PHYSIOLOGICAL CHANGES IN AGE WHICH AFFECT ADULT LEARNING PERFORMANCE

by

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EDUCATION

We accept this thesis as conforming to the required standard

The University of British Columbia

April, 1968
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Date  April, 1968
ABSTRACT

The purpose of this thesis was to review research on the developmental physiological processes of aging which have significance for adult learning. Attention was directed, specifically, to the progressive, age-related changes most immediately associated with the skills of communication: vision, audition, speech, reaction and movement times to visual and auditory stimuli, perception, retention, and performance facility. Affective reaction to physiological aging was also considered.

In recognition of the interdisciplinary nature of the relationship of aging to learning, research from diverse areas was examined. Psychological inferences, in some instances, predominate since the study is concerned not with aging but with learning concomitant with the aging processes. References of recent date were normally consulted.

Investigations have revealed no "typical adult" nor even a typical or an average progression in any aspect of physiological development; therefore, an individualized response to any adult learning situation can be expected. The evidence with the greatest impact for the education of adults lies in the areas of previous
learning, recency of learning, and habits of learning. There are educational needs not now met by adult education; not the least of these is the need for understanding the processes involved in physiological aging. It is well categorized that older people can learn and under certain conditions do learn, but adults being different learners require a different social, educational, and physical environment in which to learn. The facilities at present provided for child-youth education and "adapted" for adults present some frustrating physical limitations for adult learners. Adults have distinctive needs for learning. Where these needs have been catered to, the measure of success has been high, the failure rate low. There is an awareness of the fallacy of setting arbitrary limits to successful achievement based solely on chronological divisions.
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The assistance of Miss Brenda Schaffer in the typing of the Tables and in the arranging of the Bibliography is sincerely appreciated.
DEDICATION

I dedicate this thesis to my husband

ARNE-KJELL LUND

and to my children

ARNE-KJELL MACLEOD LUND

and

BERGLIOT MACLEOD LUND
CHAPTER I

INTRODUCTION

Something supposedly happens with age which does separate adult education from child-youth education.

- Robert Boyd - (48:160)

Hobart Burns (61:59) forewarns that by 1970, approximately one half of the potential market for adult education will be aged 45 or older. Havighurst (138) observes that adults must adapt to changing social roles and that, to date, education has yet to discover its mission for people in their 50's. Montagu (229) emphasizes educability as man's most important species trait, and Lindeman (203:48) urges the need for continuing education in order to learn awareness of ourselves as behaving organisms. Kuhlen (188) regrets the limited extent of studies related to adjustment in old age, but stresses the importance of age identification at critical periods throughout life, and positive self images. Coleman (76) advises that the success of adjudjutive behaviour is measured by how well the individual satisfies his various needs within the context of his particular physical and socio-cultural fields. Samuel Hand (133:27) concludes his paper with an appeal to adult educators to "become concerned with the job of finding ways and means of helping adults reach that stage referred to as
old age in a more satisfactory state of adjustment", and Russell
Smith (61) insists that we examine people's lives and our programs
so that our programming is deeply relevant to their various careers
and needs instead of a "crash therapy of hobbies and crafts for idle
widows. The individual's need to adjust to a constantly changing environ­
ment and the educator's role in facilitating the adjustment process are
the prime concerns of this paper.

Purpose

The purpose of this thesis is to review research on the deve­
lopment physiological processes of aging which have significance for
adult learning.

Limitations

Let it be stated at the outset that this project is not concerned
with geriatrics. It is the changing nature of the learning performance
of the individual as he ages which will remain in focus rather than the
aging processes per se. So, although histological anomalies, or the
effects of endocrine atrophy on regulatory mechanisms, or even the
highly specialized intricacies of cerebral metabolism are all freely
acceded to be vitally relevant to the overall picture, still they are ex­
cluded in this instance, except for the purpose of reference, as belonging
rightly to a more scientific treatise than this.
An acknowledgment of the effectiveness of group processes for integrating learning with experience directs attention to a particular consideration of the progressive changes with age that most immediately relate to the skills of communication. The discussion is further limited, then, to an examination of age-related changes in vision, hearing, verbal abilities, and speech. Included will be the conjunctive functions of memory and reaction time.

In every instance, adult learning is the subject being pursued; aging performance is under scrutiny only insofar as it relates to learning; and interest converges on the individual rather than on the norm. Even advanced age is not to be construed as senescence, and in all instances where decline in performance is registered, conclusions must await the possibility of distinguishing between the physiological and pathological processes of aging.

Luckiesh (211:280) has remarked that, from an overall viewpoint, the progress of civilization is largely due to mind aided by the senses, therefore malfunction of any sense or cognitive organ will certainly necessitate adjustments to the expectations of learning performance. If the malfunction is a natural and irrevocably phenomenon of the passing of time, then acceptance and resignation to the limitations are in order. If, however, the malfunction is caused by disease, then reversal is conceivable. A sampling of opinions on this point to date indicates that arteriosclerosis is so frequently, and often so subtly,
intertwined with the aging process that it is doubtful if it can be successfully excluded without the exercise of the most stringent criteria for its detection and rejection. It is submitted, in this connection, that there is little evidence to indicate that adequately rigorous measures to exclude less than clinically obvious disease were employed in early measurement scales, an observation which gives rise to some speculation as to whether some of the existent deflating measurements of the expected capabilities of adults may not prove to be due for review, modification, or even discard. In referring, then, to "normal" aging, as so many researchers are wont to do, it is not unseemly to admit to the same degree of embarrassment as the experts themselves, and to lean with increasing confidence on the statement of Clevenger, made in 1885, with respect to physiological inquiry: (71) "Knowledge being relative, who shall fix the boundaries of the ultimate?"

Definition of Terms

Learning is defined as a process which results in a change of behaviour in the individual which is more or less permanent. Formal education presumes the capability of receiving instruction so that any interference with the reception of instruction is a legitimate area of investigation for those interested in adult learning. The effects of aging often do create distortions in the individual's perception of his environment, but a definition of the phenomenon itself can be elusive.
Birren (17:13) makes a distinction between development and aging by referring to the former as a growth or change at characteristic rates toward some limits in size, form, and function with the final state or limit representing a relatively steady state, whereas the latter is defined as beginning at the point in time when the forces of growth of the organism have arrived at a relatively steady state. It is emphasized, however, that aging is not simply "negative growth", and that even within the context of the above definitions, aging can still be considered developmental in nature, and it is so considered throughout this paper.

**Rationale**

Whatever the aetiology of human aging, it is a universal biological phenomenon which allies itself with time to produce change. The manner in which the individual reacts to change, whether voluntarily or involuntarily, forms the basis of much of the research in the field of education.

In the case of infants, children, and adolescents, the rhythm of change has been minutely documented; when maturity is reached, the beat grows faint. With the growth of the relatively new science of gerontology comes an awareness that there is an urgency for charting chronological periods in the developmental stages of later maturity at least equal to that which was evidenced previously only in studies of youth.
Birren (17:13) reminds us that aging can be considered developmental in the same sense as growth, and that the aging adult, in comparison with the aging child, frequently has even more adjustments to make—adjustments involving critical physiological, psychological, and social changes. Moreover, these adjustments must be made at closer intervals. In addition, where the child learns in an atmosphere which is, for the most part, sympathetic and nurturant, the adult faces an environment which can range from resentful to indifferent.

Wigdor (351:549) makes the following observation:

Young people are hostile to the aged due to their own unconscious fears about aging and death, and this results in either over protection or outright rejection, both of which tend to be humiliating.

Havighurst (138), Erikson (106), and Maslow (225) have all pictured the aging processes as developmental. They have classified the various stages into groups of tasks, conflicts, hierarchical motivations, and such, and they have stressed that each stage demands the mastery of specific attitudes and skills. The situation is neatly paraphrased by Havighurst: (138:1) "The human individual learns his way through life."

Ideally, then, education is a concomitant of aging. The adult may, or may not, be a better learner than the child; he is undoubtedly a different learner. The ramifications of this difference; to what extent the characteristic pattern of life changes affect the normal adult's learning achievement; and to what extent can knowledgable
adaptations of educational processes be continuously effected; all of these vital concerns of adult education are under the close scrutiny of those involved in the continuing education of the maturing individual.

A common belief exists, according to Murrell (233), that men over 40 do not train well, and this, he claims, may in fact turn out to be simply that the training techniques for the over-40 groups are in need of revision. In discussing the relationship between skill and age, Welford notes: (342:287)

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..... where age changes do impinge upon performance, some relatively trivial factor may oftener be limiting what can be done, so that comparatively small changes in the task could bring it within the capacities of older people.
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It may be that, in the future, the emphasis will be less on what adults can do and more on what they have done; not on their limitations but on their fulfillments. If the processes of aging are studied in a significant way so that reflection and concern can focus on possible adaptations of educational processes to suit the requirements of a different learner, then adult education will be establishing an identity of its own instead of borrowing a make-do image from the grade school.

Review of Literature

The first study done by a geneticist was that of Sir Hugh Francis Galton, who in 1884 collected data on the physical characteristics of more than 7,000 individuals from early childhood to late
maturity. Galton's ponderous wealth of data was never analysed by him, but in 1920, Henry Ruger, an American psychologist, sampled the data and reported several highly significant relationships.

