Noise Sensitivity: Visual Search Performance Effects, and Mood and Frustration Tolerance Aftereffects in the Presence of Office Noise.

Terry A. Wong

University of Manitoba

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NOISE SENSITIVITY: VISUAL SEARCH PERFORMANCE EFFECTS, AND MOOD AND FRUSTRATION TOLERANCE AFTEREFFECTS IN THE PRESENCE OF OFFICE NOISE

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TERRY A. WONG

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Abstract

The three aspects of noise are auditory and non auditory effects, and evaluative dimensions. A review of the noise literature shows that auditory effects are well documented, whereas the considerable research on non auditory effects lacks consistent results. The evaluative dimension of noise research on a whole lacks experimentation. Specifically the absence of evaluative variables in noise research is hypothesized as a limiting factor to consistent non auditory results. It was suggested that the inclusion of noise sensitivity as an organismic variable could bring more stable and significant results to the performance, frustration tolerance, and mood state effects of noise. Forty noise sensitive and 40 noise insensitive individuals were randomly placed in either high (74.6 dB(A)) or low (52.2 dB(A)) noise office settings. Performance and frustration tolerance effects due to noise levels were confirmed with high noise reducing performance while increasing frustration. Noise level and sex interacted to produce higher fatigue scores for females in the low noise situation than males but the effect was the opposite in the high noise situation. Noise sensitive individuals scored lower on well-being and higher on stress factors when compared to the non sensitive individuals.

Unfortunately noise sensitivity and noise levels did not interact to produce a clearer picture of these effects. However the importance and problems of using noise sensitivity as an organismic variable in noise research were discussed.

Noise Sensitivity: Visual Search Performance Effects, and Mood and Frustration Tolerance Aftereffects in the Presence of Office Noise.

"Noise is a psychological concept and is defined as sound that is unwanted by the listener because it is unpleasant, bothersome, interferes with important activities, or is believed to be physiologically harmful", (Kryter, 1970). "Noise is any sound that is physiologically arousing and stressful, subjectively annoying, or disruptive of performance", (Anastasi, 1964; cited in Glass & Singer, 1973). In these definitions, three important aspects of noise are clearly outlined. First, noise has auditory effects (e.g., hearing, speech interference). Second, there can be an evaluative or attitudinal dimension (e.g., unpleasant, bothersome, annoying) to noise. Third, noise produces non auditory effects (e.g., interference with activities, performance effects, arousal, stress). All three of these aspects contribute to our understanding of the concept of noise.

Yet, these three aspects are not equally researched and understood. The auditory effects have been well defined and studied, resulting in set standards and guidelines for noise regulation (Burns, 1973; Mackenzie, 1975). Therefore debate of these effects is not necessary, this paper focuses on the two other aspects of noise. Though there has been a lot of research done on the non auditory effects of noise, the experimental methods and results have not been consistent, or well established (Cohen & Weinstein, 1981). In the case of evaluative or attitudinal aspect of noise, the makeup of the organism must be of some importance. But, organismic factors have received relatively little attention. These include demographic and personality variables. With respect to the latter, Weinstein (1978) has pointed out that individual differences in sensitivity to noise have received little research attention. The exclusion of organismic factors could explain why non auditory effects of noise have not been well understood. The inclusion of the noise sensitivity variable would be the next logical step in the progression of the noise research area. In the research discussed below, attention is given to the role of personality in the non auditory effects of noise exposure.

Non Auditory

The study of the non auditory effects of noise is a large and varied area. It is not within the scope of this paper to outline them all, or to review all available research articles. Instead the most commonly discussed aspects of the non auditory noise effects literature are presented. Articles discussed illustrate both the varied opinions and the present state of the research area. The list of possible non auditory effects of noise include physiological, annoyance, social behavior, performance, aftereffects, and affective states. A review of each of these effects will indicate just how complex, conflicting, and incomplete the research area is.

Physiological

The physiological area of non auditory effects covers physiological changes or health problems that can occur due to exposure to noise. Many researchers would like to point to a physical health or physiological effect of noise (Clark, 1984; Cohen & Weinstein, 1981; Jones, 1983). Cohen and Weinstein (1981) revealed that industrial studies have shown higher morbidity among persons exposed to at least 3-5 years of sounds of 85 dB(A) or greater, thereby suggesting that noise can lead to physical disorders. Correlational studies have shown irregular pulse rate, circulation, and blood pressure to be associated with noise-exposed individuals (Jones, 1983). But, it is the experimental proof that specific physiological responses are induced by noise that most researchers are interested in.

To compound the problem, a review of the studies mentioned in the Jones (1983) paper shows a lack of descriptions available to help the reader understand the noise makeup. Only the most recent studies (last 10 years) have even bothered to mention which weighting scale (A, B, C, etc.,) was being used to gauge noise levels. The different weighting scales place different emphasis on different sound frequency ranges to produce an integrated decibel (dB) rating. For example, the C weighting is such that sensitivity is the same on all frequencies, whereas the A weighting parallels the sensitivity of the human ear. The importance of other descriptions of noise level are discussed in the performance section. The same conclusion can be drawn by looking at Gawron's (1982) list of noise research that produced effects. Poulton's (1978) review found the same lack of descriptions of noise measurement used. The lack of consistent or clearly defined noise levels in research has only confounded the noise research area more.

Even with clearly defined noise levels, the relationship between noise and health may be very hard to establish (Clark, 1984). Individual differences in human physiology and the measurement of these variables may be a hinderance. Sharp, Swiney, Dansby, Hyatt, and Schimmel (1977) while studying a tracking task, found no significant physiological response differences in electromyographic potential or heart rate when noise (84 dB(A), household noise) was introduced versus the baseline (no noise) measure. They suggested that individual differences accounted for the results, with the individual having differing stress, arousal and coping strategies to influence the results in some complex manner.

Sometimes the problems in finding results are based on research design and measurement limitations. Finkelman, Zeitlin, Romoff, Friend, and Brown (1979) reviewed articles illustrating the effect of noise on cardiac response. Then, in their own study they could not find a noise (90 dB intermittent white noise; weighting unspecified versus quiet) stress effect with regards to cardiac response. They did, however, find a cardiac response to no, moderate and high physical stress (running on a treadmill). Their lack of consideration of individual differences could very well have been a factor in the inability to find noise stress results, though a more likely problem was the research design. Subjects were exposed to all six possible combinations of the physical and noise stress in two different orders of presentation in a randomly counterbalanced format. Therefore each subject had twelve trials lasting two minutes each with a one minute rest period. One could obviously predict a physical stress difference as the demands placed on the heart would change with the pace of the treadmill. The one minute rest period would hardly allow for a recovery to baseline of the heart rate. Therefore the heightened heart rate due to the physical stress may overshadow the noise stress effect. The physical stress would place a continuous demand on the heart, while the intermittent noise stress might not. Therefore an average heart rate as recorded in the experiment may not have been a sensitive enough measure to find significant effects.

In contrast, Lundberg and Frankenhauser (1978) stated that they found that non-control yoked subjects indicated higher arousal due to noise (70 - 105 dB(A) white noise) through their measures of catecholamine, cortisol excretion and heart rate levels. Subjects in this experiment were yoked or paired together. Half the subjects were given control over the intensity of the noise they were exposed to. The other half of the subjects had no control and were exposed to whatever intensity of noise their partner had chosen. The validity of their stated conclusions could not be established as significance figures were not stated in the results section. They also mentioned that there were considerable inter-individual differences depending on the subjects' beliefs with regard to control (i.e., internal or external).

Individual differences and measurement restrictions are two common problems in this research area. Though correlational studies in this area have established the possibility of health problems related to noise stress, the experimental research results have yet to confirm this hypothesis. Flaws in research design, measurement techniques and report writing have resulted in conflicting and debatable results. These aspects of the research area must be cleared up before the physiologically effects of noise can be found.

Annoyance

Annoyance is defined as the overall "unwantedness" of a sound in a given situation (May, 1978). The measurement of annoyance with regards to noise is a much studied issue resulting in many noise annoyance scales (Schultz, 1972). Edwards (1975) feels that the major problem with noise annoyance research is a measurement one. Corso and Moomow (1982) went so far as to create a new methodology to measure noise annoyance. Using an avoidance paradigm, they found that with combinations of 50, 60, 70, 80, and 90 dB(A) of noise (1000 hz pure tone), subjects' number of avoidance responses and latencies were a function of the absolute intensity and the range of intensities. Though most researchers feel that annoyance scales need improvement, they still believe them to be significantly reliable (Moreira & Bryan, 1972).

In using these various scales, it is agreed that the amount of individual annoyance is not only dependent on level of noise exposure but also on individual differences (Cohen & Weinstein, 1981). Griffiths and Delauzun (1977) reported that noise dissatisfaction was due to randomness of response in the measuring instrument rather than individual differences. Their small noise level range of 70 to 80 dB(A) neighborhood noise could have created those results, especially since annoyance measures are not that sensitive. The level of neighborhood traffic noise can only account for between 16% to 25% of the annoyance score variation (Jonah, Bradley & Dawson, 1981). In contrast Weinstein (1980) found that 32% of the variance in annoyance scores on neighborhood noise were accounted for by individual differences in being critical or expressing negative judgements towards noise. These individual differences did not refer to age, sex, or education which do not appear to have an affect on noise annoyance susceptibility (Moreira & Bryan, 1972). The term individual differences has been used as a catchall phrase that can include a number of variables (e.g., attitudes, anxiety, and personality; Jonah, Bradley, & Dawson, 1981; Weinstein, 1980). These variables when combined make individual differences a very powerful concept.

Looking at these variables separately reveals how important they are to annoyance and noise research. The manipulation of people's attitudes toward aircraft noise was found to affect the rating of annoyance (Cederlof, Honsson, & Sorenson, 1967; cited in Baum, Singer, & Baum, 1981). When given positive induction (officials being concerned about the airport noise) about a nearby Air Force base, the residents were less likely to report annoyance by the aircraft noise. Graeven (1975) found that the environment (job vs. home) influenced the attitudes toward noise and that perceived control was an important aspect of noise research. Perceived control refers to the extent to which subjects believe they can, or actually can, turn off the noise. Graeven (1975) found that in home settings (e.g., neighborhood streets, home) the necessity and controllability of noise correlated negatively with noise annoyance. Therefore, the more control over, and necessary the noise, the less annoyance a person expresses. However, in the job setting the relationship was reversed with individuals rating the noise most necessary and controllable as being the most annoying. Weinstein (1980) suggested that the individual's negative attitude toward noise was part of an overall negative evaluation of the total environment.

This negative evaluation may be one due to fear. The significance of fear or anxiety in directly or indirectly predicting noise annoyance effects is found in many annoyance experiments (Baum et al., 1981; Jonah et al., 1981; Stephen, 1970; Weinstein, 1980). For example, test anxiety was found as the only variable significant in predicting annoyance for individuals when exposed to increasing levels of loudness (10, 20, 30, 40, 50, 60 dB; weighting unspecified) at 250 and 4000 Hz of noise (Stephen, 1970). Fear of nearby airplane crashes has been found as the single most powerful predictor of individual annoyance at airplane noise (Tracor, 1971; cited in Baum et al., 1981). Fear is a very influential subjective or personal variable with regards to noise annoyance.

Another personal variable is personality. The study of personality in relation to annoyance measures began with the use of personality scales such as the Eysenck Personality Inventory, and has progressed to the development of a specific Noise Sensitivity Scale (Weinstein, 1980). A number of researchers have found personality to be an important factor in predicting annoyance (Jonah et al., 1981; Langdon, 1976; Moneira &

Bryan, 1972; Weinstein, 1980). More about noise sensitivity will be discussed in a later section concerning the whole of noise research.

Still, it is important to also understand how different aspects of the noise itself affects annoyance. With regards to noise exposure Arnoult, Vorrhees, and Gilfillan (1986) studied intelligibility and annoyance with exposure to helicopter noise. They found a definite decrease in intelligibility by increasing broadband signal/pink noise (0, 60, 70, 80 dB(A)) or adding increasing levels of pure tones (650, 1900, 5000 Hz). The annoyance results were alos stated as significant but more confusing to understand. Pink noise, pure tones and the interaction of the two variables resulted in significant annoyance effects. The increase of either variable in general increased the annoyance score, however, there were a number of inconsistencies in the data that the authors did not explain. Four of the possible 16 conditions showed decreases or no change in annoyance scores. These conditions made the interaction difficult to interpret, but the general trend was that as the loudness of pink noise increased, the effect of pure tones on annoyance decreased. The authors then concluded that with these results they could not suggest how to consistently decrease annoyance relative to the noise produced.

Whether looking at noise exposure or individual differences, the lack of research in general, and good annoyance measures in particular, has precluded consistent results in the area. Still, the complexity of the area even with the improvement of these areas can not be overstated. Arnoult et al. (1986) researched only a few of the variations in sounds that consitute noise. Add the variations in attitudes, fears, and personalities possible for an individual and there would appear to be many factors affecting the amount of noise annoyance one perceives. Therefore an improvement in measuring noise annoyance may not be possible until a better understanding of how and what different variables affect noise annoyance.

Social Behavior

Studies on social behavior and noise can be divided into two separate categories, with experiments either evaluating social interaction during or after the noise exposure. The social behavior researcher have also been careful to point out whether they are using laboratory and/or field research settings (e.g., Boles & Hayward, 1978; Mathews & Canon, 1975; Page, 1977). As Glass and Singer (1972) pointed out, it is difficult to think that subjects would be unaware of a noise study when sounds from loudspeakers are blasting away at them in an experimental setting. This knowledge would then in turn alter the behavior of the subject. The emphasis in social behavior is on helping behavior, aggression, judgement of others, and personal space. Studies on noise and social behavior have shown a consistent, if not large, noise effect (Cohen & Weinstein, 1981).

The field study results have been more consistent than laboratory settings. Mathews and Canon (1975) found that when males were exposed to 85, 65, and 48 dB(C) of white noise, a linear relationship between noise and helping someone to pick up dropped books in a laboratory situation appeared. In the field condition, 50 or 87 dB(C) noise level was achieved by having a lawnmower off or on respectively. They also introduced a confederate with or without a cast on his arm. Here they found significant main and interaction effects with the cast and noise situations. Subjects would more likely help pick up dropped books when the confederate had a cast and there was a low noise level. Page (1977) found that people were more likely to grant small favours (e.g., pick up package, give change for telephone) under low noise situations (72 dB(A)) than high noise situations (92 dB(A)) in the field. Their corresponding laboratory experiment lacked control over the subject's awareness of the experiment and hypothesis, and failed to obtain any significant or dependable results. Boles and Hayward (1978) found that downtown pedestrians were more likely to help fill out a questionnaire with low noise, low density (persons/sq. ft.) than with high noise, high density (64.22 vs. 75.10 dB(A)). However, more recently, Bell and Doyle (1983) found heat (23°C & 35°C) and white noise bursts (55 & 95 dB(A)) had no significant effect on helping behavior in a laboratory setting. Subjects did not differ on latency or helping in picking up dropped books in the different conditions. Since subjects were told that they could turn off the noise at any time, the authors suggest that this perceived control could have affected the results. It would appear that helping behavior results are more consistent in the field than in the laboratory setting and that perceived control is also important.

