The effects of sound on reading comprehension in an office work environment
by Lone JM Romagosa-Thomsen

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Business Education
Montana State University

Abstract:
Purpose of Study: The purpose of this study was to determine how the type of sound in an office work environment affects reading comprehension and hence the productivity of the office. The study attempted to integrate music and noise research and to consider the possibility of interaction effects. A 3*2 Anova design was chosen to explore broad research questions about whether music, noise, or some combination of the two might affect reading comprehension.

Method: The population for this study was 287 clerical workers at Montana State University - Bozeman, listed as classified by the Personnel Office. The sample consisted of 130 individuals. Forty subjects received the Work Environment Questionnaire and 90 participated in the reading comprehension experiment. A random sampling technique was used in selecting the sample from a master list of all Montana State University Classified office workers. Three levels of music were used: none, low awareness, and high awareness. Office noise was either absent or at 60dB. The vehicle for the testing was the Standard Achievement Test (SAT I), issued in 1993 by the College Board, Princeton, New Jersey. Only the reading comprehension portion of this test was used.

Results: The study found significant differences among the subjects' reading comprehension scores based on whether no music, low awareness music or high awareness music was present in the experimental work environment. No differences were found in the subjects reading comprehension scores based on whether noise was present in the experimental work environment. Music and noise did not interact to produce significant differences in the reading comprehension scores of office workers tested in this experiment.

Conclusions: 1. Typical office noises do not affect the reading comprehension of office workers.

2. The presence of high awareness music affects the reading comprehension of office workers. Reading comprehension scores are lower during high awareness music than during low awareness music.

3. The ideal work environment would have complete silence; however, either background music, typical office noises or a combination of the two produce acceptable work performance, close to that of complete silence.

4. Interaction between music and typical office noises has no effect on the reading comprehension of the office worker.

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APPROVAL

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Lone J.M. Romagosa-Thomsen

This thesis has been read by each member of the graduate committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

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Conclusions:
1. Typical office noises do not affect the reading comprehension of office workers.
2. The presence of high awareness music affects the reading comprehension of office workers. Reading comprehension scores are lower during high awareness music than during low awareness music.
3. The ideal work environment would have complete silence; however, either background music, typical office noises or a combination of the two produce acceptable work performance, close to that of complete silence.
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CHAPTER 1

INTRODUCTION

All around us the world is filled with sound. Silence - which during previous centuries was the standard - is now a luxury. Indeed, what we now call silence, is commonly a low level of background noise. Says Tom Gauntt in his article "Background music swinging into office settings"[1]: " ...these environmental sounds are so omnipresent in the office that people even cease to notice them." The question, then, becomes: How does this constant level of sound affect the workers in the office?

Definition of Sound

For the purpose of research, sound is usually divided into two categories: Noise and Music. Music can be defined relatively objectively as sound having three elements: harmony, melody and rhythm. The definition of noise, however, is more a matter of perception. Alan Hedge[2] offers the following definition of noise: "Noise is 'unwanted sound'. Noisiness is the subjective impression of how annoying the

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[1] T. Gauntt. Background Music Swinging into Office Settings. The Business Journal, Portland, June 4, 1990, pp1&3.

[2] Hedge, Alan, Ecological ergonomics: the study of human work environments. Impact of Science on Society, Winter 1992.

sound is." The general consensus in noise research, is to consider any type of sound, not included in the definition of music, as noise.

Sources of Noise in the Office

In today's offices there are many sources of noise. Some of the more common are: typewriters, computers, printers, fax machines, photocopiers, phones, environmental services (such as air-conditioning and heating), and conversation. Outside traffic noise and noise from machinery elsewhere in the building are additional sources of office noise.

Music in the Office

Only recently has music made its way into the office environment[3] and only recently has its effect been studied. Many styles of music have been listened to in offices. Says T. Gauntt: " From white noise to Talking Heads, office music is [the] hottest new beat."[4] The music heard in offices is mostly supplied by radio or personal tape collections[5], but commercial producers of work music (such as Muzak Corp. of Seattle) are slowly making their way into offices. Although music has long been a staple in other business settings,

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[3] C.Lu, A Little Office Music. Inc., Sept 1990, v12 n9 p132.