Thorndike and his protege, Lorge, are frequently quoted on the development of adult learning ability and the relevant factors of power and speed. Dr. E. V. Cowdry, himself a distinguished worker in the field of gerontology, refers to Dr. V. Korenchevsky as "the father of gerontology." (185) His career began in Russia and flourished in Britain where he established the Oxford Gerontological Unit, later to be known as one of the renowned research centers of the world subsidized by funds from the Nuffield Foundation.

Matthew Luckiesh has been a contributor to journals dedicated to improving visual performance. Weale's *The Aging Eye* provided considerable support for the section of this paper on visual acuity. The numerous volumes and papers of Nathan Shock and those of A. T. Welford have presented a wealth of material in this area of investigation and are very frequently quoted by their colleagues. Birren's volume of collected studies, *Handbook of Aging and the Individual*, served as a highly dependable resource book, while his later volume, *Human Aging*, presented an overview of research revealing the tendency to try to dichotomize natural aging and disease. Samuel Hand's paper correlated a review of research on age-related physiological and psychological changes with inherent implications for
those involved with the teaching of adults. Sundry papers and volumes edited by Wilma T. Donahue, particularly the volume, *Education For Later Maturity*, have provided direction at various points for many researchers in the field of adult education, and the series of publications by the Adult Education Association of the U. S. A. under the title of *Adult Education, Theory and Method*, particularly the one entitled, "A Conceptual Scheme For The Identification and Classification of Processes", by Coolie Verner, has provided guidance of a very specific nature during the ubiquitous moments of uncertainty and confusion. Finally, the *Adult Education Journal* supplied many recent references and articles of note of which the one by Zahn comparing the learning situation of adults with youth was found to be extremely relevant. A recent volume by Bromley, *The Psychology of Human Aging*, presents a comprehensive chapter on the physiology of aging and some of the biological theories of aging. *The Journal of Gerontology*, selected volumes and numbers from the years 1958 to 1967, supplied many reports of experiments on learning conducted to determine the educability of the aging and the aged. In many instances, papers by the same research teams but based on later data were found to strengthen, and in some cases refute, earlier findings with respect to learning.

Studies of the relationship of age and the capabilities of adults to learn have employed both the cross-sectional and the longitudinal
methods of investigation. Where the more commonly employed cross-sectional studies have tended to reveal that, after the young years, intelligence and abilities slowly deteriorate, the longitudinal studies have more recently provided evidence that, with respect to some aspects of intellectual functioning, there may be no age decline far into later life. (132:357) There is more than a hint of petulance in the current research arising from a sensed inadequacy of the prevailing cross-sectional type of measurement. Many feel that the ultimate answers to the rate of individual maturation can only come through longitudinal measurement; and the unfortunate aspect of this situation is that the researchers sometimes expire before the subjects have fully reported. With the problems of the researchers, however, we are not concerned. The task at hand presents its own problem which is to concentrate on the manner in which progressive physiological changes in specific instances relate to adult learning.

Plan of the Thesis

The introductory chapter will deal with a general awareness of the relationship of education to the maturing individual; it will recognize aging as maturation, not as reversal of growth. No attempt is contemplated to mask a personal bias that age has no significant effect on the quality of learning. At the same time, performance changes in aging must be recognized and, if possible, understood so
that adjustments, when indicated, can be made. Subsequent chapters will deal with some of the specific educational problems arising from the metamorphic processes of aging. The final chapter will deal with a summary of the general and specific recommendations relating to instructional processes which might help to circumnavigate some of the difficulties frequently encountered by adults in a continuous learning situation. In each chapter, the common changes as the result of normal maturation will be examined in terms of performance. A reprise of the theme expressed by Ashley Montagu (229) can be expected throughout: in emphasizing educability as man's most important species trait, he signifies education as the principal means through which the realization of man's evolutionary destiny can be achieved.
CHAPTER II

ADULT VISION

...as the evening twilight fades away,

The sky is filled with stars, invisible by day.

- Longfellow -

Vision is our most important educative and educated sense. It far outranks our other senses in usefulness and is estimated to be responsible for 75 to 90 per cent of the usefulness of most civilized adults. (211:280) Vision is referred to by Broadbent (53:2) as the most highly developed sense and, therefore, the most likely to yield information. Communication depends, perhaps first and foremost, on the reception of natural environmental information and prepared information in the form of printed or imprinted material. Data received by vision can be related to previously stored material through learning, and it can be reproduced and shared with others. The older person, for various reasons, is less closely attuned to his environment than is the younger person; he is, similarly, less able to respond to environmental stimuli with the same degree of immediacy. The concern of education, in this instance, is with the effects of faulty or incomplete reception of visual information, and with the steps which might be taken to reduce, or perhaps to eliminate, resultant handicaps to learning. To this end, the discussion will center on the aging visual
mechanism and its performance under physiological change, and in
relation to a changing environment.

Pertinence to Learning

Friedenwald (112:258) affirms that the life span of the eye
as a functioning organ exceeds life expectancy. Yet, he points out
that even disregarding senile alterations or pathologic degenerations,
there is a steady decrease of the average efficiency of visual func­
tions with advancing age, even in otherwise healthy eyes. Where
clarity of sight can be measured by the length of the arm, no further
measurements are required to confound the issue. But the issue
itself presents a challenge to adult education when it is estimated
that up to 85 per cent of learning occurs through the eye, and when
it is at the same time reported that from the age of 40, there is a
startling increase in the percentage of the population with defective
vision. The percentages of defective eyesight, in relation to age,
given at ten-year intervals according to Luckiesh (210:118) are shown
in Table I. It is a common observation that vision deteriorates with
age, but vision is a comprehensive term. There are, perhaps, a
dozen sorts of visual performance which differ one from the other
mainly as they refer to the kinds of visual tasks involved. All of them,
however, are based upon the remarkable skill the eye has in judging
differences in light intensity, contrast, and image direction. (124:101)
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* This Table is based on Seeing and Human Welfare, M. Luckiesh, William and Wilkins Company, Baltimore, Maryland, 1935. p. 118.
Structural Changes

With aging, the skin of the eyelids becomes thin and wrinkled and the eye itself appears sunken in its socket as a result of loss of orbital fat. The eyelids reflect the lessened support caused by poorer muscle tone, and the conjunctiva becomes thin and increasingly more sensitive to irritants. Throughout life, the lens continues to grow by depositing new fibres inside the capsule and compressing older fibres towards the centre, resulting not only in a thickening or increased density of the lens, but in a "yellowing" of the substance as well. (266) The lens becomes less able to change focus as senile changes in the ciliary muscles which control the shape of the lens lose vitality. The iris fades and the cornea thickens, loses its lustre, and becomes less transparent. Loss of muscle tonus together with age-changes in the nervous system probably play a part in altering the diameter of the pupil which controls the amount of light entering the eye, and age changes in the retina may bring about atrophy of the nerve cells and poorer blood supply. Convergence of the lines of sight from both eyes is less efficient in later life which has a direct influence on near vision. Finally, degenerative changes in the eye accumulate with age, and diseases increase in frequency. (55:48-49)

A review of structural change would hardly be complete without a passing reference to cataract, which although excluded from the discussion on medical grounds, must still be admitted temporarily
as its presence or absence relates to education. It must be of more than clinical interest to the adult educator to consider that cataract is observed to some extent in 65 per cent of "normal" individuals between 51 and 60 years of age, and that this percentage increases to 96 per cent above the age of 60. (332:68) The cumulative effect of these time-wrought changes determine the nature and the quality of adult visual performance.

**Visual Acuity**

The ability to see clearly, the ability of the eye to adapt itself to the tasks put to it, to resolve minute image details is referred to in a general sense as visual acuity; but, according to Gregg and Heath (124:100) there is no term in vision so widely known yet so misused and little understood:

The visual mechanism has no 'visual acuity sense' as such. It can accurately distinguish differences in intensity of stimuli. This is its light sense. It can distinguish differences in wave-length. This is its color sense. Visual acuity must be based on these senses, for there are no others. Perception of form, direction, and clearness are related directly to these two.

Acuity is popularly defined as a sharpness of vision--actually, a threshold measurement--but this is limiting since it refers only to the type measured by the familiar Snellen chart and referred to as "20/20" vision. There are many different types of acuity, all of which
depend upon an ability to distinguish about 600 steps in brightness from black to white: e.g. minimum visible acuity, discriminable acuity, legible acuity, etc. The relatively new concept of "dynamic visual acuity" is the ability of the eye to follow and hold accurate fixation on a moving object. There is not a high correlation between static and dynamic visual acuity. A person with 20/20 static acuity, for example, may show very poor ability to resolve a moving target. Certain kinds of human performance may rely on dynamic visual acuity as in sports which require rapid judgement of the speed and distance of moving objects.

Ruger's curve of visual acuity shows a rise from 10 to 20 years of age followed by a steady decline to age 40 to 45, whereupon there is a slight rise usually attributable to a correction for presbyopia, and then a steady decline which can be seen to level off at the 55 to 60 mark. (273) But here, again, the measurement is one of static visual acuity.

The Snellen chart which measures the visual acuity of thousands of people every day in schools, industry, and for driving licenses measures a sort of all-around, clear-seeing ability of the static vision type, but it may be a far cry from measuring "perfect vision" which encompasses many kinds of visual performance such as those that might be expected to crop up in a highly computerized environment. The Snellen chart is limited, also, in that it fails to
indicate the amount of effort or nervous energy expended in order to perform at 20/20 vision, nor does it measure the headaches, the fatigue factor, or the eyestrain of the subjects it records as 20/20. Visual acuity, then, is hardly a suitable term to cover the action of seeing. The decrement with age in vision must be considered in the broader sense of actual performance.