In regard to helping behavior after the termination of noise exposure, the variable of lab or field setting appears unimportant. Yinon and Bizman (1980) found that subjects after low noise (50 dB, SPL; weighting unspecified) conditions would more likely promise to help with homework after experiencing success (solving matrices) than failure. After the high noise (74 dB, SPL) condition there were no significant differences in helping behavior. In this experiment the subjects were first led to believe that the experiment was over before they were asked to give help. The situation then appears like a field experiment. Hoever since the noise is no longer present, the experiment is now testing for aftereffects and not noise effects anymore.

In aggression research the important factors are not setting, but how other variables influence the effect between noise and aggression. Konecni (1975) found that only when a subject labelled him or herself angry did high noise (97 dB tone; weighting unspecified) amplify the aggressive effect (number of electric shocks delivered to an insulter), when compared to the low noise (73 dB; weighting unspecified) situation. Subjects were either insulted or not insulted while doing anagrams. Then they were given the opportunity to select the number of shocks their insulter received for a wrong word association task. Donnerstein and Wilson (1976) found that the effects of white noise (55 & 95 dB(A)) on aggression are dependent on the presence of a number of other variables (e.g. anger, control, etc.). Cohen and Weinstein's (1981) review also noted that whether the subject was given control over the presence of noise appeared to be an important factor in producing increased aggression in the presence of loud noise whether the control was used or not.

Noise appears to influence how one judges others. Bull, Burbage, Crandall, Fletcher, Lloyd, Ravenberg, and Rackett (1972) found that males showed a differential attraction as a function of similiarity in the control (40 dB mechanical noise) condition and not in the noise (84 dB; weighting unspecified) condition. The opposite was true of the female subjects. Siegel and Steele (1979) found that subjects rating a video where a harmdoer accidentally disturbs the transmission of an anagram solution of the victim as due more to a personal causation than a situational one in the no noise condition. The subjects felt that the accident was more a fault of the victim in the no noise versus noise (92 dB white noise bursts; weighting unspecified) situation. Siegel and Steele (1980) in two other experiments found that noise is more likely to render extreme judgements of others even if there are extenuating circumstances. In the first experiment, under construction noise (70 dB; weighting unspecified) a subject was more likely to make more snap judgements of a person than in the quiet situation after simply reading a biographical sketch. In the second experiment the subjects were asked to attribute poor academic performance to personal or situational factors. Even if other explanations were given for poor academic performance, subjects in noisier circumstances (65 vs. 95

dB white noise bursts; weighting unspecified) judged performance more a personal factor.

Not only can noise affect judgements of others, but it can also predict how physically close one might want to get to another person. Bell and Barnard (1984) found that only males decreased permeability of personal space under stressful noise conditions (55 dB & 95 dB white noise bursts; weighting unspecified). Subjects were asked to project their own preference in personal spacing and number of persons in a room by placing figures in a model room. The subjects in the loud noise condition placed fewer fiqures and spread them farther apart in the room than those in the soft noise condition.

Many researchers have tried to explain the social behavior effects of noise. The most popular theory is that subjects are less aware of their environment under noisy than quiet situations (Korte & Grant, 1980). This explanation may help explain helping behavior and possibly the judgement of others, but not the findings on aggression and personal space. Korte and Grant (1980) suggest that inattention would make subjects less aware of their environment. Thereby subjects may not notice an individual in need of help or make decisions on less information than is available. No suggestion of how inattention acts to affect aggression and the need for personal space is given. The absence of an integrated theoretical explanation shows that social behavior research is a developing area. Examining the four different dependent variables researched in social behavior, one can see that the general considerations for research strategy have been pointed out. The need for laboratory and field research, the influence of extraneous variables on noise and behavior, the making of snap judgements, and the need for personal space have been illustrated. Yet, why differences in laboratory and field research occur, the type and number of extraneous variables affecting noise effects, the reasons for snap judgements, and the reason there is a need for more personal space have not been outlined. That these effects occur is clear, but why these effects come about is the next question in the research. To reach a better explanatory theory for the research results, researchers must include or control for more variables in their experiments. They must also explain the effects of these variables on the behavior studied, the noise itself, and the possible interaction effects. Then one can see the complexity in the relationship between noise and social behavior.

Performance

The majority of noise research has studied performance (Broadbent, 1979; Eysenck, 1982; Hancock, 1984; Jones, 1984). Here, the interest is in how people perform tasks. Clearly, "tasks" can include a tremendous variety of activities (Fleishman, Quaintance & Broedling, 1984). Cognitive, vigilance, motor, perceptual, problem solving, and information processing tasks are examples. The findings have not been conclusive, but in general most believe the relationship to be more complex than Hartley's (1973) suggestion of noise (100 dB(A)) produces cumulative adverse effects with increased time exposure. There are in general three major theoretical approaches to the noise/performance research. They fall under the headings of arousal, cognition, and attention.

Broadbent (1979) states that noise increases the general state of arousal or excitement of the nervous system. With increasing arousal comes better concentration on some sources of information, while a detriment occurs in others. Therefore, low levels of noise may then increase performance on some simple tasks vs. no noise on that task. High noise levels can cause decrements in performance on difficult tasks vs. low noise levels on that task. Increasing noise levels and task difficulty means decrements in some types of performance. Poulton (1978, 1979) believes that there is an initial increase in arousal like an orientating response. This increased arousal leads to a better initial performance. This initial response effect decreases and the steady masking of audible feedback or inner speech produces decrements in performance. Only tasks not requiring auditory feedback or inner speech rehearsal would not show decrements in performance.

Jones (1984), on the other hand, emphasizes the cognitive response to noise. The cognitive evaluation of the setting, noise, and task demands all influence how an individual is affected by noisy conditions. Task demands and noise interact, with performance effects being a function of the extent to which the tasks allows flexibility. This flexibility is in terms of the extent to which subjects can adopt different strategies to achieve the desired level of performance. Noise then enhances or restricts these strategies to create the resultant performance level. Hamilton, Hockey, and Rejman (1977) agree with the cognitive approach. But they are very specific in stating that it is the noise which makes some resources (e.g., processing speed) more available and others (e.g., temporary storage of information) less available to the subject. This availability of resources in turn predicts which tasks will improve or drop in performance due to the noise.

Eysenck (1982) and Cohen (1978) both approach noise research from the attentional point of view. They suggest that noise taxes one's attentional abilities and, therefore, effects performance. Attentional capacity is limited. Noise reduces the available attentional capacity by placing a certain demand on that capacity. The reduction in available attention will result in decreased performance on tasks that require maximum attention.

Though these theories approach the noise effects literature from a different perspective, they do all claim support from the same set of research results. Their disagreements focus on the reasons for the resultant effects, not on the effects themselves (which do differ slightly). In general the theorists agree that vigilance and dual tasks which include a vigilance task are affected by noise (Cohen & Weinstein, 1981). Vigilance tasks require continuous monitoring or attention to infrequent signals.

To illustrate the effects of noise on performance we will now only review tasks requiring sustained attention or continuous monitoring of signals. Looking at the noise performance research as a whole, disregarding the emphasis on theory, we can divide the research into two divisions. The first division is the different aspects of noise. The second division concerns task variation.

The first division of noise can be divided into three subdivisions: noise variability, noise quality, and noise level. These subdivisions are not separate areas in noise research but are different dimensions of noise that are varied in noise performance research. Therefore the main and interaction effects of these dimensions is always what is being tested.

The first dimension of noise is noise variability (intermittent versus continuous). Most researchers agree that intermittent and continuous noise effects are distinctively different (Broadbent, 1979; Hancock, 1984; Jones, 1984). For the agrument of distinction, both significant and non significant differences in effects are present in the following literature.

Woodhead (1964) was one of the first to study intermittent white noise (quiet, 70, and 110 dB spl; weighting unspecified). Woodhead (1964) introduced random number searching by having a rotating drum of 4500 random digits. Numbers were arranged in rows of tens with a certain number circled in each row. The subject was to find the numbers matching the circled number for each row.

Woodhead (1964), using noise versus a quiet situation, found no differences in finding the matching numbers across situations but found that there was an increase in not being able to find the circled numbers to match with in the intermittent noise situations.

Harris (1972) used pairs of two digit numbers randomly distributed in 15 pairs in six columns on 20 sheets. The sheets were then randomly presented. The subject was given a target number to find as the first number of the pair. Once found, the corresponding second number of the pair was marked down and became the next target number in the first pair position to be found on the piece of paper. A new piece of paper and starting number was given every 12 minutes. Under intermittent (105 dB for 125 msec, 50% cycle; weighting unspecified) and continuous noise (105 dB) situations, subjects found fewer number pairs than under the control condition (no noise). No differences occurred as a function of noise variability.

The interaction of task complexity and noise variability can be illustrated by a series of studies done by Warner and Heimstra (1971, 1972, 1973) involving visual searches for letters against 8, 16, and 32 background letters. The noise exposure ranged from intermittent (0, 30, 70, 100%) noise to continuous white noise at various levels (0, 80, 90, 100 dB; weighting unspecified). One hundred percent being continuous noise, with zero meaning ambient noise levels, and 30 and 70% representing the percentage of noise exposure during a given time period. All three studies showed a complex interaction. Level of noise, percentage of noise exposure, and task difficulty interacting in different ways at different levels to effect the detection time. For example, Warner and Heimstra (1971) found that the fastest letter detections times occurred in the order: 30%, 0%, 100%, and 70% noise exposure in the 32 letter condition, but changed to 30%, 100%, 70%, and 0% for the 8 letter situation. They (Warner & Heimstra, 1972) found that in general as the task complexity increased the effects of noise level increased. Yet this relationship was not linear. Warner and Heimstra (1973) then concluded that noise levels must be 90 dB or higher to effect detection time. Yet 90 dB noise increased detection time with a 16 letter search while decreasing detection time with a 32 letter search.

From these results, one has to conclude that noise variability is an important factor in noise research. However, the relationship between intermittent and continuous noise to performance is not a simple one. This relationship is dependent on a complex interaction of noise level and task complexity.

The second dimension of noise is noise level. Researchers have used noise levels of 42 to 114 dB in their experiments (Hancock, 1984). Some researchers have used from 42 to 80 dB as their definition of low noise level, and 64.5 to 114 dB of noise to define their high noise level. The large overlap (64.5 - 80 dB) in noise levels defined as low or high makes it very difficult to see clearly what noise affects or doesn't affect. Weinstein (1979) used 55 to 66 dB(A) noise level, as a noisy situation. He found no significant results on reading performance. While using 70 dB(A) of noise, Weinstein (1974) found an increase in the number of grammatical errors on a proofreading task. Weinstein's results demonstrate the importance of what is considered high and low noise levels.

Not only are the definitions of high and low noise levels inconsistent, the descriptions generally given for noise levels are inadequate. Usually, an author will give only the decibel (dB) rating of noise. Unfortunately, decibels are only a measurement scale and can represent sound pressure level (SPL) or sound power. Most authors expect that it is understood that decibels refer to SPL. A noise source does have a characteristic sound power, but the SPL measure of noise is a result of the sound power and other external factors (e.g., distance, temperature, velocity of medium, etc.; Hassal & Zaveri, 1979). Descriptions of most of these factors are not included in research reports. The perceived loudness of noise is also dependent on the characteristics of the sound wave. The frequency of the wave will influence the dB rating. Therefore, it is important to understand the frequency makeup of the noise one is dealing with.

The last dimension of noise is noise quality, white versus varied. This dimension is unique in that research always studies the interaction of noise quality and noise level. White noise maintains a consistent sound pressure level, contains a very wide band of audible frequencies in a random mixture, and sounds like an FM radio between stations. Varied noise can encompass any sound that varies in sound pressure level and frequency makeup. Hancock (1984) reviewed the effects of white versus varied noise and found that in general high white noise levels do not affect tasks of low processing demand, but can create detrimental effects when combined with high processing demand tasks. Most results show that varied low noise levels facilitate performance in the low demand situations (Hancock, 1984). There are a number of pieces missing to this research puzzle. One of the problems is that little research has been done with high levels of varied, or low levels of white noise. The tendency of researchers to study high levels of white noise makes the research area loaded on this dimension. Unfortunately, this is the section which is also the least applicable to real settings.

The second division in noise performance research is processing demand. Increasing the number and complexity of tasks constitute a high demand, while single simple tasks constitute a low demand. A common paradigm in this type of research is the dual task. This involves the performance of two tasks at the same time. Often, but not always, subjects are told that one task (primary) is more important than the other (subsidiary or secondary). The typical effect is a maintenance of performance on one task, and a degradation on the other. Most researchers believe that noise does not effect low demand tasks (Cohen & Weinstein, 1981; Hancock, 1980). Finkelman and Glass (1970) even suggested that the lack of early performance effects are due to the insensitivity of early, simple task measurements. When using 80 dB bursts of white noise, Finkelman and Glass (1970) found increased errors only on the subsidiary task.

Other dual task research areas do get more confusing. Woodhead (1966) found that intermittent noise (68 & 105 dB bursts; weighting unspecified) can cause a re-distribution of attention needed to respond equally to two activities. When subjects were asked to concentrate on a preferred task, there was a significant difference between noise and quiet conditions. When subjects were asked to concentrate on the unpreferred task there were no performance differences between situations. The preferred task was defined as the task the subject did better overall on. Subjects in this experiment did better (made fewer mistakes) on the counting of letters rather than crossing them out.

Fisher (1984) confirmed that loud white noise (100 dB(A)) in such dual task situations would reduce the capacities of the attentional parameter when compared to low white noise (55 dB(A)). Therefore, a subject would perform better on a primary task than on a secondary task. She also found that the primary task had increased errors, and just the shift from single to dual task resulted in large decrements. She concluded that noise only makes the difficulty of the task more pronounced. Fisher (1983) studied white noise (55 & 100 dB(A)) on card searching. The loud noise condition resulted in completing the search task quicker, but more cards had to be sampled.

These effects are not always found as discovered by Forster and Grierson (1978). Forster and Grierson (1978), in an attempt to replicate noise effects on a dual task, did a series of four studies similiar to Hockey (1970). The primary task was a pursuit tracking display and secondary task was monitoring a series of lights. Forster and Grierson (1978) stated that they replicated Hockey (1970) exactly and found no significant results. Hockey (1970) had found that noise significantly changed the selective attention of an individual. On examining both studies, two key differences arose. Hockey (1970) used 100 dB (weighting unspecified) broadband noise while Forster and Grierson (1978) used 92 dB(A) broadband noise. More importantly Hockey (1970) had the lights in the secondary task flash on for 600 msec. In Forster and Grierson's (1978) experiment, the lights remained on until the subject responded. These differences could very well account for the differences in results.