[4] T. Gauntt Background music swinging into office settings. Portland Business Journal, June 4, 1990 p 1.

[5] C. Lu. op.cit.

owners and managers of offices must first be convinced that installing music in their facility warrants the cost.

Communication Affects Worker Motivation

Providing employees with interesting and challenging work is essential to each employee's motivation[6]. Supervisors need to communicate frequently with subordinates in order to discover their innate interests and abilities and to provide appropriate opportunities for achievement and recognition for each employee.

Communication Affects Productivity

In the office work environment communication is essential to the many activities performed by managers and workers alike. The functions of management are vital to the existence of an organization and these functions are carried out through communication.

During the initial stages of planning and organizing, communication with both fellow managers and with subordinates provides the information and feedback necessary to carry out these management functions and distribute the resulting plans and goals to all parties concerned.

The managerial function of staffing thrives on communication. Supervisors use communication to determine the

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[6] F. Herzberg in L. Bittel and J. Newstrom: What Every Supervisor Should Know, McGraw-Hill, 1990, p250.

best worker for a particular position and to introduce the worker to new work requirements. Without excellent communication, staffing becomes a problem area for organizations.

Activating and controlling are, however, the stages in which communication is absolutely essential. No work would get done in an organization unless the supervisor communicates the need to begin the work. Additionally, the supervisor needs to communicate the measures of control of both the plans and goals of the organization and the performance of the employees.

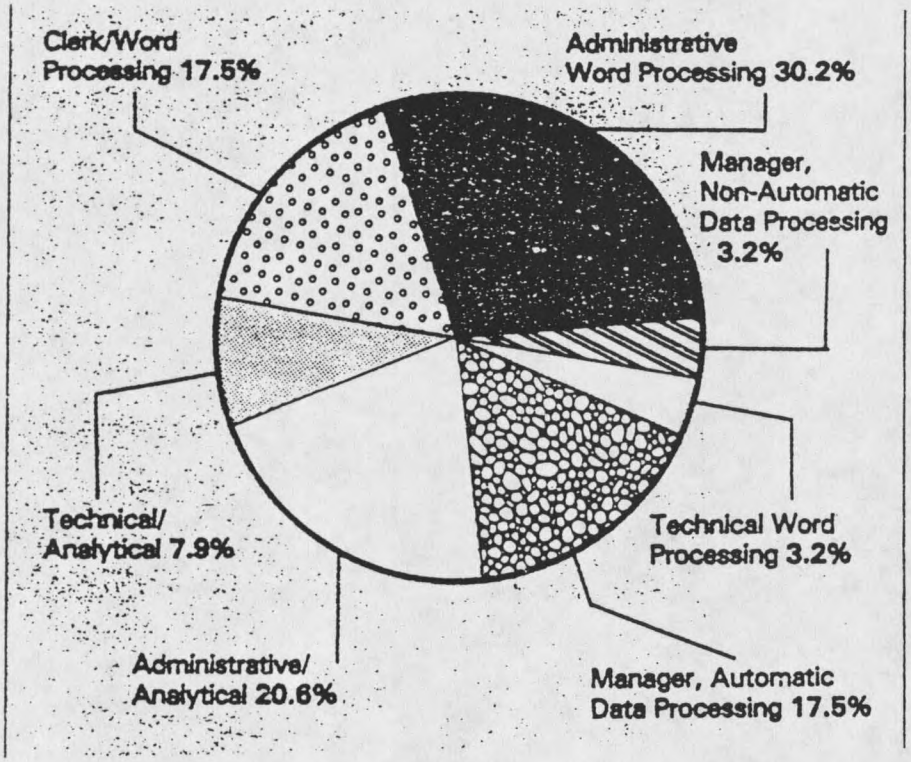
Reading Comprehension Affects Communication