Visual Performance Based on Physiological Changes

The symptoms of aging can be seen more clearly in the eye than in any of the other sense organs, and the most obvious sign of age is the deterioration of the power of accommodation. Since this can be measured quantitively in diopters, it was one of the earliest classical gerontological studies. A diopter is a standard measure of the amplitude of accommodation. It represents the degree of convexity of lens which it would be necessary to place before the eye to take the place of accommodation for the near point. Accommodation is the power of altering the focus of the eye so that divergent rays (those coming from an object nearer than 20 feet) are brought together on the retina; this is accomplished by means of an increase in the convexity of the lens and thus in its refractive power. (246:356ff.) The range of accommodation is the distance between the farthest point of distinct vision and the nearest point of distinct vision when the eye is employing its maximum amount of accommodation. The
power of accommodation gradually diminishes and the near point recedes as age advances, owing to functional changes in the adaptive mechanism of the eye about which there remains some scientific uncertainty relating to the function of the ciliary muscle, lens, lens capsule, choroid, and also on the nature and origin of the stimulus. At any rate, early in life, the accommodative mechanism begins to lose its focusing power. At about the age of 10 years, it could produce 12 to 16 diopters of focusing power, but from that time on, it begins to lessen slowly but progressively until it reaches essentially zero. This is illustrated in Table II reproduced from May's Diseases of the Eye. (246) It is important to note that where the near point recedes about 1 inch from age 25 to 30, at age 40, it has receded 9 inches, and at age 50, 16 inches. This is the age, allowing for individual differences, referred to as the "age of complaint" or the onset of presbyopia, after which accommodation correction in the form of reading glasses becomes requisite.

Presbyopia (from the Greek presbys meaning old and ops meaning eye) has no effect on distant vision. The correction is simple requiring only a convex-shaped artificial lens to take over at instances when the natural lens fails to assume the required shape for seeing clearly at close range. The attitude to loss of accommodation is of greater significance than the loss itself, as there is an emotional block to recognizing physical limitations so closely allied
TABLE II

CHANGE IN AMPLITUDE OF ACCOMMODATION DURING AGING *

<table>
<thead>
<tr>
<th>Age</th>
<th>Amp. of Acc. in Diopters</th>
<th>Near Point in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>14.0</td>
<td>2.8</td>
</tr>
<tr>
<td>15</td>
<td>12.0</td>
<td>3.3</td>
</tr>
<tr>
<td>20</td>
<td>10.0</td>
<td>4.0</td>
</tr>
<tr>
<td>25</td>
<td>8.5</td>
<td>4.7</td>
</tr>
<tr>
<td>30</td>
<td>7.0</td>
<td>5.6</td>
</tr>
<tr>
<td>35</td>
<td>5.5</td>
<td>7.0</td>
</tr>
<tr>
<td>40</td>
<td>4.5</td>
<td>9.0</td>
</tr>
<tr>
<td>45</td>
<td>3.5</td>
<td>11.</td>
</tr>
<tr>
<td>50</td>
<td>2.5</td>
<td>16.</td>
</tr>
<tr>
<td>55</td>
<td>1.75</td>
<td>22.</td>
</tr>
<tr>
<td>60</td>
<td>1.0</td>
<td>40.</td>
</tr>
<tr>
<td>65</td>
<td>0.75</td>
<td>53.</td>
</tr>
<tr>
<td>70</td>
<td>0.25</td>
<td>160.</td>
</tr>
<tr>
<td>75</td>
<td>0.0</td>
<td>-</td>
</tr>
</tbody>
</table>

* This Table is from May's Diseases of the Eye, p. 361.
to chronological age.

According to Weale (332:111) presbyopia occurs in warm countries such as Egypt, Greece, and Cuba at about 40 years of age, whereas in the colder countries of Norway and Sweden, its onset is delayed until 48 years, or even later. Women develop presbyopia from 3 to 5 years earlier than men.

Luckiesh (210:105) notes:

We are born far-sighted and, if we live to an old age without the eyes suffering too much and too permanently the penalties of civilization, we die farsighted. Between these limits is an era of near-sightedness, often imposed by civilization's tasks. . . . Much of this is preventable by improving conditions of seeing.

Whether or not the onset of presbyopia can be advanced or delayed by environmental factors as suggested by Luckiesh and others, Duane's chart, Figure 1, leaves no doubt that the deterioration or change in the accommodation of the eye shows a definite age trend.

Deterioration of the ability of the eye to accommodate is age-related as is the speed with which accommodation and its relaxation occur. (332:120-21) The rates at which three age levels reach maximum accommodation and subsequent relaxation are illustrated by Allen (1:203) in Figure 2, page 23. In this diagram, the power of accommodation for the 7 to 10-year-old group is sudden and reaches a high level of adaptation within two to three seconds; relaxation was completed in under two seconds. In the second group,
FIGURE 1

DUANE'S CHART OF ACCOMMODATION

ACCORDING TO AGE *

FIGURE 2

ACCOMMODATION AND RELAXATION SPEEDS

ACCORDING TO AGE*

* This Figure is reproduced from M. J. Allen, "The Influence of Age on the Speed of Accommodation", American Journal of Optometry, 33:205, 1956.
those 21 to 25 years, the accommodation mechanism responds almost as quickly as in the young group, but it is faster in reaching the maximum level and can be seen to level off into a plateau at approximately 8 diopters. This follows the pattern for the age level as given by May in Table II, page 20. There is only a slight change in speed of relaxation. In the third group, those 40 years and older, the plateau is reached earlier, whereas the relaxation time takes almost three seconds to complete. McFarland and O'Doherty (216:471) have recommended that airline pilots should no longer be qualified for jets after age 55, although the experience and judgement of older pilots would be of benefit for consultative value.

Since it is well established that sensory and perceptual processes tend to deteriorate with age, one might also expect a similar decline in vigilance performance. The ability to maintain a state of vigilance has received increased attention since older people frequently complain of difficulty in maintaining focused attention.

Elliott (105) proposes that the capacity to attend or concentrate involves two physiological mechanisms:

1. Focus on a chosen object or idea.

2. Exclusion of irrelevant ideas and distracting sensory stimuli.

Thompson et al. undertook to answer the question, "Does performance on a laboratory vigilance task reflect the difficulty
Thirty young and twenty-five old men were tested on the odd-even task in both the visual and auditory modality, and at three presentation speeds (4 seconds, 2 seconds, and 1 second). This task required the subjects to push a key when perceiving combinations of successive odd or even numbers. No age difference in performance was apparent at the slower speeds of 4- and 2-second intervals between stimuli but the elderly subjects showed a marked decrement in performance at 1-second intervals. It is suggested that when tasks designed for the measurement of vigilance are presented at fast speeds, there may be contamination by a perceptual-motor factor. These findings are consistent with other results in the literature suggesting that the observed decrements in the elderly may reflect a well-known deficit in perceptual-motor performance. A weakening of attention reduces the capacity to persist with mental or physical tasks and interferes with the formation of memories because attention, whether from interest, curiosity, or fear, or a sense of duty, is essential to the process of memorizing. The findings here might prove highly significant in an adult learning situation where a considerable amount of related information must be produced before proceeding with the task, as in learning to operate complicated machinery.

Loranger (205) tested the hypothesis that in old age there
is a positive correlation between critical flicker frequency (CFF) and measures of certain intellectual functions. There was found to be a positive correlation which he ascribed to a reduced central neural efficiency in old age that adversely affects both CFF and some intellectual functions.

Although experimental studies of CFF can be traced back over 100 years, it is only during the last 15 years that there has been a decided shift of interest from the role of the retina to that of the brain in the fusion of intermittent light.

Misiak (228) in determining the CFF of 319 persons aged 7 to 91 years of age, found that the CFF drops with age, this drop becoming significant in individuals after age 55. Coppinger (80) established that the extent of the age decline in CFF was dependent upon the level of stimulus brightness. There is an unmistakable decline in CFF with age which cannot be ascribed to any particular physical factor. It might possibly be a result of perceptual skills.

There is an a priori assumption that the CFF decrement in old age might be due to the cumulative effect of the following factors:

1. Smaller diameter of the pupil in old age.

2. Elevation of the minimum light threshold due to anatomical changes in the optical systems of the eye.
3. Anatomical and histological changes in the higher visual pathways.

Weale (332:319) concludes that the results of experiments relating to the deterioration of the physical organ as is observed in matters of speed or in factors which might affect speed, is almost wholly explained in terms of the senility of two of the image forming devices namely, the pupil and the lens. It is not clear in what way the drop in CFF at the 55-age level affects vision except in the case of the viewing of films, but education enters obliquely in connection with audio-visual mechanisms. As age advances, it may be that a drop in CFF could contribute to some as yet not identified visual discomfort.

Environmental Factors Affecting Visual Performance

Adult vision is subject to the ability of the aging eye to receive light stimuli. Progressive physiological changes in the lens and in the sphincter and dilator muscles controlling the size of the pupil result in a restricted light entry to the retina, requiring a greater concentration of wattage for the adult eye than for the younger eye. This process, according to Luckiesh (210:128) follows a developmental pattern as is shown in Table III.

