pairs helps define the situation or the relation among the various parts of the situation. Put a check-mark somewhere along the line (Example: ___:_√_:___) to indicate what you think is an appropriate description.

varied	___:___:___:___:___:___:___:___:___:	redundant
simple	___:___:___:___:___:___:___:___:___:	complex
novel	___:___:___:___:___:___:___:___:___:	familiar
small-scale	___:___:___:___:___:___:___:___:___:	large-scale
similar	___:___:___:___:___:___:___:___:___:	contrasting
dense	___:___:___:___:___:___:___:___:___:	sparse
intermittent	___:___:___:___:___:___:___:___:___:	continuous
usual	___:___:___:___:___:___:___:___:___:	surprising
heterogeneous	___:___:___:___:___:___:___:___:___:	homogeneous
uncrowded	___:___:___:___:___:___:___:___:___:	crowded
asymmetrical	___:___:___:___:___:___:___:___:___:	symmetrical
immediate	___:___:___:___:___:___:___:___:___:	distant
common	___:___:___:___:___:___:___:___:___:	rare
patterned	___:___:___:___:___:___:___:___:___:	random

Subject No. ___

OTHER PEOPLE (HOSTILITY SCALE)

Please circle the one phrase which best describes how you feel about the other people in this room.

HOT UNDER THE COLLAR ABOUT

CROSS WITH

DIDN'T MIND

FED UP WITH

DELIGHTED WITH

DISPLEASED WITH

BURNED UP AT

HOPPING MAD AT

PLEASED WITH

READY TO BLOW MY TOP AT

RAGING MAD AT

FAVORABLE ABOUT

TEE'D OFF AT

INDIFFERENT TOWARD

BOILING MAD AT

OFFENDED AT

DEPARTMENT RESEARCH QUESTIONNAIRE

The psychology department suggests that subjects in experiments be asked for some feedback concerning their experiences as a subject in research. Therefore please answer the following questions.

1. How well did the experimenter handle the experiment?

Excellent ___ ___ ___ ___ ___ ___ ___ ___ ___ Poor

2. How were you recruited?

3. How does this experiment compare with others you have been in?

Excellent ___ ___ ___ ___ ___ ___ ___ ___ ___ Poor

4. Were the instructions made clear?

Excellent ___ ___ ___ ___ ___ ___ ___ ___ ___ Poor

5. Were adequate facilities provided?

Excellent ___ ___ ___ ___ ___ ___ ___ ___ ___ Poor

6. Rate how you think the experimenter felt about you?

Excellent ___ ___ ___ ___ ___ ___ ___ ___ ___ Poor

7. Please rate the overall competancy of the experimenter?

Excellent ___ ___ ___ ___ ___ ___ ___ ___ ___ Poor

8. What would be the most convenient times for experimenters to run experiments?

9. Overall rate how you felt about the experimenter

Like ___ ___ ___ ___ ___ ___ ___ ___ ___ Dislike

Subject No. ___

INFORMATION RATE SCALE

Instructions to Subjects:

Please use the following adjective pairs to describe the situation you are in. Each of the following adjective pairs helps define the situation or the relation among the various parts of the situation. Put a check-mark somewhere along the line (Example: ___: √ :___) to indicate what you think is an appropriate description.

varied	___:___:___:___:___:___:___:___:___:	redundant
simple	___:___:___:___:___:___:___:___:___:	complex
novel	___:___:___:___:___:___:___:___:___:	familiar
small-scale	___:___:___:___:___:___:___:___:___:	large-scale
similar	___:___:___:___:___:___:___:___:___:	contrasting
dense	___:___:___:___:___:___:___:___:___:	sparse
intermittent	___:___:___:___:___:___:___:___:___:	continuous
usual	___:___:___:___:___:___:___:___:___:	surprising
heterogeneous	___:___:___:___:___:___:___:___:___:	homogeneous
uncrowded	___:___:___:___:___:___:___:___:___:	crowded
asymmetrical	___:___:___:___:___:___:___:___:___:	symmetrical
immediate	___:___:___:___:___:___:___:___:___:	distant
common	___:___:___:___:___:___:___:___:___:	rare
patterned	___:___:___:___:___:___:___:___:___:	random

APPENDIX VI COMBINED REGRESSION ANALYSIS

Multivariate multiple regression analysis was performed on nine criterion variables which included: information processing two, story two, hostility scale, adaptation one, the three terminal physiological measures, ratings of the facility and perceived crowding. Fourteen predictors included background measures: income, educational level, (SES), childhood density levels, number of mother's siblings and present crowding. Personality predictors included: imagery ability, dominance, arousal-seeking tendency, agression, locus of control and aesthetic sensitivity. The three initial levels of physiological data were also entered as predictors.

The standardized regression co-efficients and multiple correlation coefficients are presented in the table below. Equations for the terminal physiological measures accounted for significant amounts of variance. $F(14,82) = 5.60$ for systolic, $F(14,82) = 4.65$ for diastolic and $F(14,82) = 3.73$ for heart rate all significant at $p < .0001$.