Written communication is increasingly being used in interpersonal office communication. Most of the communication in offices, whether it be the president reading the annual report or the clerk reading the latest memo, involves a need to quickly and accurately interpret written information. Reading comprehension is also used when workers communicate with electronic equipment, as in data entry or network communication. With the increased use of electronic equipment in the office, written communication, and hence reading comprehension, has a greater impact on the productivity of

office work. Figure 1 below shows the use of technology in the office as of March 1990.[7]

Figure 1

Users of Technology



As this Figure shows, electronic technology is used by all levels of office workers.

Need for Study

Extensive research has been conducted on the effect of noise and music in factories (manual, repetitive work) and for

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[7] M. Monsalve, Maximizing New Technology. HR Magazine, March 1990 p85.

retail stores (the effect on both workers and shoppers). A pioneering British study[8] demonstrated an undeniable correlation between soothing music and worker productivity. Music has also been studied to determine its effect on such basic human traits as anxiety, stress and memory. Similarly, noise has been studied to determine the bodily effects to humans of exposure to noise. Early studies include the effect on blood circulation[9], and the effect on the pulse and respiration rate[10]. The results of these and similar studies have been used to improve everyday life, in such areas as determining safe noise levels for workers and in music therapy. While research on the effects of sound is abundant, specific research on the effect of noise and music in an office setting is relatively scarce.

Problem Statement

The purpose of this study is to determine how the type of sound in an office work environment affects reading comprehension and hence the productivity of the office.

Questions to Be Answered

1. To what extent is noise and music present in offices?

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[8] S. Wyatt and J.N. Langdon, Fatigue and Boredom in Repetive Work. His Majesty's Stationary Office, Report No.77, London, 1937.

[9] Dogiel, 1880.

[10] Binet and Courtier, 1895.

2. Does reading comprehension change if music is present in the office?
3. Does reading comprehension change with different types of music?
4. Does reading comprehension change if noise is present in the office?
5. Does the interaction of music and noise in the office environment change reading comprehension?

Limitations

This study is limited to clerical classified employees at Montana State University - Bozeman. The testing of these subjects was limited to determining reading comprehension scores during artificial sound conditions in an experimental testing office.

Summary

Silence is becoming rare, and two types of sound, noise and music, fill our ears. Sound affects communication, to either encourage conversation or to hinder it and communication is essential to the functions of an office. Reading comprehension is an integral component of office communication.

CHAPTER 2

RELATED LITERATURE

Much research has been done on the effects of sound in the office work environment. Most of this research has been devoted to the effects of noise, although some studies have attempted to measure the effects of music. The effect of noise on worker productivity is of concern to most businesses and even government agencies and professional associations (such as AIA (the American Institute of Architects)[11] and ASCAP (American Society of Composers, Authors, and Publishers)[12]) have shown interest in this area. The use of music to increase productivity is an issue that has excited tempers and promoted discussion for many years all around the world:

> "We denounce unanimously the intolerable infringement of individual freedom and the right of everyone to silence, because of the abusive use, in private and public places, of recorded or broadcast music. We ask the Executive Committee of the International Music Council to initiate a study from all angles - medical, scientific and judirical - without overlooking its artistical and educational aspects, and with a view to proposing to UNESCO, and to the proper authorities everywhere, measures calculated to put an end to this abuse."[13]

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[11] Architectural Record, August 1994.

[12] J. Bessman, The Music in The Malls. ASCAP in Action, Fall 1989, p27-28.

[13] R.M. Schafer, The Tuning of the World, Alfred Knopf, N.Y. 1977.

This resolution was passed unanimously by the General Assembly of the International Music Council of UNESCO, in Paris, October, 1969. For the first time in history an international organization involved primarily with the production of sound turned its attention to the reduction of sound[14]. This introduced an era full of discussion not only of the actual effects of noise and music, but also of the ethics of sound in our society. Generally, these discussions are beyond the scope of this paper, however, in some instances these discussions are used here to explain and support a point.