Guth (130:467), in Figure 3, page 29, showed the number of foot candles required if a constant visibility is to be maintained at
**TABLE III**

**PROGRESSIVE INCREASE IN WATTAGE REQUIRED FOR VISUAL TASK ACCORDING TO AGE, ASSUMING 100 AS THE NORM** *

<table>
<thead>
<tr>
<th>Age</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>40</td>
<td>145</td>
</tr>
<tr>
<td>50</td>
<td>180</td>
</tr>
<tr>
<td>60</td>
<td>230</td>
</tr>
<tr>
<td>70</td>
<td>300</td>
</tr>
<tr>
<td>80</td>
<td>415</td>
</tr>
</tbody>
</table>

* This Table is from M. Luckiesh, *Seeing and Human Welfare*, p. 128.
FIGURE 3

ILLUMINATION REQUIREMENTS ACCORDING TO AGE

FOR SPECIFIC VISIBILITY LEVELS *

* This Figure is reproduced from S. K. Guth, "Effects of Age on Visibility", American Journal of Optometry, 34:467, 1957.
at different ages. **Footcandle** is the name given to a unit of illumination which is the amount of light received by a perpendicular surface when one foot from the flame of a standard candle.

Nitsche and Gunther (239:117), by studying the diameter of the pupil of the aging eye in daylight and at night, point to a sequence of difference in the 80-year eye from the 20-year eye as can be seen in Table IV. Luckiesh and Moss (212:92-93) point out that the average pupil at age 50 admits only about one-half as much light as at the age of 20, and that the magnitude of the pupillary changes between daylight vision and night vision gradually diminishes with age. Thus the elderly person is largely deprived of the advantages of pupillary adjustments and is particularly handicapped at low levels of illumination. They note, too, that it is a very simple matter to ascertain scientifically the degree of illumination necessary to counteract the effects of decreasing pupil size. If visual acuity could be measured on a progressive scale, then for an acuity rating of 3, for coarse work, the 17 to 20-year-age group would require 11 footcandles, and the 61 to 65-year-age group would require 23 footcandles; whereas an acuity rating of 101, for very fine work, would require 82 footcandles for the 17 to 20-year-age group, and 117 footcandles for the 61 to 65-year-age group. There is habit formation in accepting insufficient light or even of **preferring** poor light which has resulted
### TABLE IV

**EFFECT OF AGE ON THE DIAMETER OF THE PUPIL IN MILLIMETERS BY DAY AND NIGHT**

<table>
<thead>
<tr>
<th>Age</th>
<th>In Daylight</th>
<th>At Night</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>4.7</td>
<td>8.0</td>
<td>3.3</td>
</tr>
<tr>
<td>30</td>
<td>4.3</td>
<td>7.0</td>
<td>2.7</td>
</tr>
<tr>
<td>40</td>
<td>3.9</td>
<td>6.0</td>
<td>2.1</td>
</tr>
<tr>
<td>50</td>
<td>3.5</td>
<td>5.0</td>
<td>1.5</td>
</tr>
<tr>
<td>60</td>
<td>3.1</td>
<td>4.1</td>
<td>1.0</td>
</tr>
<tr>
<td>70</td>
<td>2.7</td>
<td>3.2</td>
<td>.5</td>
</tr>
<tr>
<td>80</td>
<td>2.3</td>
<td>2.5</td>
<td>.2</td>
</tr>
</tbody>
</table>

*This Table is from *Mitteilungen*, Nitsche and Gunther, p. 117. See also Crouch (1945), and Luckiesh and Moss (1937).*
in the maintenance of conditions punishing to visual health.

Crouch (83) analyses the intensity and quality of the light stimulus and the importance of contrast to the efficiency of vision. He discusses the amount of light adequate for certain tasks in industry and also the modifying factors of age and glare in relation to visual efficiency and visual comfort. Glare has been described as "misplaced brightness" and may be the result of three main causes:

1. Excessive illumination.

2. Improper diffusion or distribution of light.

3. Reflection of light back into the eyes.

What is to be seen concerns the object (task) plus the background as well. If these are not clearly separated, difficulty, discomfort, and inefficiency ensue. Optimum vision is to be expected when the brightness of the surroundings is equal to that of the task; the decline from optimum vision becomes rapid and serious after brightness of the surroundings exceeds that of the task.

Disability glare, according to Crouch, is that effect produced whereby 1) the visual ability to perceive contrast of an object against its background is reduced, or 2) the actual contrast is reduced. The importance of the contrast of an object with its background is self evident in making the object stand out as separate and distinct from its surroundings.

Kleemeier (178) offers two major reasons why glare handicaps
1. The eyes tend to be attracted to the brightest place in the visual field. If this does not happen to be the task at hand, effort must be expended to keep the eyes away from the offending source.

2. Glare raises the level of background brightness making it difficult for the eye to distinguish small differences in contrast.

Luckiesh (210:175-76) conducted experiments to test the effect of contrast upon the speed of reading. He tested black print on pages tinted grey against black print on white pages in which the contrast was increased. It was found that the speed of reading was much slower for the reduced contrast, but the speed increased 104 per cent when the intensity of illumination was increased. He concluded that decrease in contrast decreases the ease and speed of reading.

The size of type has a significant effect on reading facility. When the size of print is that of 10-point type on 12-point base, more white space surrounds the letters, thereby increasing the amount of contrast.

Reflected glare influences reading. In this case, it is the quality and physical properties of the paper on which the printing appears which is subject to analysis, particularly those papers with a hard, glossy texture conducive to reflected glare. The specular and diffuse reflection factors of some of the commonly used papers and inks are shown in Table V. Crouch (83) claims that the reflected
<table>
<thead>
<tr>
<th></th>
<th>Reflection-Factor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specular (Percent)</td>
<td>Diffuse (Percent)</td>
</tr>
<tr>
<td>So-called matte black paper</td>
<td>0.05</td>
<td>4</td>
</tr>
<tr>
<td>So-called matte white paper</td>
<td>0.30</td>
<td>77</td>
</tr>
<tr>
<td>Paper from popular magazine</td>
<td>0.35</td>
<td>73</td>
</tr>
<tr>
<td>Paper from scientific journal</td>
<td>0.70</td>
<td>75</td>
</tr>
<tr>
<td>Drawing paper</td>
<td>0.45</td>
<td>80</td>
</tr>
<tr>
<td>Newspaper</td>
<td>0.65</td>
<td>68</td>
</tr>
<tr>
<td>Medium glossy paper</td>
<td>0.55</td>
<td>78</td>
</tr>
<tr>
<td>Fairly glossy paper</td>
<td>0.80</td>
<td>75</td>
</tr>
<tr>
<td>Semi-matte white photographic paper</td>
<td>1.4</td>
<td>83</td>
</tr>
<tr>
<td>Very glossy white photographic paper</td>
<td>4.8</td>
<td>83</td>
</tr>
<tr>
<td>Metallic papers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Silver&quot;</td>
<td>4.2</td>
<td>49</td>
</tr>
<tr>
<td>&quot;Gold&quot;</td>
<td>7.9</td>
<td>26</td>
</tr>
<tr>
<td>&quot;Copper&quot;</td>
<td>11.0</td>
<td>28</td>
</tr>
<tr>
<td>Inks on appropriate papers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dull black</td>
<td>0.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Ordinary black</td>
<td>0.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Glossy black</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Super-gloss black</td>
<td>3.9</td>
<td>1.6</td>
</tr>
</tbody>
</table>

glare from certain types of published materials, due to the glossy surfaces of the papers on which they are printed, causes a reduction in contrast between the print and the background on which the print appears. This reflection from gloss is called specular reflection. Although the reflection from papers is mostly of a diffuse nature, there is some reflection present in the usual range of papers, and this can be measured as the table illustrates. Where the specular reflection factor is high, such as in very glossy, white, photographic paper, a degree of reading discomfort can be expected to occur. Inks, too, can be responsible for reflected glare, and it is, therefore, recommended that dull, black be used in preference to glossy or super-gloss black.

For the aging individual, then, the amount of light and the specular nature of the light reflected from the reading surface play a part in visual performance and comfort.

Bouma (46) has shown that the luminance of the light is not the only operative factor. White light contains radiations which are scattered a great deal more than sodium light; therefore, in experiments carried out on 18 to 50-year-olds, it was found that the differential sensitivity dropped 1.48 in the absence of a glare source, by 1.57 when glare was due to a sodium light, and by 1.69 when it was due to an equally bright white lamp.

Kleemeier (178) suggests that sodium light is better than
incandescent light in terms of recovery from the after-effects of glare. Recovery times from exposure to white glare were almost twice as long as those from comparable sodium glare. Moreover, Weale (332:173) suggests that older people prefer yellowish to cold, white light for all exacting visual tasks except those involving colour judgement. Reference to this will be made later on when discussing colour vision.

Environmental manipulation, other than increased candle-power or quality of artificial light, might be found in providing additional help in the selection of focal points. Kleemeier (178) found that an increase in size of the test picture led to a significant improvement in the performance of visual tests for the aged groups. Thomas and Charles (307) felt it to be unlikely that improvement as a result of increased stimulus size was a result of improved visibility. They advanced the following explanations:

1. Increase of sensory input compensates to some extent for some loss of efficiency in both central and peripheral neural mechanisms.