The analysis of the noise aspect of the noise performance research reveals that noise is made up of three dimensions which are always present to interact to produce effects. The inadequate documentation of the specific characteristics of the noise used reveals the lack of understanding of this concept. Noise variabilities and level have a direct interaction with task complexity to produce specific results. So also, one would expect does noise quality, as the three dimensions are inseparable. A clear outline of the noise used and the test of more realistic noise environments and noise ranges would not only increase the external validity and applicability of noise research, but also help to outline the many variables involved in noise effects and provide important information to produce an integrated theory of noise effects.

The progress of research on the different dimensions of noise identified above are closely tied to theory development. The favored approaches in recent years were to look at the cognitive (Jones, 1984) or attentional (Eysenck, 1982) responses to noise. But looking at the explanation of each theory, one finds that there is a large overlap in their theoretical approaches as well as their predictions. Except for Poulton's (1978) arousal and masking theory, all the theories point to the limited capacity of the individual in dealing with noise. Broadbent (1979) states that arousal hinders this capacity to concentrate. Eysenck (1982) and Cohen (1978) call this an attentional capacity. Jones (1984) refers to this capacity as a given set of strategies to cope with noise. Hamilton et al. (1977) states specifically these types of strategies or capacities. The integration of these theories may provide the theory on how one copes with noise.

Aftereffects

In the studies outlined above, the dependent variables were measured during noise exposure. In recent years, some research attention has been directed towards the measure of aftereffects. As the term suggests, the critical feature of this type of effect is that it occurs after noise has been terminated (Cohen, 1980; Gawron, 1984; Spacapan & Cohen, 1983). Thus it is a poststimulation effect. Cohen's (1980) review has found aftereffects to be more consistent than the effects during noise.

This consistency has made aftereffects a very popular research variable in noise research. Here, noise research starts to fall under the larger stress research area. Noise is considered a stressor by many researchers (Baum, Singer, & Baum, 1981; Cohen & Weinstein, 1981; Spacapan & Cohen, 1983). This association with stress first interested researchers in studying aftereffects with respect to noise research. Therefore the theories about aftereffects cover more than just noise, but stressors in general. There are currently eight theories on why aftereffects occur.

The adaptive cost hypothesis (Glass & Singer, 1972) states that the more adaptation required (due to task and situation), then the greater the aftereffect. The definition of this actual "cost" is not clearly stated.

Cohen (1978) suggested that aftereffects were due to an information overload. A subject has a limited attentional capacity, which decreases with stress exposure. This can lower the capacity to handle later tasks and result in poorer performance.

Learned helplessness theory would predict that the aftereffects are due to lack of motivation (Glass & Singer, 1972). The inability of the subject to control or predict the presence of noise and poor performance would lower the subject's motivation. The lack of motivation would cause the subject to persist less in subsequent tasks.

The arousal theory (Poulton, 1978) would suggest that the drop in arousal level after the termination of noise would decrease performance. Noise increases arousal which, in turn, increases performance up to an optimal level. The termination of noise drops arousal below normal and therefore also decreases performance.

The frustration mood hypothesis (Cohen, 1980) concerns the frustration, annoyance, and irritation that builds up due to the presence of noise. Under uncontrollable, unpredictable noise the subject is frustrated and annoyed. These moods lessen the motivation to perform well in subsequent tasks.

The persistent coping stategies or overlearning hypothesis (Rodin & Baum, 1978; cited in Cohen, 1980) suggests that a strategy of coping is overlearned while in the stress condition. This strategy persists on other tasks even if the strategy results in worsened performance.

The dissonance and self-perception theory bases its ideas on the fact that subjects given a choice to be under the stress of noise or not do not show the characteristic aftereffect (Glass & Singer, 1972). The reason being that subjects judge the noise as less stressful due to their choice.

The artifacts of experimental situation would simply say that the performance is due to the demand set up by the situation and the experimenter (Glass & Singer, 1972). The subjects exposed to aversive noise would develop a negative attitude toward the experimenter and situation. Once this attitude is taken, the subject does not work as hard on following tasks.

Though all these theories are plausible, some are better supported by research results than others. Cohen (1980) in his review of aftereffects, evaluated all the theories in the light of current research and concluded that there were three plausible theories. These three theories have noise effects theory counterparts, which have similiar theoretical orientations. The adaptive cost and information overload concepts could fall in line with Cohen (1978) and Eysenck's (1982) attentional theory on noise performance effects. The persistent coping strategies could easily be endorsed by Hamilton et al. (1977) and Jones' (1984) theories about cognitive causes of noise performance effects.

When the data relating to these theories are considered, a number of dependent measures appear. Sherrod and Downs (1974) found a decrease in altruism (linear trend) with time and number of math problems solved after exposure to noise. One of the most common measures is the measure of frustration tolerance (Cohen, 1980; Cohen & Weinstein, 1981; Glass & Singer, 1973). Unless otherwise noted, all of the aftereffects studies discussed below used this measure. The most popular measure of frustration tolerance is the Feather task (Feather, 1961). The Feather task involves the subject's persistence in trying to solve two insoluble problems (further explained in the Method section).

Though the aftereffects of noise are more consistent and larger than effects during noise, the variables and noise dimensions which control this aftereffect are still in debate. In a study of frustration tolerance, Wohlwill, Nasar, DeJoy and Foruzani (1976) found an aftereffect in a group of subjects even when they were not required to perform the dial monitoring task. Rotton, Olszewski, Charleton, & Soler (1978) also found reduced frustration tolerance in a group not required to perform a recall task (80 dB; weighting unspecified). The mere exposure of noise appears to produce an aftereffect without the necessity to perform a task during the noise exposure. Spacapan and Cohen (1983) even questioned whether actual noise exposure was necessary? Spacapan and Cohen (1983) noted that just the expectation of noise (100 dB(A)) could result in frustration tolerance aftereffects (Feather task).

If there is noise exposure, then what dimensions of noise affect aftereffects? Percival and Loeb (1980) furthered aftereffects research by studying noise schedules (random & fixed; 95 dB(A)). In their study, conglomerate (tape mix of English and Spanish speaker, mimeograph, calculator, and typewriter) noise and aircraft noise peaks produced greater aftereffects than aircraft and white noise. Random schedule noise also produced greater aftereffects than fixed schedule noise. DeJoy (1985) used a dial coding task and concluded that aftereffects were more a result of the type of task exposure an individual experiences than the type of noise one is exposured to (85 dB(A)). He found that the unpredictability of the noise did not heighten aftereffects (Feather task and proofreading). Here dispute occurs again, as most researchers agree that unpredictable and uncontrolled noise should produce the largest aftereffect (Cohen, 1980). Aftereffects are consistently found but the variables and noise dimensions that affect these aftereffects are still not clear.

As in the case of concurrent auditory effects, there is much theoretical debate in regards to aftereffects. The three predominant theories at the present time in noise aftereffects literature are attentionally and cognitively based. Like noise effects, the limited capacity concept can account for most of the aftereffects theories stated. The one exception being again Poulton's (1978) arousal theory. The theory of limited capacity in coping with noise discussed in the noise effects literature is taken one step further with aftereffects theory. The capacity utilized by the individual has a "cost" or recovery time after the termination of noise. The difference in aftereffect theories stated earlier appears to be in how they define this capacity and the "cost" involved. The adaptive cost hypothesis (Glass & Singer, 1972) simply labels it adaptation and cost. The information overload theory (Cohen, 1978) labels the capacity attentional and the "cost" as a decrease in the ability to sustain attention on later tasks. Learned helplessness theory (Glass & Singer, 1972) describes the capacity as the ability to deal with uncontrolled and unpredictabled situations which leads to a "cost" in motivation. The frustration mood hypothesis (Cohen, 1980) and artifacts of experimental situation (Glass & Singer, 1972) don't describe a capacity but state that the "cost" is frustration-annoyance and negative attitudes respectively. The persistent coping strategies (Rodin & Baum, 1978; cited in Cohen, 1980) labels the capacity as strategies and the "cost" as persistence at those strategies. The dissonance and self-perception theory (Glass & Singer, 1972) hypothesize that the perception of control would modify this capacity and "cost". The central theme of these theories is on limited capacity and "cost". Therefore variables or dimensions affecting and defining this capacity and "cost" are of interest in noise aftereffects research.

Affective States

Psychological variables have commonly been studied in the stress literature (Fleming, Baum & Singer, 1984; Glass & Singer, 1972). Therefore, it is not surprising that mood states should be measured when noise research is done. Gawron (1984) found affective (mood states), but not performance effects with noise. Her review concluded that anxiety, tension, subjective displeasure and annoyance were present. Spacapan and Cohen (1983) found mood changes with noise. Wohlwill et al. (1976) got differing moods due to noise even when no task was required. Jones and Broadbent (1979) using the Mood Adjective Checklist found that office noise (55 and 80 dB(C)) increased dysphoria, scepticism and deactivation, while decreasing efficiency, euphoria, and activation. Willner and Neiva (1986) found that loud noise (80 dB at 500 Hz; weighting unspecified) increased the recall of negative trait words. Not enough research has involved affective states to understand how this variable relates to theories of non auditory effects, but it is important to measure affective states in further noise research.

Summary

The areas of non auditory effects of noise are incomplete, conflicting, and complex. A careful integration of the numerous variables important in non auditory noise effects is needed to help clarify this area of research. The incompleteness of this area is shown through the many changes happening in the field. In the past, concurrent performance effects have been the most heavily researched. Now, the emphasis is to study the aftereffects, as they have proven to produce more consistent results. The most popular theories in concurrent effects literature were once based on arousal (Broadbent, 1979; Poulton, 1978), now they are cognitively (Hamilton et al., 1977; Jones, 1984) and attentionally (Cohen, 1978; Eysenck, 1982) based. With each non auditory variable studied more intervening variables have been found to affect the noise effects.

The conflicting nature of the area is best shown in terms of the available data. For every experiment with significant results, there are at least the same number with nonsignificant results. A noise environment may also create differences in one area of non auditory effect while not affecting another. Ward and Suedfeld (1973) in a study of highway noise found adverse effects in social interaction in group problem solving and subjective reaction (Affect Adjective Checklist) while not finding changes in cognitive performance or pulse rate. They used loudspeakers to broadcast traffic noises ranging from 77 to 80 dB(A) across three days. The quiet condition had traffic noises of 63 to 70 dB(A). The problem, however, is also a theoretical one as there are six differing theories to explain performance effects of noise and eight theories of aftereffects. These theories also claim the same set of experimental results for their support.

The above two features (incompleteness and conflict) point to the complexity of the area. The most reliable concurrent noise performance effects are found in vigilance or attention oriented tasks. But here the significant differences occur only when very high demands are placed on the subject. As reviewed earlier, these effects, though the most reliable, are still not consistently found. In addition mood states have also become important, and more research is now including this variable. The areas of physiology and annoyance need more sensitive measuring instruments to demonstrate a clear effect. Social behavioral effects are confounded by the lack of control or understanding of intervening variables such as the concept of lab versus field research. Therefore, as the research area has advanced, the complexity of the area has also increased. To bring an understanding of this complexity, one must have an integrated theory of non auditory effects. The answer to this quest lies in the concept of limited capacity and "cost". All the major theories in this area outline this general theory. It is through the detailed explanation of this concept that a theory for noise research can be found. To achieve this purpose, more reliable and consistent effects must be found. The most clearly defined research effects of noise at this time are performance, aftereffects and mood states. With the addition of the organismic variable to the noise research area and specifically to these effects, the purpose should be achieved.

Organismic Variables

According to the definition of noise quoted at the beginning, there are three aspects to noise. The second aspect depends on the organism and how it evaluates the sound. Organismic variables can be divided into demographic and personality aspects.

Demographic

The effects of noise can be influenced by a number of demographic factors. Lahtela, Niemi, Kuusela, and Hypen (1986) found that the elderly were much more negatively affected by intermittent broadband noise (80 dB(A)) on reaction time to making a visual choice than the young (age range 35 to 80). However, Davies and Davies (1975) found that white noise (95 vs. 70 dB(A)) facilitated the elderly's (65-72 vs. 18-31 yrs.) performance on a cancellation task (crossing out the letter 'e'). Both sets of authors do agree that the effects, though significant, are very small.

Larger effects can be found between sexes. Elliot (1971) noted that boys tolerated significantly higher levels of white noise than girls before turning the noise off. Tolin and Fisher (1974) found a complex interaction of noise situations (constant, regular, and variable intermittent noise) and sex on performance on a visual vigilance task. For example, males made more incorrect detections than females in intermittent noise conditions but not with constant noise. Baker, Holding, and Loeb (1984) found that, under the same white noise conditions, men increased speed with an addition task, while women increased accuracy with practice (55 & 95 dB(A)). In the same study, men and women changed performance depending on the time of day (8-10 am. vs. 4-6 pm.). Women in the quiet situation performed the task in the evening as well as men in the noise condition did in the morning.

These results indicate a very complex relationship between noise and organismic variables like sex, age and circadian rhythms. As yet there has been no firm explanation of this relationship. However most of the researchers above have suggested that the noise effects are due to differing arousal or activation of the subject.

Personality

Though the study of individual differences is a complex one (Wilkinson, 1974), it is also important in understanding how people interact with their environment. One major emphasis of individual differences is personality. Discipio (1971) found that introverts improved performance in sequentially connecting randomly distributed numbers on a sheet, while extraverts got worse with continued exposure to white noise (80 dB spl; weighting unspecified). Elliot (1971) noted that extraverts could tolerate higher levels of white noise than introverts (weighting unspecified). Extraverts are characterized as outgoing and wishing to interact with others, while introverts direct their thoughts and interests inwardly.

To further demonstrate individual differences, Collins-Eiland, Dansereau, and Brooks (1986) divided subjects using the Rotter Internal-External Locus of Control Scale (Rotter, 1966). The subjects were then exposed to meaningful conversation noise (60 dB, weighting unspecified) or quiet situations while reading a 2000 word passage. The researchers found a significant interaction effect between internal-external and noise-quiet dimensions with a free recall essay test. Internals outperformed externals in the noisy situation and externals outperformed internals in the quiet situation. Internals believe that reinforcement is controlled by their own behavior and externals believe that reinforcement is controlled by an outside force such as luck, fate or powerful others.