Five Categories of Reports on Music and Noise

Reports on the influence of music and noise can be divided into five main categories:

a) Popular articles, written in general terms and appearing in widely read magazines such as Time, Business Week, Newsweek or Reader's Digest.

b) Reports based on questionnaires and interviews.

c) Reports by governmental agencies and professional associations.

d) Promotional literature from commercial distributors of environmental music.

e) Scientific reports as the result of experimental investigations.

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[14] R.M. Schafer. op. cit. p98

Material from all of these five categories have been used in the present research study.

The Concept of Arousal

One effect of moderate levels of sound, whether that be noise or music, is arousal. In this context arousal refers to "the dimension of general alertness or activation"[15], defined in terms of nervous system activity. It is generally accepted among psychologists that there is an optimal level of arousal for performing certain activities. Above or below this optimal level, performance suffers, because the individual is over- or under aroused. Landy[16] has described the relationship between arousal and performance, showing that different tasks have differing optimal levels. The optimal level for a low-input task and for a high-input task differ in that a high-input task requires a higher level of arousal.

In the former Soviet Union, this research was translated into law. The provisions of law SNiP 785-69, stated the maximum permissible noise levels in offices:

> Offices with machinery.....60 dB
> Offices where thinking work demanding high levels of concentration occurs.....50 dB[17]

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[15] F. Landy. op. cit. pp543-545.

[16] ibid. p535.

[17] U.S. Environmental Protection Agency: An Assessment of Noise Concerns in other Nations, 1971, p.17.

The optimal level of background sound in the United States is considered between 45 and 55 decibels and although this is not mandated by law, it is common practice. If, however, the workers in a particular office are doing a variety of jobs, some involving low input (i.e. manual, repetitive tasks), while others are doing high-input (complex, mental) tasks it seems likely that at any given time some will be under- and some over aroused. This concept of arousal is integral to the effect of both noise and music in the office work environment.

The Effects of Noise

What is Noise?

To determine the effects of noise, we must first look at the types of sounds that are considered noise. While sound in general is easily definable in terms of decibel and frequency, the concept of noise is somewhat more elusive. Landy mentions that "noise is often thought to be an unwanted or an annoying sound, but this means that *noise* must be more *subjective* than *sound.*" (Italics by Landy)[18]. That this is true is further shown by Boyce, by Kraemer, Sievert & Partners and by Nemecek & Grandjean[19], who all failed to find a correlation between the

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[18] F.J. Landy. Psychology of Work Behavior. The Dorsey Press, 1985, pp521-522.

[19] As reported in E. Sundstrom, Workplaces: The Phychology of the Physical Environment in Offices and Factories. Cambridge University Press, 1986, pp132-133.

loudness of sound in offices and the disturbance by noise among employees. But as Leffingwell wrote in 1925:

> "Disturbance or irritation may arise from the peculiar nature of the sound, such as the rasping, grinding, screeching sound of the friction of metal on metal, as...from an unoiled bearing; or it may be disturbing because of its repetition, or because of echoes or reverberation."[20]

In spite of the subjective origin of the concept of noise that this definition suggests, it has been shown - objectively - that noise creates certain reactions in workers. It is the intensity of noise necessary to produce a particular response, that will change from one person to another.

Sources of Noise in the Office

In today's offices there are many sources of noise. Some of the more common are: typewriters, computers, printers, fax machines, photocopiers, phones, environmental services (e.g. airconditioning and heating), and conversation. Traffic noise from the outside and noise from machinery elsewhere in the building are other sources of office noise.

Low Intensity Noise

Most offices have a certain amount of continuous, low intensity background noise. Low levels of background noise do

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[20] W.H. Leffingwell. Office Management: Principles and Practice. McGraw-Hill, 1925.

not seem to have detrimental effects on communication, in fact Sundstrom[21] states that

> "in offices a certain amount of interference with speech is desirable, both to mask distracting sounds and to keep conversations from being heard."