2. Fuller attention is directed to significant aspects of the visual object and irrelevant cues in the visual field are reduced.

It was suggested, too, that an increase of stimulus size improves performance on tasks which are challenging or difficult for the older person, possibly as a result, partly, of release of tension and an
expansion of confidence.

Retraining programmes involving new equipment must take into account the special problems encountered by the older workers. Murrell (233) points out that in many cases machines, instruction labels on machines and parts, and lighting are not arranged with the over-40 groups in mind, and this creates greater performance stress combined with lesser performance efficiency and skill on the part of the older worker.

It may be that fatigue or limited attention span are an outcome of more than visual accommodation developments or environmental factors, and that some system similar to that of the movie technique of "dollying in" to highlight the area under observation could be implemented to advantage with older subjects. The Black Theatre of Prague, for example, presents a newer concept still of relieving the viewer of the unnecessary stress of holding rigid focus or even of selecting what to focus on and when to alter the focal point. This type of visual presentation might introduce an interesting research project in the field of manipulative focus as it relates to the aging eye. Stieglitz (298:281-82) notes:

But trained eyes that know what to look for and a mind which understands the implications of what is observed can often see more than sharper, younger, but relatively uneducated eyes. Measured purely objectively, the ability to see (including comprehension as part of seeing) actually improves with aging.
Experiments reviewed by Weale (332:135) support the belief that there is a senile delay in dark adaptation. When the retina has been strongly illuminated for awhile, the lowest intensity to which it will respond may be 1,000 or 10,000 times that which would give a sensation before, and a moderate illumination will now look dim. The absolute threshold of vision decreases very greatly during the first 20 or 30 minutes after a light-adapted eye has been plunged into the dark. McFarland and Fisher (214) estimate that, for every increase of 13 years in age beyond age 20, the threshold intensity of illumination must be doubled to be seen by the fully dark-adapted eye. The implication of these findings to the environmental needs of the aging person are important and direct. Crouch (83) recommends transition lighting as an environmental aid to take care of changes of brightness by graduated steps of adaptation. There is a significance here in relation to the adult who is subjected to any sudden transition from high to low illumination such as entering a building from bright sunlight or whenever there is a sudden switch from films or slides to the normal room illumination. A summary of the age-related changes in visual function and performance is illustrated in Figure 4.

**Colour Vision**

Lowenstein (209:65) emphasizes that colour vision adds enormously not only to the richness of visual experience, but also to the amount of visual information available. Bromley (55:48) suggests
FIGURE 4

EFFECTS OF AGE UPON VISUAL FUNCTIONS
AND VISUAL ABILITIES*

* This Figure is reproduced from The Science of Seeing, M. Luckiesh and Frank K. Moss, D. Van Nostrand Company, Inc., New York, N. Y., 1937. Page 251.
that colour sensitivity shows a gradual loss with age of fine discrimination brought about by the yellowing of the lens, retinal changes, and possibly other factors. Weale (332) notes that the lens of the eye fulfills two functions; that of transmission of light, and that of refraction of light. The yellowing of the lens causes it to absorb light in the violet and blue parts of the spectrum. The outcome of these changes in the lens on vision is that:

1. The retina receives less light.
2. The retina receives less blue-violet radiation in particular.

The perception of colours depends, to some extent, on the spectral distribution of the light striking the receptors, and on the type or types of receptor responding, e.g., rods or cones. The senile yellowing of the lens, Weale suggests, acts in the manner of sunglasses whereby green-tinted glasses make things look green. The older the eye, he continues, the yellower the lens and the greater the difficulty of seeing violet and blue. Consequently, older people need more blue light to give a sensation of blue. Diamond sorters claim that older craftsmen are not as reliable as the young in separating yellow from white stones. The same question of reliability could exist for all those involved in other types of skills involving titration.

Weale supports the evidence which claims that colour sense
deteriorates only after age 55. Experiments with older age groups revealed less sensitivity to light of short wave-lengths (blue and violet) than was found among young people, but this senile change diminished as one moved toward the red end of the spectrum. The loss of yellow-blue discrimination occurs first with respect to age but this does not affect the loss of red-green discrimination. In the age group 60 to 70, there is an incidence of red-green defect reported in 12 to 17 per cent in men, and in 5 to 7.5 per cent in women. In the presence of a cataract, this percentage is substantially increased. There would seem to be no relationship between intelligence and colour vision, although there seems to be a correlative factor between colour discrimination and compensation; i.e. an artist is not as likely to lose his colour vision as quickly as someone who is not an artist, and a person with good colour vision is not as apt to lose colour perception through aging as is one who did not have good colour vision to begin with. (332)

Kleemeier (178:423) recommends the use of colour to minimize the visual handicaps of age. Surface colours which improve contrast can aid visibility. Even increased illumination can be defeated by an abundance of dark reflecting surfaces whereas brightly contrasting paint can effectively reduce the hazards of poorly illuminated cornices or the edges of steps.
Visual Perception

Perception is the conscious mental registration of a sensory stimulus or, in other words, visual perception is the ability to see things. Rubin and Walls (272:5) state that we are so organized through early learning that we "must make something" out of every retinal image. No matter how simple the retinal stimulus-configuration may be, we usually succeed in attaching meaning to it.

The older person, according to Keemeier, (178) might be characterized as being perceptually more distant from his environment. Sensory and perceptual limitations with advancing age often result in a lessened opportunity for the older subjects to "gather what is being called for." The older person is also slower to scan and to evaluate the environment in an optimum period of time, therefore, conditions must be modified to compensate for age-acquired losses in these and other modalities.

In perception, more than in any other consideration of aging, the functions of the central mechanisms and those of the peripheral sense organs become confused. Rajalakshmi and Jeeves (255) emphasize that the decline in speed of sensory-motor performance with age is, in the main, not due to changes in the peripheral structures; although increased ability to re-organize percepts was related to increased education.

Silverman (289) reports on the findings of Basowitz and
Korchin (1957) who found that aged subjects as compared to young were less able to identify both ambiguous drawings and concealed figures. The old subjects made more errors and responded to fewer items than the young subjects. One interpretation to account for this finding, says Silverman, was that there may exist in the aged an "excessive cautiousness, i.e. a defensive reluctance to venture response for fear of recognizing their inadequacy." Several investigators have suggested that there may be a tendency on the part of the aged subject to withhold or delay a response in order to avoid risk of error and thus loss of self-esteem.

Botwinick, Brinley, and Robbin (42) as a result of experiments comparing old and young subjects on the speed and accuracy of judgements made with regard to which of two tachistoscopically presented vertical lines was the shorter, found that the old could decide more quickly when forced to do so. This suggested to the authors that the older person takes a longer time with the difficult discriminations when he has the time to take, but relative to his ability to discriminate correctly, the older person may not require that added time. They propose that there may be an increase with age in the confidence level required before responding. There is an admitted difficulty, however, in trying to isolate this tendency from the effect of a genuine loss in ability for the task.

Botwinick, (37:190-92) in studies involving the reversible
figures of "my wife and my mother-in-law", found that problems become difficult for the elderly as a lack of certainty is introduced, and that if uncertainty can be eliminated from the task, older subjects perform better. From this study, too, it was believed that once an older person forms a perception, it is more difficult for him to change his mind concerning what he has perceived, even when allowed the benefit of considerable coaching.

Weale (332:151) believes that aging may be more a question of not being able to arrive at the correct deduction to be drawn from the sensory input. Delayed efferent responses so far as they might relate to accident proneness are compensated for by increased wisdom and deliberate caution.

Riggs (265) lists some of the factors which determine visual perception:

1. Dimensions of the retinal mosaic.
2. Size of the pupil.
3. Intensity of the stimulating light.
4. Contrast of test object to its background.
5. Stimulus duration.
7. Eye movements.

It can be easily understood from the material reviewed that physiological changes in the nature of the eye itself supply some,
although far from all of the answers to the accepted decline in perceptual speed. Weale (332:129) cautions that we are possibly closer to the no-man's land between physiological and pathological senility in the eye than in any other area of investigation. When emotionally-charged situations are harnessed to physiological deficits, there is some cause to reflect on the German proverb: "He lies like an eyewitness."
CHAPTER III

ADULT HEARING

Hearing . . . has helped man perhaps more than any other factor besides vision to become the master of his destiny.

- Otto Lowenstein -

Harris, (137) Broadbent, (53) and others have drawn attention to the close interdependence of sensory data in perception and in learning. Harris, particularly, associates the singular organization of the two sensory systems in the collecting and sorting out of stimuli impinging on the organism. There is a weight of evidence in favour of one organ enhancing the sensation of the other. To belabour this would be to protest the advent of sound films. Research in the field of gerontology dealing with "simultaneity" and "synaesthesia" of stimuli at the point of convergence in the central nervous system is introducing some new and interesting concepts relating to learning. These investigations have prompted further research in the areas of visual and auditory attention, discrimination, and selection. This chapter will deal with the role of developmental auditory performance in the learning situation, and will consider, too, the adult's affective reaction to hearing decrement, and his awareness of the changing nature of his auditory environment.
Pertinence to Learning

From the point of view of education, it has been estimated that whereas 80 to 85 per cent of learning occurs through vision, only 10 per cent depends on hearing. For the adult learner confronted with a steady deterioration of visual acuity, the ability to hear effectively takes on added importance. Hearing is often the key which increases the power of comprehension. Loss of hearing during the adult years, according to Bromley, (55:49) is usually gradual and may not be noticed by the individual because most of the sounds which are relevant to his behaviour are well above threshold value.