Another division of personality might be Type A and B behavior patterns. Type A is a high-pressure, competitive, driven behaviour and Type B is the relative absence of these traits. Significant interaction effects were found with Type A - Type B behavior patterns (Bortner Scale) and increasing noise levels (68 - 110 dB(A)) while subjects were performing a dual task (Moch, 1984). The simple primary task (crossing out words) showed no significant differences, but the complex task (memorizing nonsense syllables) showed interaction effects. The Type A individuals maintained their performance level in spite of the increasing noise. The Type B individual's performance on the memorization task dropped with the increase in noise levels.

Another personality dimension is noise sensitivity. Noise sensitivity is defined as a factor underlying attitudes towards noise in general, differentiating it from annoyance which concerns attitudes towards a specific noise environment (Anderson, 1971; cited in Stansfeld, Clark, Turpin, Jenkins & Tarnopolsky, 1985). By definition then, noise sensitivity is viewed as a trait, as it is relatively stable. Weinstein (1978, 1980) examined individual differences in noise sensitivity using a 21-item questionnaire. He found that there are consistent individual differences in how people evaluate noise. His scale was found to be predictive of how an individual would react to future noise situations. Noise sensitivity was found to correlate with scholastic ability, social interactions, and privacy (Weinstein, 1978). Topf (1985) found that noise sensitivity (Weinstein's scale) was predictive of disturbances in hospitals, and concluded like Weinstein that noise sensitivity is a personal attribute predictive of reaction to environments. Iwata (1984) found that noise sensitive (scale similiar to Weinstein's) individuals were generally less healthy (Cornell Medical Index) and had a higher incidence of maladjusted personalities (Yatabe-Guilford Personality Inventory). Smith and Stansfeld (1986) found no interaction between noise sensitivity (by indicating what type of noise annoys them from a list of seven) and aircraft noise in producing everyday errors. Everyday errors were defined as common errors an individual might make during a week. For example, "Do you find you forget whether you've turned off a light or a fire or locked the door?" However, their self-report type measure of noise sensitivity was the least reliable scale found (Stansfeld, Clark, Jenkins, & Tarnopolsky, 1985).

Stansfeld, Clark, Jenkins, and Tarnopolsky (1985) compared the validity of a number of noise sensitivity scales. Their testing of noise sensitivity include McKennell (1963; cited in Stansfeld et al., 1985), Self-Report, Weinstein's scale (1978), and the General Noise Questionnaire (Anderson, 1971; cited in Stansfeld et al., 1985). McKennell's (1963) scale was the list of seven noise types refered to above. The Self-Report scale asked a single question of, "Would you say you were more sensitive or less sensitive than other people to noise?", with a four answer response of "more", "less", "same", or "don't know". The General Noise Questionaire (Anderson, 1971) is a complex scale of 21-items refering to the enjoyment of everday activities (e.g., cooking, reading, etc.). The scoring system asked how much noise would disturb these activities from a +5 score of increased enjoyment to a -5 score of decreased enjoyment. Results showed that retesting after three years had 70% of the high sensitive individuals scoring high again on all scales while only 38% of low scorers on the first occasion scored low on all scales again. The intercorrelations of the four sclaes ranged from r=0.62 to r=0.65. There were also 80% agreement between scales as to those who were judged highly sensitive to noise. From the study, noise sensitivity (Weinstein scale included) had a strong relationship to annoyance, psychiatric symptoms, neurotic scores and general reactivity. Highly sensitive individuals would score higher on each of these categories. A follow-up study compared noise sensitivity to physiological measures (Stansfeld, Clark, Turpin, Jenkins, & Tarnopolsky, 1985). Here high noise sensitivity was correlated with a consistently slower heart rate. There was no relationship to systolic or diastolic blood pressure, skin conductance, or threshold of hearing. Sensitive individuals did over- and under-estimate high and low noise respectively. From the above results, it is clear to see that noise sensitivity is a personal attribute with a distinctive set of characteristics.

In the study of individual differences many personality variables have been used to understand the relationship between them and noise. Extraverts vs.

introverts, internals vs. externals, and Type A vs. Type B personalities have all produced differential reactions to noise situations. The most detailed research related to personality and noise is with the noise sensitivity scale (Weinstein, 1978). The development of the noise sensitivity scale and early experimental results have shown that noise sensitivity is a personal attribute and predictive of future reactions to noise environments. This variable could then be a powerful tool in studying noise effects and aftereffects.

Summary

Organismic factors have been the least researched in the noise literature. As noise impinges on individuals to produce effects and aftereffects, the individual has to evaluate this sound. Organismic factors affect the evaluations of this noise. The importance of taking sex and age effects into account in noise research should be clear. An organismic variable gaining prominence in noise research is noise sensitivity.

Integration and Hypothesis

The research reviewed above clearly indicates the psychological nature of noise. This is shown by the operation of factors such as sex and personality, and its effects on dependent variables such as mood states and frustration tolerance. Because of this, it is possible that a personality factor such as noise sensitivity would account for some of the conflicting noise effect and aftereffect data.

The general orientation of noise theory is centered on the limited capacity of the individual. Noise taxes this capacity so that at times effects are produced. Yet in most situations this capacity is able to withstand the strain of noise. The "cost" comes in the aftermath or resultant aftereffects. The individual needs to recover from this noise stress, and aftereffects are produced more consistently. Our questions then are aimed at understanding this relationship. Are there noise levels which individuals might generally be exposed to which may produce this aftereffect? Does the noise sensitivity of the individual affect the noise effects and/or aftereffects? Is the "cost" found only in frustration tolerance or does it also occur in mood states? If this "cost" effect is present then does noise sensitivity affect or interact with noise levels to affect mood states? Answers to these questions would help to clear up some of the complexity of the noise research area.

Specifically, it was hypothesized that noise sensitivity would have an effect on task performance during noise exposure, and non auditory effects after the noise exposure is terminated. The introduction of noise sensitivity in non auditory effects would produce a clear division in performance effects between noise sensitive individuals in high and low noise conditions. (1) Noise sensitive individuals would perform poorly in high noise, while performing well in low noise conditions. Noise insensitive individuals would not be, or only slightly, affected by the different noise levels. (2) Noise sensitive people would, however, not produce a differentiated aftereffect because the cost to perform would still be the same for either individual. (3) The high noise situation would, however, produce the most aftereffects when compared to the low noise situation. (4) The mood prediction was that noise sensitive and insensitive individuals would be aroused and fatigued equally by the task and situation but the amount of perceived stress and well-being would vary. (5) High noise was predicted to interact with noise sensitivity to produce higher stress. (6) The high noise level situation was also predicted to have higher arousal and fatigue effects than the low noise situation.

Method

Subjects

Subjects were selected from a pool of 344 Introductory psychology students at the University of Manitoba who completed the Noise Sensitivity Scale (NSS). Of these, 80 subjects (40 males, 40 females) were selected for the Office Task study based on their scores on the Noise Sensitivity Scale. Forty noise sensitive and forty noise insensitive subjects were chosen. None of the subjects had hearing loss or visual impairments which weren't corrected for with eye glasses or contact lenses. All students received a course credit for fulfilling their research participation requirement.

Materials

The following materials were used in this experiment.

Noise Sensitivity Scale (NSS).

The NSS is a 20 item instrument adapted from Weinstein (1978). This scale was embedded into the Enviromental Attitudes Scale (EAS). The EAS (Appendix A) was designed so that the subjects would not be sensitized to the purpose of the study. This was accomplished by embedding the NSS items in the 65-item EAS questionnaire.

The rest of the items asked for general attitudes toward the environment (lighting, temperature, air quality, and spatial arrangements). These items were not analyzed. The responses to the items range from 1, "disagree strongly" to 5, "agree strongly". Before completing the EAS, subjects provided some demographic information so we could contact the subjects later to participate in the Office Tasks study.

All the NSS items were scored in the positive direction, with high scores indicating noise sensitivity and low scores showing noise insensitivity. Since scores on their items were summed, total scores could range from 20 to 100. Item number nine of Weinstein's (1978) original questionnaire, "How much would it matter to you if an apartment you were interested in renting was located across from a fire station?" was dropped for easier scoring. The NSS items embedded in the EAS were 2, 5, 9, 13, 16, 20, 24, 28, 32, 35, 38, 41, 44, 47, 50, 52, 55, 58, 61, 64.

Weinstein (1978) has found Kuder-Richardson reliability of .84 to .87 with 3 samples of students and a test-retest reliability of .75 with a nine week interval and a sample size of 72. The type of test reliability done was not mentioned. The items were all scored on a 5 point Likert format. Topf (1985) used the scale and obtained a Cronbach's alpha of .76 (N=150) in her study.

Office Tasks

The Office Tasks package contained the following tasks and questionnaires (Appendix B).

Accounting Ledger Job (ALJ). The ALJ is essentially a visual search task, developed to provide a fairly demanding task for the subjects. The subjects were requested to search, as quickly as possible, for three three-digit numbers in a matrix of 16 X 50 three digit numbers (e.g., Appendix C). The subjects may use their own strategies and were not required to find all three numbers before moving on to the next page and another set of numbers.

The ALJ is a pile of 35 individually different sheets. The printed digits were elite size with 12 characters per inch and a height of 6 points. The numbers in the matrix of each sheet were randomly positioned, non-repeating, and ranged from 111 to 999. Each sheet contained three target numbers listed on top of the matrix. The three individual digits of the target numbers were also non-repeating. The matrix was divided into four 8 X 25 number quadrants with each target number being found in a different quadrant. The three quadrants per sheet that contained target numbers were randomly chosen, as well as the target numbers themselves.

The clerical visual search task was used because Hughes and McNelis (1978) suggested that this task is respresentative of the commonly encountered visual tasks in an office setting. A number of researchers have found noise effects with search tasks (Harris, 1972; Warner & Heimstra, 1971, 1972, 1973; Woodhead, 1964).

<u>Perceptual Task (PT)</u>. The PT was one developed by Feather (1961), and consisted of four line diagrams (Appendix D). The diagrams were reproduced on 14 X 10.5 cm. pieces of paper. The papers were arranged in four piles in front of the student. The papers were placed face down with a numbered cover sheet placed on top of each pile (numbered 1 to 4). All instructions were read before the task began. The task was to trace over all the lines of the diagram without tracing over any line twice or lifting up the pencil from the paper. There were two soluble diagrams and two insoluble diagrams arranged with the first pile insoluble, second soluble, third insoluble, and fourth soluble. The subjects had a 40-second time limit for each piece of paper, but could attempt a figure (pile) as many times as they wished. Once they changed piles, they could not return to work on a previous figure.

Glass and Singer (1972) first used the scale as a measure of the amount of frustration an individual can tolerate after exposure to noise. The subjects were exposed to four possible noise conditions: (a) loud unpredictable, (b) loud predictable, (c) soft unpredictable, and (d) soft predictable. The insoluble puzzles led to failure and frustration. Therefore the subjects' persistence (number of attempts on insoluble diagrams) by interpretation would be related to their ability to tolerate, or put up with, frustration. The results showed that with unpredictable noise, the loud condition had significantly fewer attempted trials in both the first and second insoluble diagram than the soft noise condition. This indicated that loud unpredictable noise made people less tolerant of frustration than soft unpredictable noise. Cohen's (1980) review of noise aftereffects concluded that frustration tolerance is a reliable measure of noise aftereffects. Wohlwill et al. (1976) specifically found aftereffects using the frustration tolerance measure of Feather (1961) after exposure to 80-85 dB(A) conglomerate noise (including office sounds like typewriters, phones, etc.,) for a period of 30 minutes.

Adjective Check List (ACL). The ACL questionnaire is a 16 item questionnaire containing Likert-type scales from

1, "not at all" to 5, "extremely". The ACL asks how the subject is feeling at that particular moment with items such as sleepy, peaceful, jittery, active, etc. The scale is largely a modification (Kaye, 1984) of the instruments developed by Hendrick and Lilly (1970), Mackay, Cox, Burrows and Lazzerini (1978), and Nowlis (1965).

The ACL accesses the factors of stress/anxiety, well-being, arousal, and fatigue. The items tense, worried, jittery, and nervous refer to the stress/anxiety factor, while the items peaceful, relaxed, contented, and pleasant refer to the well-being factor. The items active, energetic, vigorous, and lively indicate the presence of the arousal factor, while the items drowsy, tired, sluggish, and sleepy indicate the presence of fatigue.

Office and Job List (OJL). The OJL is an eight item questionnaire designed to access the subject's feelings toward the job tasks and the office setting. The OJL asks the subjects to rate how interesting and difficult they found the office tasks from 1, "Not at all" to 5, "Extremely". The questionnaire is specifically interested in whether the subjects found the office sounds disturbing or not. This questionnaire also inquired as to whether the subjects thought the tasks and settings were appropriate for an office environment from 1, "No" to 3, "Yes".

Post Experimental Questionnaire (PEQ). The PEQ consisted of two open ended questions which inquired as to what the subjects thought the experiment was about and how they thought they were to perform. The PEQ checks for such internal validity threats as hypothesis guessing as a possible cause for the results obtained.

Feedback Sheet

The Feedback Sheet revealed the true nature of the study to the subjects (Appendix E). This sheet also explained why deception was necessary and some preliminary results of the study. The feedback sheet was distributed to the subjects at the end of the term to fulfill ethical requirements.

Office Setting

The experimental room (Height X Width X Length; 2.44 X 3.35 X 7.82 m) contained 10 tables (each, 0.77 X 1.07 X 0.77 m), and two speakers (45 watts each, at the back of the room). For the experimenter's identification, the tables were numbered from one to ten. Each table was self-contained and did not require the subject to get up to complete the experiment. Starting from the far left-hand corner of the table (moving right) there were the Account Ledger Job tasks (face down), followed by the

Perceptual Task (four piles of paper), and in the file bin on the far right-hand corner were the ACL, OJL, and PEQ sheets. Directly in the center of the table in front of the subject was the Office Tasks booklet.

The temperature ranged from 22° - 25° C during the experiment. The humidity is only important in cases of extremely high values, which did not occur during the running of the study. To get an average horizontal illuminance of 1000 lux for the room, the setting of illuminance at the center of Table 1 ranged from 1240 to 1280 lux. There were nine fluorescent light fixtures attached to the ceiling of the room with four fluorescent lights per fixture.

Office Noise

The office noise was taped in the Psychology General Office at the University of Manitoba. Two 45 minute sessions were taped 15 minutes after lunch hour on BASF LH-EI 90 tapes. One tape was of the secretaries' work environment and the other was taped in the photocopy room. The microphones were placed at the north and south ends of the rooms. They were not conspicuous, though the secretaries were aware of their presence. The two tapes were mixed together to get a conglomerate of office noises.