Experts in office acoustics typically recommend background sounds of about 45-55 decibels[22]. In the first "open office" in the United States at DuPont's offices in Wilmington, Delaware, 40 decibels were considered too quiet. People could understand each other from far away, and it became common for workers to hush their voices. The solution was to add more sound by installing electronic sound makers[23]. The problem of speech privacy concerns the intelligibility of the sound. Intelligible speech occurs in the 2000-4000 Hertz range (the full speech range is 100-8000 Hertz) although women have voices one octave higher than men[24]. To overcome the sound problem, a sound masking system (white noise) can be installed, as was the case in DuPont's offices.

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[21] E. Sundstrom. op.cit., p283.

[22] R.A. Hansen. Unintelligibility, not audibility, determines acoustical privacy in an open plan. British Journal of Psychology, 1974 pp42-47.

[23] E. Sundstrom. op. cit.,p313.

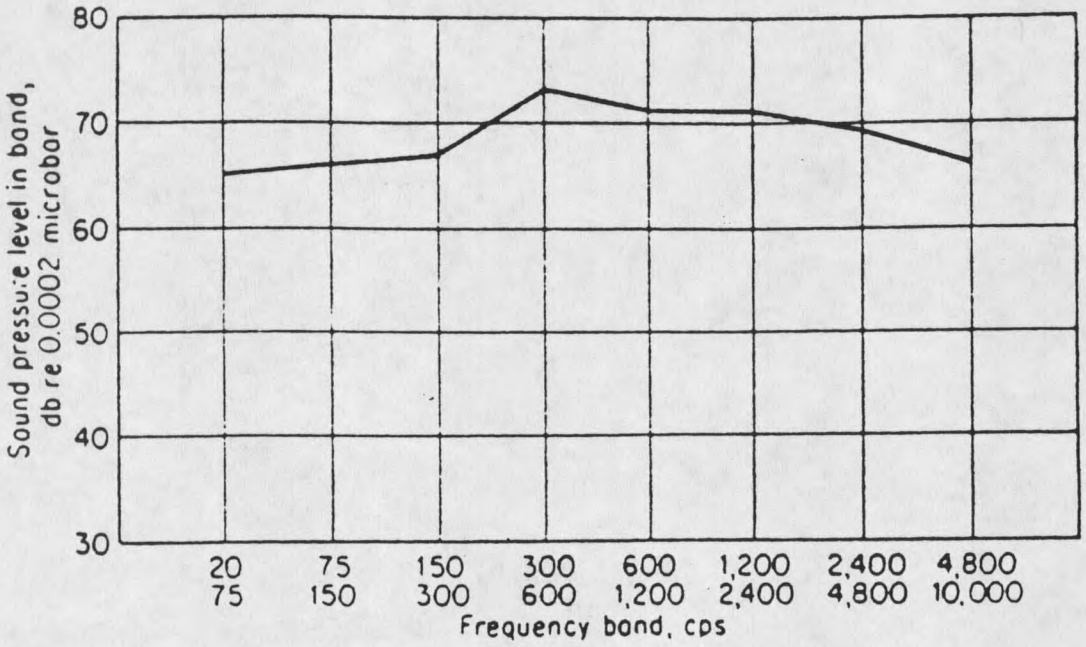
[24] A. Hedge, Ecological Ergonomics: the study of human work environments. Impact of Science on Society, Winter 1992, p62.

Moderate Intensity Noise.

Moderate intensity noise (about 50-80 dB) includes the sounds of a typical office. Although the background noise at an average office is 50 decibels, office equipment may create higher decibel levels when in use. Figures 2 - 4 illustrate examples of office machine noise, listed in decibels and frequencies[25].

Figure 2

Noise levels measured 6-10 feet from printer



[25] L.N. Miller, Case Histories of Noise Control in Office Buildings, in Noise Reduction, L.L. Beranek,Ed., McGraw-Hill, 1980, pp614-615.