A progressive hearing loss with age results in problems of interpersonal communication. Many of the means of communication depend upon good hearing, but not until there is a breakdown does the individual realize how completely a full, well-rounded life depends on sound and speech as interpreted by the sense of hearing. The invention of the telephone opened the way for voice transmission, but modern scientific electronics will bring us more new and better devices destined to perfect communication between people. Adult education must be aware of the implications inherent in research on hearing, specifically that in relation to hearing and noise. (11) Not only the adult educator, but also the adult learner should be actively concerned as there is an urgent need to create
public awareness of the problems of hearing loss. (65:14) The adult who senses a hearing decrement is likely to be the one most intimately aware of his situation. It is the educator's responsibility to be at least equally aware, and even more intensely concerned.

Finally, Heron (143:93) pinpoints an area ripe for research:

... It is worth noting that no studies have yet been located in which both vision and hearing have been studied in the same individuals in relation to age, nor have the combined effects of both been taken into account when investigating, for example, the effects of increasing the sensory stimulus on motor performance.

Age-related Changes in Auditory Function

An investigation of the faculty of hearing in the human animal soon brings abruptly to the fore a realization that compared to the rest of the animal world, man's auditory perception is limited to a startling degree. Griffin (129) refers to echo-sounding in bats which could only be fathomed if a concept of "image-hearing" might be employed for the processes of auditory perception as "image-vision" is familiarly employed for the processes of visual perception.

Auditory sensitivity decreases with age in a way similar to visual acuity. There is an aging of the peripheral sense organ, of the middle ear, and of the cochlea. There is likely to be, too, some aging in the area of the central nervous system which
contributes to changes in hearing. Diminished hearing is a normal concomitant of advancing age.

Changes in auditory responses as a function of aging have been reported by many investigators. (226:267-70) A summary of the pertinent findings includes:

1. Progressive decrement in hearing acuity for pure tones with each succeeding decade.

2. Greater pure-tone loss in the high frequencies, although women tend to lose the ability to hear low tones first whereas men tend to lose the ability to hear high tones first. The onset of this change may be as early as age 20 to 30 years.


Glorig and Nixon (118) have stated that we need three terms to describe the changes in auditory function related to age:

1. **Presbycusis** -- the changes due to normal physiological aging.

2. **Sociocusis** -- the changes that may be ascribed to wear and tear regardless of occupation.

3. **Occupationally induced hearing loss** -- the changes frequently attributed to area of employment and conditions of employment.

Harbert et al. (135) have reported specific lesions associated with aging of the inner ear. Babbitt (7) reported that changes in supporting walls of the external auditory canals in aged persons diminishes the size of the external orifice and thus lowers acuity of hearing.
The changes in audition as a result of age can be classified as peripheral and central. Peripheral changes are attributable to the ear itself and to the auditory nerve. Natural atrophy of tissue, decrease of ganglion cells, and mechanical and metabolic changes can account for loss of absolute, pure-tone threshold.

**Auditory Acuity.**

Ruger's hearing curve on which audio acuity is plotted against age shows that maximum auditory acuity is attained between 10 and 15 years of age, very gradually but consistently declines thereafter to about 65, and then tends to level off. (133) De Ropp (92) refers to aging as a "catalogue of losses" with auditory acuity starting to drop at age 10, and visual acuity taking a sharp drop at age 40 plus. Table VI, derived from Korenchevsky (185:476), compares vision and hearing decline with age along with the increase in reaction time to sound and light stimuli which is also age dependent.

Luckiesh (210:118) has estimated the percentage of those with defective vision by age group as ranging from 23 per cent at ages 10 to 19 up to as high as 95 per cent for those 60 to 69 years of age. Estimates of the percentages of those in similar age groupings with defective hearing have ranged from 11 per cent at ages 10 to 19 up to 51 per cent and even higher at age 70. Harbert et al. (135) prepared the following scale for subjects having suffered a gradual
<table>
<thead>
<tr>
<th>Authors</th>
<th>Koga &amp; Morant</th>
<th>Koga &amp; Morant</th>
<th>Koga &amp; Morant</th>
<th>Koga &amp; Morant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of best Performance</td>
<td>20.5</td>
<td>5</td>
<td>24.5</td>
<td>25.5</td>
</tr>
<tr>
<td>Tests</td>
<td>Visual acuity</td>
<td>Highest audible pitch</td>
<td>Reaction time to sound</td>
<td>Reaction time to sight</td>
</tr>
<tr>
<td>Age groups:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-30</td>
<td>2.6</td>
<td>9.5</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>30-35</td>
<td>7.8</td>
<td>14.3</td>
<td>0.9</td>
<td>0.7</td>
</tr>
<tr>
<td>35-40</td>
<td>15.2</td>
<td>19.0</td>
<td>2.0</td>
<td>1.8</td>
</tr>
<tr>
<td>40-45</td>
<td>24.3</td>
<td>24.3</td>
<td>3.2</td>
<td>3.1</td>
</tr>
<tr>
<td>45-50</td>
<td>34.5</td>
<td>29.5</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td>50-55</td>
<td>45.3</td>
<td>34.8</td>
<td>6.0</td>
<td>6.1</td>
</tr>
<tr>
<td>55-60</td>
<td>56.3</td>
<td>40.5</td>
<td>7.3</td>
<td>7.6</td>
</tr>
<tr>
<td>60-65</td>
<td>66.9</td>
<td>45.7</td>
<td>8.7</td>
<td>9.0</td>
</tr>
<tr>
<td>65-70</td>
<td>76.7</td>
<td>51.0</td>
<td>10.1</td>
<td>10.7</td>
</tr>
<tr>
<td>70-75</td>
<td>84.9</td>
<td>55.7</td>
<td>11.5</td>
<td>12.3</td>
</tr>
</tbody>
</table>

* This table is reproduced from V. Korenchevsky, *Physiological and Pathological Ageing*, Basel, Switzerland, S. Karger, 1961. p. 476.
progressive hearing loss. Their findings supported the Ruger curve as quoted by Hand (133:5) which shows a diminishing trend after age 60 to 65. From a total of 50 subjects, the numbers shown in Table VII were found to have experienced any further acuity loss.

Boas (34:204-10) reports that changes in the receptor nerves of the inner ear result in some universal impairment of hearing after age 65, but the progress of such deafness is very variable among individuals, many of whom retain an adequate hearing well into their ninth decade. It is likely, however, that Boas was referring more to auditory discrimination than to auditory acuity.

Auditory acuity is measured by a Bell scale in units of 10, or decibels. Measurements for auditory acuity usually deal with absolute, pure-tone threshold, and are not complicated by measurements of discrimination. Degree of hearing loss can be determined either by measuring the relative pure-tone thresholds in decibels for various audible frequencies, or by estimating its effects upon the reception of speech or other meaningful sounds. Tests of both types can be carried out in the laboratory or clinic. But, since most of the sounds we hear are sounds out of context, the vital significance of the loss must be gauged in terms of its interference with an individual's relationships with others.

Kleemeier (178:423) points out, in this connection, that
TABLE VII

PERCENTAGE ESTIMATES OF FURTHER HEARING LOSS AFTER AGE SIXTY *

<table>
<thead>
<tr>
<th>Ages</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-69</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>70-79</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>80-85</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

* This Table is reproduced from V. Korenchevsky, Physiological and Pathological Aging, 1961. p. 476.
the loss of high-tone acuity is an insidious process rarely noticed by an individual unless it is quite marked and has started to invade the upper speech frequencies. Mueller (144) says that nobody will recognize a 10-decibel, pure-tone loss, but at 20 decibels, friends and family will know it, and at 30 decibels, the patient himself will be aware of it. The National Health Survey data indicate that awareness by others becomes general when the hearing loss reaches the 40-decibel level.

At age 20, hearing loss is about 10 decibels; at age 80 to 90, hearing loss is about 70 decibels. Therefore, older people must have louder sounds in order to hear. Whereas at 20 years of age, sound must be at least 10 decibels to be heard, at 75 to 80 years of age, sound must be at least 70 decibels to be heard. The decibel measurement of common sound situations has been recorded as is shown in Table VIII.

**Presbycusis**

The term "presbycusis" was originally used to describe the defective hearing of old people, but it is currently applied as a summary description of the changes in auditory functioning which accompany aging. The most common form of presbycusis is characterized by symmetrical hearing loss affecting tones above 4000 cycles per second (cps). Hearing loss for frequencies below 4000 cps may
<table>
<thead>
<tr>
<th>Sound</th>
<th>Decibel Loudness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet Whisper</td>
<td>15</td>
</tr>
<tr>
<td>Ordinary Whisper</td>
<td>30</td>
</tr>
<tr>
<td>Very Quiet Radio</td>
<td>40</td>
</tr>
<tr>
<td>Ordinary Conversation</td>
<td>60</td>
</tr>
<tr>
<td>Ordinary Classroom Background Noise</td>
<td>60</td>
</tr>
<tr>
<td>Average Noisy Office</td>
<td>70</td>
</tr>
<tr>
<td>Loud Speech for Radio</td>
<td>80</td>
</tr>
<tr>
<td>Noisy Factory</td>
<td>90</td>
</tr>
<tr>
<td>Niagara Waterfall</td>
<td>90</td>
</tr>
<tr>
<td>Subway Express Passing</td>
<td>100</td>
</tr>
<tr>
<td>Discomfort for Listening to Speech</td>
<td>100</td>
</tr>
<tr>
<td>Airplane Motor at Close Range</td>
<td>120</td>
</tr>
<tr>
<td>Painful Noise</td>
<td>130 plus</td>
</tr>
</tbody>
</table>

* This Table is reproduced from the Connecticut State Department of Education, Bulletin No. 52, 1957. p/11.
become significant after age 50. (135)

Hinchcliffe (145) defines the audiologic features of presbycusis as an impairment or a decrease in function of these faculties:

1. Impairment of:
   a) Auditory threshold sensitivity.
   b) Frequency discrimination.
   c) Temporal discrimination.
   d) Sound discrimination.
   e) Auditory judgement.
   f) Speech discrimination.