To evaluate the office noise an acoustic analyzer (GEN RAD Model 1988 Precision Integration Sound Level Meter and Analyzer) was obtained. The microphone of the analyzer was placed at the center of the room and adjusted to a height of 1.27 m (about ear height for a seated individual). The acoustic analyzer measures the sound pressure level (SPL) present. The SPL is the decibel (dB) equivalent of the mean square sound pressure. The A weighting was used as it is the measure which parallels the sensitivity of the human ear most closely (Hassall & Zaveri, 1979). The acoustic analyzer allows for three measures to characterize the noise being measured over a given time interval. The equivalent continuous sound level (LEQ) is an integrated measure of the acoustic energy level for varied noise levels across a given time period. Therefore, the LEQ is the constant sound level that would produce the same acoustic energy as the time varying sounds did during the measurement period. The sound exposure level (SEL) is the total sound level energy measured over the time period (summed mean square SPL). The maximum sound pressure level (MAXSPL) is the highest instantaneous SPL measurement registered on the acoustic analyzer during the measurement period.

Measuring during a 10 min. interval at the beginning of the tape, the low noise condition was set at 52.2 dB(A)

LEQ, 80.0 dB(A) SEL, and had a 66.7 dB(A) MAXSPL. The high noise condition was set at 74.6 dB(A) LEQ, 102.4 dB(A) SEL, and had a 89.1 dB(A) MAXSPL. Mackenzie (1975) estimated that office noise ranged from 50-80 dB(A). Fifty-two dB(A) SPL was set so that it would mask the normal ambient noise level of between 40-50 dB(A). The Occupational Safety and Health Act (OSHA) of 1970 requires that industrial noise level not exceed 90 dB(A), as this is the level where temporary threshold shifts start to occur (Taylor, 1970). If one is exposed to such a high level of noise for a short period of time then the sensitivity of the ear will decrease compared to before noise exposure (Hassall & Zaveri, 1979). This decrease in sensitivity is temporary, but as the level and/or time exposure increases then the recovery time for the ear increases. With continued noise exposure the ear may never recover and there is now a permanent threshold shift. To guarantee the safety of the subject and to keep the setting normal, an 74.6 dB(A) SPL level was set so that the MAXSPL would not exceed 90 dB(A).

To fully describe the acoustic characteristics of interior environments an octave band analysis and reverberation measure are recommended (Hegvold & May, 1978).

Insert Table 1 about here

Table 1 illustrates the octave band analysis done on the office noise recordings. Each measure was taken with the acoustic analyzer over a five minute interval at the beginning of the tape. Keighley (1970) in his evaluation of 44 pubic and private offices recorded one minute for every 20 minutes of office noise. Only 30 minutes of office noise was used giving a one to six ratio evaluation of the office noise. Keighley (1970) also established that office settings could range from 50 dB(A), average level for drawing offices to 82 dB(A), average level for machine offices. The low and high noise settings for LEQ both fall within this range. Purcell and Thorne (1977) established a linear curve pattern for an octave band analysis. The linear curve pattern for the low office noise condition of LEQ and MAXSPL would be located slightly lower on the db(A) scale than Purcell and Thorne (1977), but would parallel the curve's general pattern. Nemecek and Grandjean (1973a, 1973b) found in 15 landscaped offices frequent peaks occured 8 to 9 dB(A) above the average reading and infrequent peaks occuring 9 to 11 dB(A) above the average. The office noise used in this study had MAXSPL reading 13-14 dB(A) above the LEQ.

Insert Table 2 about here

In Table 2 is a breakdown of the levels registered at each of the tables in the room. The measurements were taken with the acoustic analyzer over a five minute interval at the beginning of the office noise tape. The microphone was again set up at ear height when seated at each of the chair positions. One can see that there is only a possible 3 dB(A) LEQ variation across the tables in the low and high noise setting.

Reverberation time (T_{60}) is the time in seconds for a reverberant sound field to decay 60 dB after a noise source has been shut off. Calculation of the reverberation time is based on the initial slope of the sound level decay and is outlined in Lord, Gatley, and Evensen (1980).

Insert Table 3 about here

In Table 3 is a breakdown of the different reverberation times across the recommended measuring frequencies. The overall average reverberation time (T_{60}=1.59s) for the room is not within the optimum reverberation times outlined for what could be considered a "dead" room. A "dead" room being a room where sound quality is most valued (e.g., theaters or broadcast studios; Hegvold & May, 1978). To represent an office sound environment, the room should not have been a "dead" room. This room would then be considered a "live" room with many sound reflections reaching the observer. These reverberation times did, however, meet the criteria that they not vary much across frequencies. Therefore the room environment did not selectively reflect or absorb only certain frequencies of sound, the range of reverberation times being 1.53 to 1.77 seconds.

Design and Procedure

Students were screened by filling out the EAS. Contained within the EAS was the NSS. This was done so that subjects would not be specifically aware that noise sensitivity was of interest in the study. Harcum and Monti (1973) noted that subjects if aware of the hypothesis will try to help prove the experimenter's hypothesis in noise research. The subjects were chosen from this screening test: 80 subjects (10 females, 10 males) were assigned to one of four groups (low noise-low sensitivity, low noise-high sensitivity, high noise-low sensitivity, high noise-high sensitivity).

The decision to have half male and half female subjects in this study was to address the issues brought up by Hudgens and Billingsley (1978). The proportion of males and females in the workforce is rapidly approaching 50-50. Yet there is a lack of noise studies done with women subjects. Eicher and Lapointe (1985) also pointed out the inability of research to be generalized to the real world without equal sex subject research.

The number of subjects selected to participate in the Office Tasks study was based partially on prior research, statistical concerns, and the selection of noise sensitive and insensitive individuals. Hancock's (1984) review of noise performance research shows an average of 20 subjects per experimental cell. The twenty subjects (10 females, 10 males) per cell were sufficient to fall into the guidelines of normality and, therefore, not require a normality check in the statistical analysis. Noise sensitive and insensitive individuals were defined as the upper and lower quartile scores on the NSS respectively. The 344 screened subjects allowed for approximately 40 noise sensitive and 40 noise insensitive individuals who were able to participate in the study. Male subjects obtaining scores of 74 or higher were considered as noise sensitive, and scores of 62 or lower were considered noise insensitive. Female subjects obtaining scores of 75 or higher were considered noise sensitive, and scores of 62 or lower were considered noise insensitive.

The subjects were contacted by phone to participate in an Office Tasks experiment. They were told that they were chosen from a list of students who had filled in a number of previous questionnaires and asked if they were interested in participating in this experiment. A different experimenter from the one who administered the EAS contacted the subjects and ran the Office Tasks experiment. The subjects entering the experimental room were then randomly assigned to one of ten tables. The sessions were randomly assigned to the high or low noise condition. The noise sensitivity and sex factor were not controlled for at each individual session but were dependent on the availability of time slots for the students. After eight randomly assigned sessions were run, extra sessions were run to fill the number of subjects required per situation. To complete the study, 26 sessions in total had to be run with the number of subjects per session ranging from one to ten. Subjects who missed sessions were then run under the original situation assigned to them randomly.

Once the students were seated at the tables, the experiment began. The instructions for the experiment were both recorded on tape and written down on the Office Tasks booklet. The experimenter was only there to sign the experimental cards and answer any questions pertaining to the understanding of the instructions. The ALJ lasted 30 minutes and the PT lasted 15 minutes. The office noise was played only during the ALJ task. ACL, OJL and PEQ sections were filled in at the students own pace after the previous two tasks had been completed. The total experiment lasted approximately one hour. The students were dismissed after they had completed the Office Tasks booklet and any questions they had were answered. After all sessions were run, feedback sheets were distributed in the introductory classes the subjects were recruited from.

Results

The Statistical Analysis System (SAS) package was used to do the data analysis. Pillai's Trace was used to evaluate significance in the multivariate analysis of variance (Manova) as it is the most robust to heterogeneity of variance. Post hoc comparisons were done by hand. The level of significance set at disproving the null hypothesis was 0.05 while the level set at proving the null hypothesis was 0.10.

The ages of the subjects were between 18 and 26, so age differences were not looked at in this experiment.

Hypotheses

ALJ. A number of dependent measures were derived from the Accounting Ledger Job. The number of opportunities the subjects had to find target numbers, the number of numbers the subjects marked that they had found, the number of target numbers found correctly, the number of mistakes (wrong positions or wrong numbers found), and the number of numbers skipped or not found were all recorded. The independent variables were sex, noise sensitivity, and noise level. A Manova was used to evaluate the dependent variables as they are all derived from the same task and, therefore, must be related. Prior to performing the Manova, assumptions of variance homogeneity and normality were met. Experimental cells contained equal numbers to insure variance homogeneity and cell sizes were large enough to assume normality. No outliers or missing data values were present.

No overall significance was found when a Manova was performed on sex [$F(3, 70) = 0.16$, $p<.9209$] and noise level [$F(3, 70) = 2.09$, $p<.1090$]. As these result were to be expected, a review of the univariate analysis was done. The univariate analysis looking specifically at the number of numbers skipped revealed a significant effect [$F(1, 72) = 4.68$, $p<.0338$]. Subjects under high noise conditions skipped more target numbers (M=2.73, $S.D.$=3.14) than subjects under the low noise condition (M=1.45, $S.D.$=1.80). No overall or univariate noise sensitivity effect was found [$F(3, 70) = 0.31$, $p<.8151$] No interaction between noise sensitivity and noise level was found [$F(3, 70) = 0.04$, $p<.9896$]. Therefore the first hypothesis that noise sensitivity and level would interact to produce unique effects was not confirmed.

PT. The Perceptual Task allowed for three dependent measures: (a) number of attempts of the first insoluble diagram, (b) number of attempts of the second insoluble diagram, and (c) the total of (a) and (b) for three measures of frustration tolerance. The independent variables were sex, noise sensitivity, and noise level. A Manova was used to evaluate the dependent variables as they are all derived from the same task and therefore must be related. Prior to performing the Manova, assumptions of variance homogeneity and normality were met. Experimental cells contained equal numbers to insure variance homogeneity and cell sizes were large enough to assume normality. No outliers or missing data values were present.

No significant effects due to noise sensitivity were found with the Manova [$F(2, 71) = 0.74$, $p<.4821$], confirming Hypothesis 2 that noise sensitivity would not affect aftereffects. The overall noise level was found significantly different [$F(2, 71) = 4.43$, $p<.0154$]. The significant differences were specifically found in the second insoluble diagram [$F(1, 72) = 7.76$, $p<.0068$] and the total score [$F(1, 72) = 3.99$, $p<.0496$]. The low noise level had the higher number of attempts in both situations. Subjects in the low noise attempted $M=8.82$ ($S.D.=4.23$) second insoluble diagrams and $M=16.45$ ($S.D.=5.85$) total insoluble diagrams as compared to subjects in the high noise condition, who tried $M=6.30$ ($S.D.=3.72$) second insoluble diagrams and $M=13.47$ ($S.D.=7.47$) total insoluble diagrams. These results then confirm Hypothesis 3 that high noise levels would create greater frustration in the subjects.

ACL. The Adjective Checklist was divided into the four dimensions of stress, well-being, fatigue, and arousal for the dependent measures. The independent variables were sex, noise sensitivity, and noise level. A Manova was used to evaluate the dependent variables as they are all derived from the same task and therefore must be related. Prior to performing the Manova, assumptions of variance homogeneity and normality were met.

Experimental cells contained equal numbers to insure variance homogeneity and cell sizes were large enough to assume normality. No outliers or missing data values were present.

The Manova had non significant results with noise sensitivity on arousal and fatique [$F(2, 71) = 1.09$, $p<.3407$] to confirm Hypothesis 4 that noise sensitivity would not affect arousal and fatigue. The Manova for arousal and fatigue did have a significant interaction between noise level and sex [$F(2, 71) = 3.25$, $p<.0455$]. The specific difference was found on the fatigue dimension of the scale [$F(1, 72) = 6.27$, $p<.0145$, Figure 1], with males having higher fatigue scores under the high noise situation while females having higher fatigue scores in the low noise situation. Pairwise post hoc comparisons with the Bonferroni inequality test found that females under low noise levels significantly differed on fatigue from males under low noise situations ($p<.01$). These results provide partial support for Hypothesis 6 in the case of fatigue with male subjects. Hypothesis 6 had predicted that high noise would result in higher arousal and fatigue.

Insert Figure 1 about here

An overall Manova for stress and well-being was also done. An overall significant noise sensitivity difference was found [$F(2, 71) = 4.36$, $p<.0163$]. Both well-being [$F(1, 72) = 4.21$, $p<.0438$] and stress dimensions [$F(1, 72) = 7.63$, $p<.0073$] were significant. The noise insensitive subjects (M=8.32, $S.D.$=2.35) had higher scores on well-being than sensitive subjects (M=7.22, $S.D.$=2.40) and the noise insensitive subjects (M=5.42, $S.D.$=1.97) had lower stress scores than sensitive subjects (M=7.00, $S.D.$=3.23). There was an overall sex effect [$F(2, 71) = 3.68$, $p<.0302$]. This effect was specifically found in the stress score [$F(1, 72) = 5.40$, $p<.0230$]. Males had consistently lower stress scores (M=5.55, $S.D.$=2.22) than females (M=6.87, $S.D.$=3.12). Noise levels did not affect stress or well-being [$F(2, 71) = 1.66$, $p<.1978$]. No noise level and noise sensitivity interactions effects were found [$F(2, 71) = 0.48$, $p<.6185$] and Hypothesis 5 that noise level and sensitivity would interact to produce differential stress and well-being scores was not confirmed.

Noise Sensitivity Scale

The subjects chosen for the office tasks study had a point biserial correlation of r=0.258 ($p<.0207$) with noise sensitivity and the question of whether the office noise was disturbing or not. The point biserial correlation was done because of the dichotomy in rating noise sensitive and insensitive individuals. The significant but low correlation makes the predictive ability of the NSS questionable in this office setting. Since the NSS has never been used to predict noise sensitivity in an office setting, further evaluations of the NSS were done. From the original 344 subjects a descriptive analysis of the NSS was undertaken. The noise sensitivity ratings ranged from 22 to 98 with a mean score of 67.58. The distribution curve was only very slightly negatively skewed (-0.497).

To better evaluate the predictive ability of the NSS, a correlation matrix, Principal Component factor analysis, and varimax rotation were done on the screened sample. The correlation matrix of the NSS revealed correlation scores of 0.359 to 0.716 of the items with the total noise sensitivity rating. However, there were four eigenvalues above one in the principal component analysis with only three factors containing items with loadings of above 0.50 (Table 4). Factor 1 had seven items (20, 32, 35, 44, 50, 58, 64) with a total explained variance of 26.99%. Factor 2 had three items (24, 38,41) with a total explained variance of 7.08%. Factor 3 had three items (2, 9, 52) with a total explained variance of 5.78%. Factor 4 had two items (16, 61) and a total explained variance of 5.57%. The total variance accounted for by the four factors was 45.41%. Factor 1 had items generally concerned with noise disturbance during work or high concentration. Factor 2 had items relating to mild everyday neighbourhood noise. Factor 3 contained items dealing with the unwanted loud noises in one's environment. Factor 4 items dealt with noise that disrupted everyday behavior (e.g., sleep). The Factors in general center around situations where sounds became disturbing for the individual. If the item loading criterion was set at 0.40 then the four factors would include all the NSS items (Factor 1 - 47, 55; Factor 2 - 5, 13; Factor 4 - 28). The inclusion of these items did not alter the Factor labels described above.