The second table contains means and standard deviations for all predictor variables.

i) TABLE STANDARDIZED REGRESSION COEFFICIENTS - INDEP X DEPENDENT VARIABLES

		$1P_2$	$Story_2$	Hostility	A_1	Systolic Terminal	Dystolic Terminal	Heart Rate Terminal	Facil-ities	Perceived Crowding
		1	2	3	4	5	6	7	8	9
1	INCOME	.200900	.132166	.104470	-.110674	.074221	.063444	-.069413	-.121286	-.114449
2	EDUCATION	-.028397	.041489	-.167604	.149114	.064951	-.047749	-.000654	-.127817	-.078221
3	CHILD. DENSITY	-.065428	.059545	-.127990	-.133449	.112166	.165155	-.016867	-.084129	.033465
4	MOTH. SIB.	-.004619	.106606	.056653	.135282	.031633	-.034807	.167694	.237787	.108176
5	PRESENT CRD.	-.041850	-.124725	.088670	-.021428	.107583	.020188	-.032535	.183852	-.089912
6	IMAGERY	-.120299	.050087	.102164	.031530	.009917	-.039116	.053668	.000482	-.099955
7	DOMINANCE	-.003049	-.080256	.153706	.007101	-.020981	-.033806	.059872	-.033329	-.072769
8	AROUSAL SEEK.	.140725	-.010135	.002453	-.090793	-.209898	-.250121	-.217051	-.000380	-.093049
9	AGGRESSION	.095496	.210496	.235862	-.045424	-.021675	-.089155	-.260782	-.057563	.036298
10	LOCUS CONTROL	-.017390	-.026955	-.047744	-.046112	-.032998	.089491	.044474	-.048566	-.160944
11	CREATIVITY	-.182754	.081972	-.003349	-.031769	-.030761	-.082563	-.134682	.006282	-.131069
12	SYSTOL. INIT.	-.025099	-.025091	-.242165	.162254	.591897	.091252	.168679	.168355	-.146143
13	DYSTOL. INIT.	.116977	.082800	.139884	-.081401	.053392	.476618	-.063303	-.117067	-.186312
14	HEART INIT.	-.108376	-.048488	.072050	.065690	.068823	.001362	.535853	-.080123	.112013
	MULTIPLE R	.33	.34	.39	.24	.70*	.67*	.62*	.35	.42
	MULTIPLE R^2 (Proportion of variance accounted for)	.11	.12	.15	.06	.49	.44	.39	.13	.18

*P < .0001

ii) TABLE MEANS AND STANDARD DEVIATION OF PREDICTOR VARIABLES

Predictor Variables		Density Low	Density High
INCOME	Male	-.56 (2.13)*	-.80 (1.65)
	Female	-.92 (1.65)	-.28 (2.23)
EDUCATION	Male	1.20 (1.71)	.88 (1.45)
	Female	1.72 (1.54)	1.52 (1.73)
CHILDHOOD DENSITY	Male	.76) (1.05)	.72 (1.28)
	Female	.72 (.74)	.56 (.96)
NUMBER OF MOTHER'S SIBLINGS	Male	1.32 (2.32)	.76 (1.96)
	Female	1.16 (2.32)	.76 (2.42)
PRESENT CROWDING	Male	1.08 (2.72)	.44 (2.62)
	Female	.28 (3.01)	1.12 (2.42)
IMAGERY BATTERY	Male	36.77 (12.91)	35.45 (12.27)
	Female	34.16 (13.19)	32.13 (12.35)
DOMINANCE	Male	28.88 (6.05)	27.40 (5.99)
	Female	26.64 (5.27)	28.92 (4.55)
AROUSAL SEEKING TENDENCY	Male	46.28 (25.13)	37.16 (24.49)
	Female	58.28 (24.48)	57.40 (21.49)

* Standard Deviations in Parentheses

(ii) TABLE Means and Standard Deviation of Predictor Variables Continued)

Predictor Variables		Density Low	High
AGRESSION	Male	29.40 (9.48)	31.44 (9.72)
	Female	30.48 (9.12)	28.28 (8.87)
LOCUS OF CONTROL	Male	10.72 (4.65)	12.08 (4.32)
	Female	12.48 (3.60)	10.20 (3.52)
AESTHETIC SENSITIVITY	Male	21.12 (9.15)	23.48 (9.47)
	Female	28.92 (11.03)	26.00 (11.43)
INITIAL SYSTOLIC	Male	128.44 (12.36)	137.36 (12.16)
	Female	113.52 (12.59)	119.28 (14.48)
INITIAL DIASTOLIC	Male	79.44 (12.00)	87.40 (12.54)
	Female	72.48 (9.62)	77.72 (7.37)
INITIAL HEART RATE	Male	80.08 (10.87)	77.60 (11.05)
	Female	73.52 (9.02)	76.00 (11.44)