2. A lowering of the upper tone limit.

3. Decreases in the intelligibility of distorted speech.

4. Decreases in the ability to recall long sentences.

Beales (11:138) gives a graphic account of the development of presbycusis:

In the early stages of presbycusis or in minor degrees, there is difficulty in distinguishing all the words in a sentence. The voice can be heard but not all the conversation. The sibilants and certain consonants V, D, B, TH, may be missed or confused. Voices of low tone are heard better than those of high tone, and a child's voice may not be heard at all. Sounds such as the ringing of bells and the singing of birds may be missed, and often the failure to hear the telephone bell may be the first indication to someone that his hearing is impaired. The difficulty of understanding speech is increased if it is rapid, and background noise makes matters worse. Although slow, clear speech is often heard well, a shout distorts the voice and may cause distress.
The most widely investigated aspect of presbycusis is the study of auditory sensitivity, but this may, in fact, have less significance to the adult educator than an investigation into some of the other factors.

In testing the auditory responses of 62 selected men between 74 and 89 years of age, Melrose et al. (226) noted with particular interest that, in spite of a general tendency to keep the radio or TV turned up too loud for the comfort of the rest of the family, these subjects had a relatively good hearing acuity for their age group. The lack of a significant correlation between age and pure-tone loss suggested that the presbycusis process may slow down after the age of 65. Another conclusion was that subjects past the age of 65 showed very little additional loss in later years over and above the losses found when the same subjects were tested at age 65. There was an exceedingly wide range of auditory behaviour; some subjects of 80 years plus showed hearing acuity as good as the average value observed in 20 to 30-year-olds. No appreciable decrement in pure-tone hearing acuity was found as a function of aging during the ninth decade of life.

Zizliz’ (360) experiments relating to high-frequency hearing loss spotlight an interesting aspect of this particular research which, to date, has been somewhat neglected. If hearing loss could be detected at high frequencies before the lower frequencies related
to speech discrimination are involved, it would certainly be signifi-
cant to many fields in general, and to adult education in particu-
lar.

**Noise and Hearing**

The awareness of noise exposure as a potential hazard to
the hearing of man is neither recent nor contemporary. However,
the scope of this problem has not been fully appreciated until recent
years. In realization of the fact that the hazards of noise exposure
are of increasing significance due to the escalating production of
noise by our technological society, people in the field of occupational
health are seeking to learn more about this invisible but audible
hazard. (151:iii)

That exposure to high noise levels for long periods of time
produces permanent hearing losses has been intimated for many
years. To what extent noise *per se* may contribute to the normally
experienced loss in auditory acuity which is associated with
increasing age is not known. McFarland (213) believes that an
exposure to excessive noise levels accounts for the somewhat
poorer tone sensitivity of a group of airplane pilots than for an
unselected group. Glorig and Nixon (118:1596) make a direct refer-
ence to noise exposure as related to occupationally induced hearing
loss. Beales (11) reports with urgency on the direct relationship
of noise to hearing decrement. Beales reports that Hinchcliffe, in 1959, compared the hearing of a rural and urban population in the age groups 55 to 64 years, and 65 to 75 years. He found that there was a mean hearing loss of 18 decibels and 25 decibels for the rural population, and 45 decibels and 49 decibels for the urban population. There is, thus, a startling difference between the age of onset of marked hearing loss in town and country, and this can only be explained by the differences in noise in such surroundings. It seems clear that noise is the main factor in the aetiology of presbycusis, but not the only factor as physical changes occur in all our tissues with aging: e.g. the inner ear is affected by arteriosclerosis, climate, and stress and strain also contribute. (11:132-138)

Rosen et al. (270) found that in a noise-free environment, there was a much reduced loss of hearing acuity with age than in a normal, noise-prone environment. They studied the Mabaans, a tribe of natives in a remote area of the Sudan, as they have not been exposed to the noises of modern civilization. Figures 5 (a) and 5 (b), pages 60 and 61, present the age-induced hearing loss of Mabaans (Men) in a relatively noise-free environment with that of a sample of American men taken at a Wisconsin State Fair in 1954. Figures 6 (a) and 6 (b), pages 62 and 63 present a comparison of Mabaan women with American women.
HEARING LOSS, BY DECADES, IN A NOISE-FREE CULTURE

MALE MABAANS
HEARING LOSS, BY DECADES, AMERICAN MEN
HEARING LOSS, BY DECADES, IN A NOISE-FREE CULTURE

FEMALE MABAANS
HEARING LOSS, BY DECADES, AMERICAN WOMEN
The effect of aging on auditory acuity is influenced by the following factors:

1. Physiological aging.
2. Genetic factors such as tissue changes, climate, stress, disease, etc.

The noise factor, as can be seen in Figure 7, relates to hearing loss earliest and results in the highest loss in decibels at the 80-year level. This Figure also shows that the Mabaans at the age of 70 to 79 years have a hearing acuity better than that of the age group of 30 to 39 years in the U. S. A.

Broadbent (53:96-107) draws attention to some relevant conclusions regarding noise, learning, and performance:

1. The effect of noise seems to imply an effect within the nervous system similar to the blinking effect of the eye, whereby incoming information is momentarily cut off.

2. Noise, therefore, produces brief failures which are perceptual rather than motor in nature.

3. Brief moments of distraction are highly suspect as a cause of accidents.

4. Any interruption of attention can result in critical disturbance of the function of immediate memory and thus affect learning.
FIGURE 7

SPECIFIC CONTRIBUTING FACTORS RELATING TO PRESBYCUSIS
5. With repeated exposure to high-pitched noise of 100 decibels, some deafness would be produced.

Studies into the association between noise and hearing loss in industry, a major occupational problem, have brought out some surprising findings this past year. It has been demonstrated, according to the U. S. Department of Health, Education, and Welfare, that protective difference in the ear muscles of women makes them better than men for certain jobs in industry. Women are able to work at higher noise levels than men without suffering permanent hearing loss, and they can also hear higher tones above such noises more easily than men. (238:10)

Finally, Beales (11:141) notes:

... although there are a number of factors leading to the decline in our hearing with age, by far the most important of these is environmental noise, and it is only logical to assume that as noise goes on increasing, the decline in our hearing will get more pronounced and will occur earlier in our lives. It is also the responsibility of all of us to know how presbycusis affects people as we have to meet them in our daily lives. It should be remembered that very many of us who have good hearing today may have lost it in middle life and old age.

**Auditory Discrimination**

The hearing of pure tones constitutes a very small and insignificant part of the ordinary auditory experience of most individuals. By far the most important sounds to which we listen are the
sounds of speech. Hirsh (147:119) emphasizes that we usually listen to speech or music against a background of noise or other voices. Remarkably enough, we seem to be able to single out the signal which we wish to hear and suppress the sounds or the effects of what we don't wish to hear. The Social Adequacy Index (SAI) is a general concept for expressing a hearing impairment in terms of what a man can or cannot do. Hirsh (147:190) proposes two measurements for Social Adequacy:

1. The hearing loss for speech.
2. The discrimination loss.

Discrimination from the point of view of education is infinitely more important than auditory acuity. It is more important to distinguish a sound than just to be able to say a sound happened. The importance of this ability to discriminate sounds in everyday situations means the importance of being able to distinguish voices from background noises, one voice from another, one word from another. In other words, we must proceed from the concept of detectability to the concept of intelligibility.

The concept of intelligibility is the measure of a person's response to the spoken word. Different speech sounds are characterized by different frequencies, different duration, different intensities, and different intensities at different frequencies, etc. In spoken English, the consonants are of prime importance to
intelligibility. Von Buddenbrock (325:56) underlines the argument by stating that "the main thing so far as our sense of hearing is concerned is to understand the words of the people near us. The results of hearing without comprehension are all too common: (34)

1. Seeming inattention.
2. Incorrect replies to misunderstood questions.
3. Inability to join group discussions.
4. Aloofness from social intercourse.
5. Memory loss of selectivity to voice and speech patterns.

Olsen concurs with the frequently expressed view that auditory discrimination involves a number of complex factors and processes related to the stimulus, the sensory organs, and the central or perceptual processes. (242:394-97)

Widely reported studies on normal hearing have established age-related levels of tonal discrimination. It is well known that old people face a problem in the area of auditory discrimination related to a loss of acuity in the upper part of the range of sound frequencies, and this may affect the recognition of certain speech patterns.