Insert Table 4 about here

Regression

Since noise sensitivity did not produce many significant results, a regression analysis was done to see the predictive ability of the other independent variables possible in the experiment on the dependent variables described above. The situational orientation of the NSS factors indicates that the entire NSS may not have been the most useful in predicting noise annoyance or effects in an office situation. However, other variables such as whether the subjects found the noise disturbing or not could be a good predictor of the dependent variables. A regression analysis allows for this hypothesis to be tested. Therefore the results could give a better understanding of noise effects and noise sensitivity in a specific office setting.

A number of rules were observed in the regression analyses of each dependent variable to follow. Due to the fact that there were only 80 subjects and a possibility of 10 predictor variables, the significance limit placed on the predictor variables were $p<.025$. The predictor variables used for each dependent variable were level of noise, noise sensitivity, number of subjects in the room for the experiment, the exact noise exposure for each subject position, sex of the subject, finding the ALJ difficult, finding the PT difficult, finding the ALJ interesting, finding the PT interesting, and finding the office sounds disturbing. The questions concerning the subject's opinions of the office tasks (ALJ and PT) and office sounds were found on the OJL. The Forward and Backward Stepwise regression procedures were used in each case and resulted in identical results, therefore, only the Forward procedure was reported.

ALJ. The regression analysis indicated that the correct numbers found was significantly predicted by finding the office sounds disturbing [$F(1, 78) = 11.97$, $p<.0009$, $r^2=.133$]. The number of opportunities the subjects had to find target numbers was predicted by finding the ALJ difficult [$F(2, 77) = 14.34$, $p<.0001$, $r^2=.155$], and the number of subjects in the experimental room [$F(2, 77) = 7.08$, $p<.0095$, $r^2=.071$] for a total $r^2=.226$. The number of numbers the subjects put down as found was predicted by finding the office sounds disturbing [$F(2, 77) = 6.56$, $p<.0124$, $r^2=.142$], and finding the ALJ difficult [$F(2, 77) = 5.70$, $p<.0194$, $r^2=.059$] for a total $r^2=.201$. The number of mistakes made and the number skipped were not predicted significantly by any independent variable. Finding the office noise disturbing was predictive of two of the five dependent variables of the ALJ. Noise sensitivity was not predictive of any of these variables.

PT. The regression analysis indicated that the number of first insoluble diagrams attempted was predicted by finding the PT difficult [$F(3, 76) = 17.24$, $p<.0001$, $r^2=.154$], the sex of the subject [$F(3, 76) = 7.48$,

$p<.0078$, $r^2=.067$] and finding the ALJ difficult [$F(3, 76) = 6.59$, $p<.0122$, $r^2=.062$] for a total $r^2=.283$. The number of second insoluble diagrams attempted was only predicted by the exact noise level for each seat position [$F(1, 78) = 8.43$, $p<.0048$, $r^2=.098$]. The overall number of insoluble diagrams attempted was predicted by finding the PT difficult [$F(2, 77) = 33.36$, $p<.0001$, $r^2=.229$] and sex [$F(2, 77) = 12.99$, $p<.0006$, $r^2=.111$] for a total $r^2=.340$.

ACL. The regression analysis indicated that the fatigue factor was not predicted by any variable. The arousal factor was predicted by how difficult the subjects found the PT [$F(1, 78) = 6.39$, $p<.0135$, $r^2=.076$]. The stress factor was predicted by the disturbance caused by the noise [$F(2, 77) = 14.28$, $p<.0003$, $r^2=.135$] and the sex of the subject [$F(2, 77) = 6.81$, $p<.0109$], $r^2=.070$] for a total $r^2=.205$. The well-being factor was predicted by how disturbing the subjects found the office noise [$F(1, 78) = 6.90$, $p<.0104$, $r^2=.072$].

Adjective Mood Checklist

The ACL was a modification of the original Mood Adjective Checklist (Mackay et al., 1979). Therefore a re-analysis of the different factors in the scale was done to check for cross-study reliability. A correlation matrix, Principal Component factor analysis, and a varimax rotation on the ACL scores were done. The loading criterion was set at .60 because of the small sample involved. Four eigenvalues above one were found (Table 5). Factor 1 corresponded with the arousal dimension with each of the predicted items loading above 0.60 on the factor with the varimax rotation. Factor 2 corresponded with the fatigue dimension with each of the predicted items loading above 0.60 on the factor with the varimax rotation. The well-being dimension corresponded to Factor 3 but without item 9 loading above 0.60. The stress dimension corresponded to Factor 4 but without item 7 loading above 0.60. The items defined in each factor were then the ones used to achieve the mood state scores for the dependent variables of stress, well-being, arousal, and fatigue used in the earlier analysis.

Insert Table 5 about here

If the criterion for loading was set at 0.40 then item 7 would have also loaded on to the stress dimension.

<u>Office and Job List</u>

The OJL measured other independent variables (e.g., sex) which might be important to the experiment.

Therefore the majority of the Office and Job list was used as predictor variables in the regression analyses done above.

Insert Table 6 and Table 7 about here

In the evaluation of the office tasks and environment, Table 6 and 7 shows how the subjects perceived the situation. The majority of the subjects felt that the room represented an office environment (60.0 and 65.0%). The subjects were evenly divided in their attitudes about the tasks representing office tasks. There were no noticable differences in people's perception of the office envrironment under high or low noise. There were more undecided individuals when it come to the office tasks for the high (40.0%) vs. low (22.5%) noise condition.

Post Experimental Questionnaire

A review of the PEQ responses showed no significant sex differences so the summary tables of the results collapsed across sexes. The post experimental questionnaire revealed that there were a number of purposes of the study suggested by the subjects. They ranged from a study of office environments to a study of time pressure on a task. No mention of noise sensitivity was noted. The PEQ responses for question one of the purpose of the experiment fell into seven general categories. There were responses which refered to the distraction or break in concentration caused by noise, the mood changes occurring due to noise and/or environment, the differential performance effects due to different tasks, sex based differences, the pressure of time on performance, the general hypothesis of environment affecting performance, and a don't now or blank response. Low noise-sensitive individuals suspected more mood changes. High noise-sensitive individuals suspected more environmental effects. High noise-insensitive individuals suspected more time pressure effects. Most individuals regardless of the situation and category suspected that the noise was a distraction.

Insert Table 8 about here

The subjects also had a range of responses to how they thought they were to perform. They ranged from doing poorly due to noisy situations to getting tired as the experiment progressed. Five of the general response categories for the second question of how subjects were to perform were identical to the first question's categories. The sixth category of response for the second question was characterized as a "good subject". Subjects responded to the question by stating that they tried to be as true and honest to the study as possible. The responses for the different groupings were generally more variable here than the first question. High noise-sensitive individuals were more likely to point to a noise distraction. Low noise-sensitive and high noise-insensitive expected mood changes. Low noise individuals in general were more likely to be "good subjects".

Insert Table 9 about here

Discussion

In the case of task performance, the obvious measures such as the number of target opportunities, the number marked as found, and the number correctly found did not show any evidence of noise level effects nor an interaction of noise sensitivity with noise level effects. This result is consistent with previous research (Broadbent, 1979; Woodhead, 1964) where noise level effects are not found with single (repetitive, simple) tasks. In contrast to the lack of task performance effects during noise exposure, aftereffects were readily obtained in terms of the second insoluble and total insoluble attempt scores on the PT. The high noise situation produced a lower fustration tolerance as reflected in the PT when compared to the low noise level. In addition to the post-noise measure of frustration tolerance, the number of numbers skipped in the ALJ can also be taken as evidence of a frustration tolerance effect. The high noise level produced more skipped numbers versus the low noise situation. Noise sensitivity did not affect either of these measures. Also, the predicted interaction of the noise sensitivity and noise level variables in the ALJ was not found. Though the null effects of noise sensitivity on aftereffects were predicted, it means little if noise sensitivity effects during noise exposure were not found. Two null results with noise sensitivity could mean that the construct is not useful to noise research or that the construct is not well enough understood to be useful at this time. If noise sensitivity effects during noise exposure were found then the logic of the aftereffects hypothesis could be further strengthened, by the knowledge that noise sensitivity is a useful variable. The question of whether noise sensitivity is a useful variable has yet to be answered. As predicted, there were no noise sensitivity effects for arousal and fatigue, while measurements of stress and well-being were affected by noise sensitivity in the predicted direction. Noise sensitive individuals felt more stress and less well-being than noise insensitive individuals. An interaction between noise level and noise sensitivity for stress was also predicted but not found. The noise level did interact with sex and not noise sensitivity to produce unique results in the fatigue dimension. That is females were more fatigued in low noise vs. high noise situations, while males behaved in the reverse manner.

The reason for the absence of performance effects of noise sensitivity could be the same as that for the absence of noise effects. That is, noise sensitivity may have no impact on simple, repetitive, search tasks. Another reason may lie in the measurement instrument, as shown by the results of the factor analysis and the regression analysis. The factor analysis of the NSS revealed two things. Firstly, the noise sensitivity scale broke down into four factors. Looking at the items loading into the different factors, it would appear that Factor 1 concerns noise when the subject is trying to concentrate on studying. Factor 2 is concerned with mild irritating noise and Factor 3 concerns very loud noise caused by others. Factor 4 concerns noise interupting activities. Even if the scale is a noise sensitive scale in general, the four dimensions illustrate the difficulty in defining and understanding noise. Secondly, the factors break down situationally. The factors divide more due to the view of noise according to the setting rather than the nature of the noise itself. Therefore the NSS might be a good general noise sensitivity scale, but not appropriate to testing for specific sensitivity to office noise or setting.

The NSS score did significantly correlate with how disturbing the subjects found the office noise. However, this correlation was quite low considering the similarity of the two concepts. The question of office noise disturbance accesses the annoyance the subjects felt during the task. The strength of this annoyance variable in regression analysis points to the possible effect of annoyance on performance during noise. When a regression analysis was done for dependent variables, two of the five performance effects, and stress and well-being were all significantly related to the feeling of disturbance caused by the office noise. But there do not appear to be any studies dealing with this relationship of annoyance and performance effects. The question may be whether noise sensitivity and annoyance are distinctly different concepts, or whether there is a particular dimension of noise sensitivity that is specific to an individual's annoyance towards noise while performing various tasks. If found, this dimension would then help researchers better predict people's performance during noise.

In regards to the aftereffects tasks, the second insoluble diagram is the best measure of aftereffects. As was found in Glass and Singer (1972) the second insoluble diagram had a significantly higher number of attempts after low noise than high noise. In the regression analysis the first insoluble diagram was related to a number of variables (e.g., sex, rated difficulty of tasks), but the second insoluble diagram was specifically significantly related to the noise level at each seat position. This fact builds a strong link between aftereffects and specific noise levels.

Affective states as measured by the ACL were found to be quite valid as the factor analysis defined most of the variables suggested as tapping into each dimension. The only two items left out of the affective states analysis were "jittery" and "contented". This result could well be due to the small sample size and therefore the need for conservative loading criterion. More liberal criterion would have included one or both items in their respective dimensions.

The sex of the subject has also been confirmed as an important variable in the noise research area. In this study, sex was found significant in producing stress and interacting with noise level to affect fatigue as well as relating through regression analysis to two aftereffects measures. Therefore sex is an independent variable that should be controlled for or studied in noise research.

Given the state of the theories on noise research reviewed earlier in the paper, the results are hard to discuss in terms of any one theory. The nature of the tasks and the overlap of the theories do not allow for a comparison between arousal, cognitive, or attentional theories. The results do allow for a discussion of the general concept of limited capacity and "cost". The "cost" is clearly shown through the aftereffects and is made stronger by the fact that noise level is the single most important factor in this result. The only difference in demands placed on the subject's capacity in this experiment was noise levels. Therefore the differential demands placed by noise level differences resulted in differential "cost". To further support this notion future research may want to look at a variations in task complexity or the interaction of task complexity with noise levels to produce a differential "cost". This "cost" is revealed in the aftereffect of frustration tolerance measures. The results also point to the limited capacity of the individual. The "cost" is lower frustration tolerance. The capacity is to tolerate high demands created by the task or the noise. The noise levels influence how much capacity the subject has to tolerate or deal with other tasks. In line with this suggestion are the performance effect results, with significant differences in effects found in the number of skipped numbers. This measure accesses the numbers skipped (not attempted) and/or gave up on. In either case the measure indirectly relate to the possible frustration or intolerance the subjects were feeling. The aftereffects results already showed that frustration tolerance is directly related to the noise level. The subject's capacity to tolerate not finding, or attempting to find the right positions is modified by noise. High noise levels then cause an increase in giving up on, or not even searching for the target numbers. The affective states results also point to a frustration tolerance effect. The dimensions of stress, well-being, and arousal were unaffected by the noise level. But the fatigue dimension which would best relate to frustration was affected by the sex by noise level interaction. The female subject's tendency to be less fatigued with high noise levels is inexplicable with regards to the frustration premise, but the male's tendency to be more fatigued with high noise is explained quite readily. The male subjects with increased frustration due to the loud noises are more fatigued. The results suggest that tolerance could be the limited capacity and furstration the "cost" in the general theory of noise effects.

Many authors have suggested that continuous noise levels below 90 dB(A) are "safe" or produce no effects (Broadbent, 1979; Cohen & Weinstein, 1981; Hancock, 1984). This is one of the reasons so many researchers use extremely high noise levels [>90 dB(A)] in their experiments. This experiment shows that noise levels below 90 dB(A) can cause performance effects, aftereffects, and affective state changes.

A problem with the research design in hindsight could be the placement of the ACL. The ACL was filled out after the PT which could mean that the ACL was measuring the feeling due to both the ALJ with noise and PT in quiet. The regression analysis of the arousal dimension of the ACL hints at this possibility as the perception of difficulty of the PT was the best predictor of the arousal score.

The subjects perceived the setting as office like, but further improvement in the type of tasks and the way they are presented must be done to make subjects perceive them as office tasks. The different noise levels did not influence this perception. The improvement could help control for hypothesis guessing and other internal validity threats.

In evaluating the internal validity, the PEQ found that the subjects were not aware of the noise sensitivity aspect of the study. However, they did suggest a noise level distraction hypothesis. The lack of clear noise level effects in the majority of the ALJ measures show that this hypothesis guessing did not effect the results of this experiment. Of the rest of the hypotheses, none dominant the minds of the subjects nor did they lump together in how they thought they were to perform.

To summarize, there are six conclusions that can be drawn: (1) Noise sensitivity is a multi-dimensional concept and should be treated as such in the future. (2) Aftereffects are best measured by the second insoluble diagram of the PT. (3) The ACL validly measured four dimensions which appear to access stress, well-being, fatigue and arousal.

The major conclusions emerging from the study are: (4) Sex is an important variable to be taken into consideration in the noise research area. (5) The results support a general limited capacity and "cost" theory. (6) Noise levels within acceptable levels for hearing [< 90 dB(A)] still produced performance effects, frustration tolerance aftereffects, and affective state changes.

The noise research area is a developing field which is starting to branch out into many different areas. It is important to remember that it is only through drawing these branches together that an integrated theory of noise effects is possible. This paper has tried to draw some of the different branches together in order to understand noise effects better.

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Appendix A

ENVIRONMENTAL ATTITUDES SCALE

First, we need some information about you.

On the IBM (Multiple Choice) Answer Sheet:

Please PRINT your Name in the space indicated.

Put your Student Number in the appropriate places.

Indicate your Country of Birth over the space marked EXAMINATION CENTRE.

Indicate your Age over the space marked for SEAT NUMBER.

Indicate your Country of Citizenship over the space marked for COURSE.

Indicate your Sex over the space marked for SECTION.

Place your Phone Number over the space marked for INSTRUCTOR.

Place your answer for the following question over the space marked for YEAR.

Is English your first language (Mother tongue)? YES NO

PLEASE READ ALL INSTRUCTIONS OVER CAREFULLY BEFORE BEGINNING!

The Environmental Attitudes scale is a series of questions which will find out how you feel about different features of the environments that you work, study, play, sleep, etc. in. There are no right or wrong answers. We are only interested in finding out about your feelings towards environments. Please answer all the items on the IBM (Multiple Choice) answer sheet.

1. It makes a big difference to me whether there is carpeting in a room.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

2. I would mind living on a noisy street even if the apartment I had was nice.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

3. A comfortable temperature is more important to me than how nice a room is.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

4. My privacy is something that I am very fussy about.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

5. I am more aware of noise than I used to be.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

6. I am more aware of lighting than I used to be.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

7. I am more aware of temperature than I used to be.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

8. I generally find that tables are too high relative to the chair provided.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

9. I mind if someone turns up his/her stereo full blast even if it is once in a while.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

10. I am disturbed if the air in my room is stale.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

11. Other people changing the thermostat annoys me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

12. Cigarette smoke in a restaurant really bothers me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

13. At movies, whispering and crinkling candy wrappers disturb me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

14. Bright lighting bothers me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

15. Extreme temperatures disturb me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

16. I am easily awakened by noise.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

17. The temperature of my room has a great affect on how well I sleep.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

18. The cleanliness of the room that I sleep in is important to me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

19. It is very important to me to have a place where I can study without distractions.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

20. If it's noisy where I'm studying, I try to close the door or window or move someplace else.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

21. The lighting that I have when I am studying is very important to me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

22. The wall colors of my room are important to me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

23. If there are too many people in a room, then I feel uncomfortable.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

24. I get annoyed when my neighbors are noisy.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

25. I prefer a cloth covered seat to a wooden seat.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

26. I shiver easily.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

27. Everything has to be in the right place in my room.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

28. I can't get used to noises very easily.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

29. I am fussy about the kind of desk and chair that I have when studying.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

30. When I work at a desk, I prefer to have a desk lamp, rather than just the ceiling lights.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

31. I will adjust or request others to adjust the temperature if I am not comfortable.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

32. Sometimes noises get on my nerves and get me irritated.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

33. I dislike dust settling out on furniture in my room.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

34. In a classroom, I prefer fluorescent lighting over incandescent (tungsten) lighting.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

35. Even music I normally like will bother me if I'm trying to concentrate.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

36. I like bright sunny days better than an overcast day without any rain or snow.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

37. I would much prefer to work in my own small office than in a large one where I could see my co-workers.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

38. It bothers me to hear the sounds of everyday living from neighbors (footsteps, running water, etc).

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

39. Small changes in temperature bother me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

40. If I sit for quite a while at a desk, I experience pains in my back.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

41. When I want to be alone, it disturbs me to hear outside noises.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

42. Temperature affects my moods.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

43. I am sensitive to odours in the environment.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

44. I can't concentrate when there are a lot of things going on around me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

45. Temperature affects my activities.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

46. I think that the quality of the outdoor air in Winnipeg is acceptable.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

47. In a library, it disturbs me when people carry on a conversation even if they do it quietly.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

48. I will move if there is an air draft where I am sitting.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

49. I pay a lot of attention to the windchill factor in the weather forecast.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

50. There are often times when I want complete silence.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

51. Stuffy air bothers me when I am working at a job or studying.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

52. Motorcycles ought to be required to have bigger mufflers.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

53. There should be temperature controls in every room.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

54. The dry air in buildings in the winter makes it uncomfortable for me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

55. I find it hard to relax in a place that's noisy.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

56. I prefer a day with some variety and change in the weather rather than it being the same all day.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

57. Classrooms are too brightly lit.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

58. I get mad at people who make noise that keeps me from falling asleep or getting work done.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

59. With fluorescent lighting, I often notice flicker.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

60. I find it hard to feel comfortable if the temperature is not to my liking.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

61. I wouldn't live in an apartment with thin walls.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

62. I am sensitive to lighting.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

63. I am sensitive to temperature.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

64. I am sensitive to noise.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

65. My environment is very important to me.

1	2	3	4	5
DISAGREE STRONGLY	DISAGREE SLIGHTLY	NEITHER AGREE OR DISAGREE	AGREE SLIGHTLY	AGREE STRONGLY

This is the end of the Environmental Attitudes Scale, please check your answer sheet to make sure you are at answer number 65. If not, then would you run through the questions again.

<u>REMINDER</u>:
Place Name, Student Number, Country of Birth, etc. on the IBM sheet.

Appendix B

OFFICE TASKS

INTRODUCTION

Welcome to Office Environment. All instructions are written in this booklet and/or tape recorded, so please read and listen to each set of instructions carefully before proceeding. If at anytime you have questions, please raise your hand.

In this research project, we are interested in how people perform jobs that are similar, or perhaps even identical, to those carried out by workers in all types of offices. So, you are going to spend part of a "working day" in this particular "office".

You will be given some jobs to do, and at the end of your work period we will ask you some questions. The materials that you will need for each part of this experiment are placed on the desk in front of you. In order to create a reasonably realistic work environment, we will provide some tape-recorded office sounds at appropriate times in the experiment.

Please place all finished jobs in the bottom file bin in front of you. There should be a pencil on your desk to do the tasks. Raise your hand if you do not have a pencil.

A chime will sound when you are to begin and stop a particular job. Here is what the chime sounds like.

At the end of the office work phase of the experiment, we will ask you a series of questions. They will deal with how you feel about the job that you worked on, the office you are working in, and how you feel about yourself.

You may now turn to the next page for further instructions.

ACCOUNTING LEDGER JOB

INSTRUCTIONS

You may remove the Accounting Ledger Job cover page. The first page is a sample of the job. The pages contain a matrix of three digit numbers. These represent the amount in dollars for a number of purchases. There are 50 rows, and 16 columns (A-P) of these numbers. There are three target amounts at the top of each page. Your job is to find the target amounts in the matrix and mark their positions in the space provided. Once you have found each number, then you can set the page aside in the bottom file bin and continue to the next page and matrix. If you can not find all three numbers on a page you may still continue to the next matrix if you wish. You may not, however, return to a previous matrix once it has been set aside.

You may begin when the chime sounds, and continue working until the chime sounds again. After the second chime sounds please stop until you have been instructed to continue.

Please work as quickly as possible.

You may set aside your instruction manual and prepare to begin the Accounting Ledger Job.

PERCEPTUAL TASK

INSTRUCTIONS

This job involves the four piles of papers in front of you. They are numbered from 1 to 4. Do not look at them yet. Here is what you will have to do. Each paper has a diagram on it. Each pile of paper contains a different figure. When you turn over a paper, your task is to trace over the diagram with the pencil provided. This has to be done according to two rules:

1. You are not permitted to trace or cross over any line you have drawn.

2. You are not permitted to lift your pencil from the paper.

There are other restrictions involved in this job. You can only work at a paper for 40 seconds. At the end of 40 seconds a chime will sound. But, you can have as many of these 40-second trials on a figure as you want. If you do not succeed in tracing over all the lines in a figure, you will then have the choice of trying again from the same pile, or going on to the next diagram and pile.

Remember, once you've stopped working on a pile you can't go back to it again. If you want to continue with the same figure after the chime you should turn the last attempt over and set it in the bottom bin. Then take another copy of the same figure from the pile. You will again have 40 seconds to work at that figure.

Let's go over the requirements for this job once more before we begin. When the chime sounds, you are to take a paper from pile number one. Your job is to trace over all the lines of the figure without tracing or crossing over any line, or lifting the pencil from the paper. When the chime rings again, you can go to the next pile if you have been successful. If you did not complete the job, you can turn the paper over and try again by taking another paper from the same pile, or you can go on to the figure in the next pile. Once you have moved to the next pile you can not go back to an earlier figure.

You may keep working until you are told to stop, completed the task or wish to stop (Then please wait for further instructions). If you have any questions, be sure to ask the experimenter before we begin. You may begin when the chime sounds.

ADJECTIVE CHECK LIST

Below is a list of words describing various moods and feelings. For each one, indicate to what extent the word applies to you right now. Please enter your responses on the IBM (Multiple-choice) answer sheet. Also please place your name and student number on the IBM sheet in the appropriate spaces.

1. Sleepy

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

2. Peaceful

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

3. Lively

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

4. Tense

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

5. Pleasant

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

6. Drowsy

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

7. Jittery

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

8. Active

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

9. Contented

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

10. Worried

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

11. Vigorous

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

12. Nervous

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

13. Energetic

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

14. Sluggish

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

15. Relaxed

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

16. Tired

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

This is the end of the Mood Questionnaire, please check your answer sheet to make sure you are at answer number 16. If not, then would you run through the questions again. Then please continue on to the next page.

OFFICE AND JOB LIST

Below is a list of questions about the jobs and office setting you were placed in. Please enter your responses on the IBM (Multiple-choice) answer sheet, starting on number 17.

17. Did you find the Accounting Ledger Job difficult?

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

18. Did you find the Perceptual Task difficult?

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

19. Did you find the Accounting Ledger Job interesting?

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

20. Did you find the Perceptual Task interesting?

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

21. Did you find the office sounds disturbing?

Not at all	Slightly	Moderately	Quite	Extremely
1	2	3	4	5

22. Do you feel that the jobs represented office tasks?

No	Don't Know	Yes
1	2	3

23. Do you feel the setting represented an office environment?

No	Don't Know	Yes
1	2	3

24. Indicate your sex.

Male	Female
1	2

Please check your answer sheet to make sure you are at answer number 24, before continuing to the next page.

QUESTIONNAIRE

1. Each experiment is conducted for a particular purpose. What do you think was the purpose of this experiment? What was being studied?

2. The experimenter usually conducts the study expecting certain results. Exactly how do you think you were expected to respond?

This concludes the experiment. Please place this booklet face down on the desk. You may now leave the experimental room. Please do not discuss any part of this experiment with anyone else. Thank you for your participation and cooperation.

Appendix C

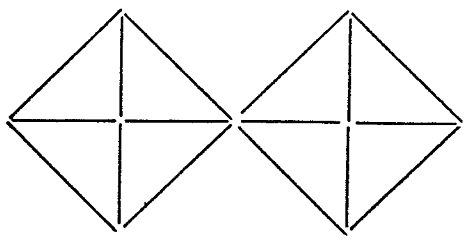
SAMPLE

TARGETS: 321 809 908

POSITIONS: L12 L49 F15

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	203	381	337	220	467	328	445	592	188	819	860	877	759	294	173	547
2	118	555	649	734	524	995	818	817	132	675	724	593	194	981	876	206
3	960	930	289	156	577	570	124	266	655	196	586	920	859	671	943	959
4	302	810	962	634	133	840	159	874	802	951	202	299	134	217	502	326
5	252	642	297	641	969	189	899	657	129	539	941	186	906	585	934	917
6	154	454	663	983	430	868	514	711	945	515	497	397	970	153	596	531
7	735	200	998	709	439	820	149	407	148	498	276	446	889	195	372	219
8	976	296	601	836	483	624	181	907	796	114	822	139	419	530	224	947
9	733	845	429	631	578	553	939	891	771	474	376	873	258	473	727	390
10	720	937	691	609	842	125	500	723	290	234	523	843	180	788	485	764
11	436	412	116	535	367	678	329	938	561	638	532	388	279	852	688	357
12	594	505	174	710	772	418	961	312	743	171	616	321	516	396	282	750
13	936	210	379	212	992	835	179	281	490	973	770	751	559	247	421	984
14	162	422	856	410	204	804	953	271	556	600	389	236	942	145	463	274
15	136	865	923	311	185	908	128	354	150	640	687	268	797	375	761	548
16	748	617	898	832	946	362	169	275	866	823	896	931	875	364	239	484
17	457	368	602	779	434	610	339	351	486	305	165	915	462	656	248	620
18	538	560	448	405	696	680	821	420	800	280	277	913	902	187	890	795
19	508	352	545	783	742	861	243	504	374	632	406	353	774	830	470	622
20	478	343	521	399	414	201	927	654	862	155	717	808	325	482	489	672
21	438	982	164	789	384	334	689	755	626	356	315	424	544	320	952	499
22	623	348	455	385	781	954	914	828	509	510	844	738	158	829	901	540
23	245	763	308	163	707	703	681	120	892	647	287	841	537	665	304	366
24	319	182	170	827	518	618	769	256	928	625	782	398	491	267	558	492
25	404	360	257	197	423	382	708	895	151	494	975	909	929	798	178	729
26	924	431	757	629	175	662	525	668	870	449	664	284	702	443	944	806
27	161	192	741	990	160	573	705	979	974	193	881	507	242	636	191	209
28	138	968	563	318	394	378	811	459	858	803	460	336	349	232	737	262
29	314	425	562	205	167	458	222	725	790	392	660	749	264	695	773	824
30	428	912	152	977	918	569	814	999	506	780	648	208	327	131	493	383
31	739	699	342	752	731	700	922	285	250	233	373	916	549	522	904	211
32	316	718	712	451	831	698	466	130	766	812	303	447	413	363	568	517
33	732	142	595	579	574	231	615	611	630	143	255	313	587	215	452	117
34	884	496	251	259	176	697	650	607	306	988	872	571	719	590	228	554
35	503	253	119	241	415	958	441	123	444	260	621	512	358	402	851	400
36	426	721	997	501	826	227	235	453	223	487	967	850	676	756	265	693
37	991	576	564	270	996	701	126	599	341	730	437	713	172	581	146	395
38	511	935	166	679	726	111	475	589	476	758	408	240	300	370	461	740
39	767	416	310	140	658	331	639	606	244	706	411	871	857	198	332	985
40	684	273	298	888	361	834	115	847	993	978	347	122	113	307	338	603
41	333	879	837	528	965	987	694	704	813	286	882	786	386	972	659	849
42	254	229	469	787	591	141	801	768	883	986	905	588	345	477	686	365
43	393	177	685	628	551	391	237	121	614	646	456	897	340	744	168	926
44	957	653	669	335	949	794	295	344	919	465	633	690	994	677	584	839
45	218	667	886	157	777	670	878	350	309	582	529	288	635	520	216	784
46	292	608	921	673	765	403	747	964	359	805	848	716	536	948	880	546
47	481	775	324	144	792	612	495	887	225	580	855	278	833	488	190	541
48	950	791	864	468	893	534	778	479	793	346	377	932	226	754	955	785
49	207	746	557	815	272	736	387	885	575	572	760	809	440	293	940	527
50	652	666	597	971	135	112	715	682	867	283	613	692	261	533	450	137

Appendix D



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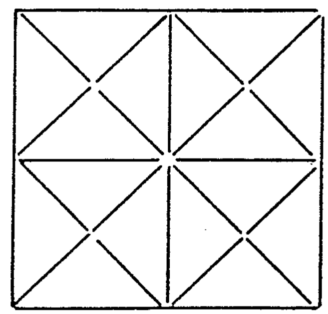

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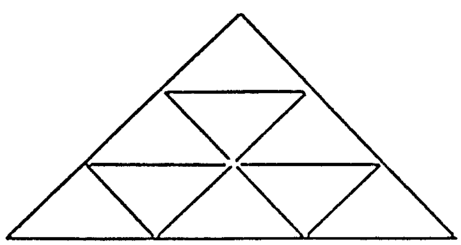

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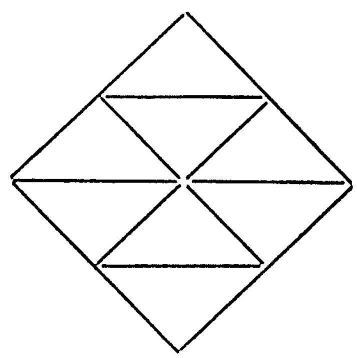


Soluble

Appendix E

Feedback Sheet

EXPERIMENT:
ENVIRONMENTAL ATTITUDES SCALE/OFFICE ENVIRONMENT

Earlier in the term you were requested to fill out an Environmental attitudes scale. Only the noise related items of this scale were actually scored. These items are part of a noise sensitivity scale. We needed to find noise sensitive and insensitive individuals to participate in our study of office noise (Office Environment). We, however, could not let individuals be aware that this study involved noise sensitivity as the effects of noise have been shown to be effected by the psychological set and expectation of the subject. Through the study we were trying to establish the effects and aftereffects of office noise on performance and frustration.

Noise sensitive and insensitive subjects were placed randomly into high (75 dB) and low (50 dB) office noise conditions. The subjects were then requested to perform a demanding search task (Accounting Ledger Job). After the search task, the subjects' tolerance for frustration was measured through the Perceptual task. Their mood states (Adjective Checklist) and general attitudes (Office and Job List) towards the experiment were also obtained.

Generally the research on the effects of noise on performance is inconsistent. It is hoped that noise sensitivity will be found to mediate this relationship. The addition of noise sensitivity would also add to the growing research on the frustration tolerance and mood states effects of noise.

Authors Notes

This paper was done to fulfil my Masters degree program.

I'd like to express by sincere thanks to my advisor, Dr. Stuart Kaye for all his help and encouragement he has given me throughout my entire program. To my committee of Dr. John McIntyre and Dr. John Welch, I'd like to express my appreciation for their efforts in giving me constructive comments and suggestions on my M.A. thesis.

Table 1

Octave Band Analysis of Office Noise

	Noise Level (dB)					
	Low			High		
Octave Filter Frequency (Hz)	LEQ	SEL	MAXSPL	LEQ	SEL	MAXSPL
WTG	52.7	77.5	65.5	75.1	99.9	89.1
31.5	51.4	76.2	58.0	46.3	71.1	54.5
63	45.9	70.7	58.0	57.0	81.8	69.3
125	47.5	72.3	53.4	59.0	83.8	77.4
250	41.9	66.7	47.5*	59.2	84.0	69.4
500	43.1	67.9	53.4	66.5	91.3	75.9
1000	42.7	67.5	57.1	65.3	90.1	80.0
2000	48.3	73.1	63.3	71.8	96.6	86.7
4000	43.3	68.1	56.0	66.9	91.7	79.8
8000	27.6	52.4	38.4	48.0	72.8	58.7
16000	-	-	- **	37.4	62.2	40.5*

* Changed from 50-100 dB to 30-80 range on acoustic analyzer
** Levels too low to measure

Table 2

Noise Level Range Across Tables

	Noise Level (dB)					
	Low			High		
Table	LEQ	SEL	MAXSPL	LEQ	SEL	MAXSPL
1	54.0	78.8	64.3	77.3	102.1	88.9
2	54.4	79.2	67.0	77.5	102.3	89.7
3	53.5	78.3	63.7	77.2	102.0	88.0
4	52.0	76.8	64.4	75.3	100.1	87.7
5	51.8	76.6	63.0	74.4	99.2	87.2
6	51.8	76.6	63.4	74.8	99.7	87.8
7	52.2	77.0	62.8	74.9	99.7	87.8
8	53.4	78.2	64.2	76.6	101.4	87.6
9	53.5	78.3	66.1	76.3	101.1	88.9
10	53.9	78.7	70.8	76.8	101.6	88.2

Table 3

Reverberation Time Estimates

	Time Estimates (Seconds)			
Octave Filter Frequency (Hz)	Sample #1	Sample #2	Sample #3	Average*
WTG	1.53	1.59	1.62	1.58
125	1.56	1.68	1.50	1.58
500	1.59	1.62	1.47	1.56
1000	1.77	1.98	1.56	1.77
2000	1.56	1.56	1.53	1.55
4000	1.47	1.56	1.47	1.53
			Overall =	1.59

Volume of room is $63.92m^3$.
*Solution is based on raw data.

Table 4

Principal Component Factor Analysis with a Varimax Rotation of the NSS

	Factor			
Question	1	2	3	4
Q2	0.081	0.021	0.566**	-0.041
Q5	0.148	0.472*	0.233	-0.036
Q9	-0.009	0.195	0.601**	-0.102
Q13	0.154	0.489*	0.012	0.489
Q16	0.205	0.190	0.184	-0.556**
Q20	0.734**	-0.089	0.057	-0.002
Q24	0.117	0.628**	0.414	-0.069
Q28	0.245	0.332	0.382	-0.405*
Q32	0.513**	0.360	0.051	0.051
Q35	0.613**	0.043	0.177	-0.049
Q38	0.076	0.728**	0.025	-0.076
Q41	0.368	0.560**	-0.054	-0.043
Q44	0.619**	0.245	-0.008	-0.249
Q47	0.472*	0.290	0.198	0.203
Q50	0.650**	0.195	0.055	0.124
Q52	0.165	0.038	0.601**	0.124
Q55	0.436*	0.390	0.268	-0.162
Q58	0.577**	0.209	0.125	-0.012
Q61	0.288	0.014	0.376	0.521**
Q64	0.520**	0.340	0.404	-0.161
% Variance Account for	26.99	7.08	5.78	5.57
Factor Labels	Concentration disturbance	mild noise	loud noise	disturbs activities

** Criterion for Loading = 0.50
* Criterion for Loading = 0.40

Table 5

Principal Component Factor Analysis with a Varimax Rotation of the ACL

	Factor			
Question	1	2	3	4
Q1	-0.118	0.845**	-0.157	0.033
Q2	-0.049	-0.057	0.800**	-0.154
Q3	0.755**	-0.309	0.067	0.174
Q4	0.180	0.065	-0.432	0.673**
Q5	0.157	-0.071	0.731**	-0.075
Q6	-0.044	0.899**	0.102	0.053
Q7	0.563	0.291	-0.248	0.442*
Q8	0.887**	-0.132	0.060	-0.029
Q9	-0.005	-0.205	0.338	-0.226
Q10	0.000	0.135	0.013	0.815**
Q11	0.730**	-0.178	-0.180	0.214
Q12	0.179	0.020	-0.071	0.872**
Q13	0.859**	-0.184	0.071	-0.020
Q14	-0.240	0.722**	-0.128	0.191
Q15	-0.112	0.023	0.834**	-0.123
Q16	-0.267	0.791**	-0.075	0.078
% Variance Account for	25.80	24.39	11.03	7.01
Factor Labels	Arousal	Fatigue	Well-being	Stress

** Criterion for Loading = 0.60
* Criterion for Loading = 0.40

Table 6

Subject's Perception of the Office Tasks and Office Environment Under High Noise

Question	Percentage of Responses		
	No	Don't Know	Yes
Jobs representative of office tasks?	30.0 (N=12)	40.0 (N=16)	30.0 (N=12)
Setting representative of office environment?	15.0 (N=6)	22.5 (N=9)	60.0 (N=24)

Note: Percentages may not total 100% as some subjects marked their answer sheets incorrectly.

Table 7

Subject's Perception of the Office Tasks and Office Environment Under Low Noise

Question	Percentage of Responses: No	Don't Know	Yes
Jobs representative of office tasks?	37.5 (N=15)	22.5 (N=9)	37.5 (N=15)
Setting representative of office environment?	15.0 (N=6)	20.0 (N=8)	65.0 (N=26)

Note: Percentages may not total 100% as some subjects marked their answer sheets incorrectly.

Table 8

Post Experimental Questionnaire (Question 1)

	Subjects(frequency)			
	Sensitive		Insensitive	
Purpose of Study	High	Low	High	Low
Distraction of noise	6	5	6	6
Mood changes	3	7	3	4
Differential performance on different tasks	2	1	3	2
Sex differences	–	2	–	–
Time pressure	3	3	5	3
Office environment effects	6	2	2	2
Don't know	–	–	1	3

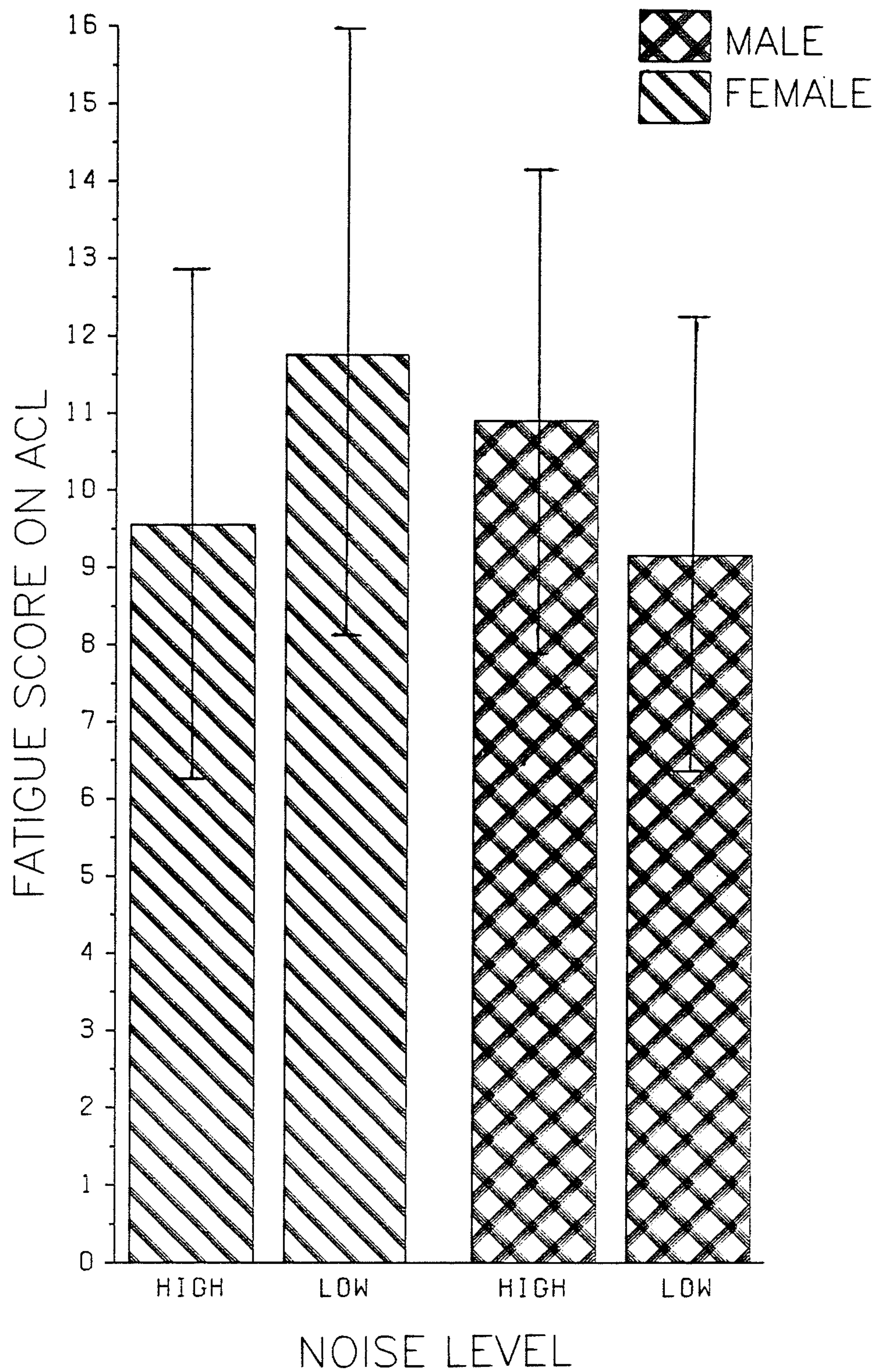
Table 9

Post Experimental Questionnaire (Question 2)

	Subjects(frequency)			
	Sensitive		Insensitive	
Expected Performance	High	Low	High	Low
Better without the distraction of noise	11	2	6	5
Mood changes	4	8	7	4
Differential performance on different tasks	1	1	1	3
Sex differences	–	2	–	–
Good Subject	2	5	1	4
Don't know	2	2	5	4

Figure Caption

Figure 1. The interaction effects of level and sex on fatigue as reflected on the Adjective Checklist after exposure to noise.



MALE
FEMALE
FATIGUE SCORE ON ACL
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
HIGH
LOW
HIGH
LOW
NOISE LEVEL