Harbert et al. (135:306) have prepared a number of charts to show the relationship of speech reception threshold and discrimination score. Figure 8 reveals the progressive loss of discrimination which accompanies a decline in the speech reception threshold, (SRT); Figures 9 and 10, pages 70 and 71, show the inter-relationship
FIGURE 8

PROGRESSIVE LOSS OF DISCRIMINATION
WITH DECLINE IN SPEECH
RECEPTION THRESHOLD
FIGURE 9

RELATIONSHIP OF DISCRIMINATION SCORE AND AGE
FIGURE 10

RELATIONSHIP OF SPEECH RECEPTION THRESHOLD

AND AGE
between both SRT and discrimination and age.

Another problem related to auditory discrimination where speech patterns are concerned is that involved in the attention, concentration, and flexibility required to cope with constantly changing sound patterns. It is recognized that the older person experiences a gradual loss of flexibility, and it has been suggested by Braun (49:543-58) and Weiss (338:522) that this loss interferes with the capacity of the old individual for making the best use of his sensory functions. In Table IX, the United States Department of Health, Education, and Welfare presents statistics on the age-related, developmental hearing levels of adults to sounds within the ranges for speech reception. Here it can readily be seen that in the age range of 45 to 54 years, the number of people in the United States experiencing difficulty in hearing the sounds of speech is roughly 50 per cent.

**Masking and Speech Reception**

Interference with maximal auditory efficiency in practical, everyday situations occurs most frequently as a result of noise level or any other form of interference such as the presence of others engaged in conversation. This type of interference is usually referred to as "masking". Olsen (242:395) defines masking as "the phenomenon where one sound causes a second sound to become
TABLE IX

PERCENTAGES, BY AGE GROUPS, OF WHITE ADULTS IN THE U. S. A. HAVING HEARING LEVELS WITHIN THE RANGES FOR SPEECH RECEPTION *

<table>
<thead>
<tr>
<th>Ages In Years</th>
<th>500 CPS</th>
<th>1000 CPS</th>
<th>2000 CPS</th>
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<tbody>
<tr>
<td></td>
<td>Both Sexes</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>18-24</td>
<td>68.0</td>
<td>64.5</td>
<td>71.0</td>
</tr>
<tr>
<td>25-34</td>
<td>65.3</td>
<td>64.2</td>
<td>66.3</td>
</tr>
<tr>
<td>35-44</td>
<td>54.5</td>
<td>52.4</td>
<td>56.4</td>
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<tr>
<td>45-54</td>
<td>43.4</td>
<td>41.6</td>
<td>45.0</td>
</tr>
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<td>55-64</td>
<td>29.4</td>
<td>31.5</td>
<td>27.4</td>
</tr>
<tr>
<td>65-74</td>
<td>15.4</td>
<td>18.7</td>
<td>12.6</td>
</tr>
<tr>
<td>75-79</td>
<td>8.7</td>
<td>9.2</td>
<td>8.1</td>
</tr>
</tbody>
</table>

less audible by co-existing with it. " In older people, it has been noted that the ability to comprehend the spoken word is markedly reduced by the presence of masking sounds. (178 and 338)

The masking of speech sounds is a complex phenomenon. There are certain perceptual constancies to speech which are built up as the individual learns the language. Therefore, he can rely on these perceptual patterns or relationships rather than depend on discrete stimulus reception. Experiments suggest that there is a relationship between discrimination of auditory information and noise which depends on the context, or number of alternatives from which the "message" is to be chosen. Thus sentences require a lower signal-to-noise ratio than do nonsense syllables. When the masking noise lacks interest for the subject, or when it is considered irrelevant to his needs, then discrimination is more easily attainable than it would be under circumstances where a competitive situation exists. When the masking noise is another message of equal significance, then recognition of word patterns, concentrated attention to the task, and flexibility in "scanning" the material for meaningful sequence would be almost as important as the auditory acuity required to recognize the desired voice. (242:394-97)

The problem of following one conversation in the presence of others is sometimes referred to as the "cocktail party" problem.
How older people are able to handle this problem has practical significance in the assessment of possible communication difficulties, and a most decided significance to adult education.

Based on the premise that old people might have measurable difficulties in communication involving masked auditory stimuli, Olsen (242) conducted a study to investigate one aspect of the discrimination of auditory information as related to aging. A comparison was made between the performance of old and young individuals on voice recognition and message output under conditions of voice interference. The "correct" voice was identified and then, while this voice carried the message, another voice or voices were used for a masking effect. The task was to report the message from the "correct voice" by disregarding the interference. The results indicated that the older subjects were significantly lower than the young, both in voice recognition and in the message output scores. Olsen postulates that in older subjects an "overload" situation occurred which affected central integration functions and caused the old subjects to become confused and unable to use their abilities effectively when faced with a complex task necessitating continued attention, perceptual discrimination, or organization of material, and direct transmission of information.

In order to evaluate handicaps in auditory discrimination
which have practical implications for old individuals in the area of verbal communication the voice interference situation points to one source of difficulty. The results of this study suggest that voice interference resulted in a measurable loss of precision in grasping the essentials of auditory messages well enough to relay them, and that old persons were placed at a disadvantage. By masking the message voice, there arose a "complexity of task" factor which might be considered as well as the single factors such as high-tone loss, short-term memory retention, or simple auditory acuity.

When planning for the education of older persons, it would be well to bear in mind that an increased aural overload threshold is related more to age than to hearing level. Discrimination for distorted speech is poorer in older as related to younger individuals. (135)

Melrose et al. (226) use the term "phonemic regression" to refer to the inordinate loss of speech discrimination ability in the presence of a mild loss for pur tones. Phonemic regression is presumed to accompany presbycusis but the Melrose study indicated that it is not always a concomitant of presbycusis. Discrepancy between pure-tone audiometry and discrimination scores has been considered evidence of higher pathway involvement, e.g. the central nervous system.
Harbert et al. (135:305) report that the median speech reception threshold and discrimination score are 40 decibels and 70 per cent. When the discrimination score is better than 70 per cent, the median hearing level for speech frequencies is 25 decibels; whereas with discrimination scores less than 70 per cent, the median level is 45 decibels. Presbycusis showed poor discrimination even with pure-tone speech frequency of 20 decibels or less.

Table X, prepared for the United States Department of Health, Education, and Welfare, presents the maximum noise level (in decibels) permissible for comfortable speech reception. For conversation to be heard efficiently in a small office, the noise interference level should not rise above 40 decibels.

Schaie et al. (276) have directed particular attention towards suspected relationships between auditory performance and general intellectual functioning. Correlations between auditory sensitivity, age, and intelligence were reported.

Affective Responses

Emotional factors can affect speech discrimination. Anxiety-prompted attempts to "try hard" to hear in order to "pass" a test and, therefore, not be classified as "old" have, according to Melrose et al. (226), resulted in discrepancy scoring of some intelligence tests relying rather too heavily on responses based on auditory reactions. A lack of confidence was reported in the
<table>
<thead>
<tr>
<th>Type of Room</th>
<th>Maximum Permissible Level</th>
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<tr>
<td>Small private office</td>
<td>40</td>
</tr>
<tr>
<td>Conference room for 20</td>
<td>30</td>
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<tr>
<td>Conference room for 50</td>
<td>25</td>
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<tr>
<td>Movie Theater</td>
<td>30</td>
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<tr>
<td>Theater for Drama (500 seats, no amplification)</td>
<td>25</td>
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<tr>
<td>Coliseum for sports only (amplification)</td>
<td>50</td>
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<tr>
<td>Concert Hall (no amplification)</td>
<td>20</td>
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<td>Secretarial offices (typing)</td>
<td>55</td>
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<tr>
<td>Homes (sleeping area)</td>
<td>25</td>
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<td>School rooms</td>
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ability to interpret or correlate what is heard. It was considered safer not to hear so as to be regarded as "slightly deaf" rather than to hear and to be exposed as "slightly stupid."

John Davy reported experiments carried out by Broadbent and Gregory of the psychology unit at Cambridge suggesting the probability that a "censor" decided which words are acceptable to the conscious mind thus supporting the Freudian concept of the alter-ego. Volunteers were asked to listen to a series of "neutral" and "obscene" words partly masked by background noise. They correctly recognized obscene words less often than neutral words. An extension of this kind of experiment with older subjects might well substantiate the claims that "Grandpa hears only what he wants to hear." It may also suggest, that wherever education seeks to threaten the learner in any way, the message just might not be getting through. Talland and Cairnie (306) in addressing themselves to this particular situation write as follows:

Changes in central inhibitory processes characterize normal aging, and these changes are manifested in an increased set rigidity in cognitive as well as in motor performance.

In testing two groups for auditory perception, Group 1, ages 65 to 75, and Group 2, ages 20 to 40, Talland and Cairnie (306) found that the flexibility to cope with alternative solutions or with conflicts between anticipation and event deteriorates with age.
Anticipation or set can serve to facilitate cognitive responses in older individuals, but if information which is not congruent with an expectancy is received, the anticipation factor can have an inhibitory effect instead. Talland (304) refers to "set rigidity" as the performance characteristic of the older age group indicating a diminished capacity to change attitudes.

**Attention and Vigilance**

Since it is in the reception and organization of incoming sensory data that one of the major behavioral effects of aging can be observed, vigilance tasks might be expected to show an aging effect. (127) Studies of vigilance performance in relation to age might have consequences for the employment of older operators in certain situations. In tests of auditory vigilance (e.g. listening to tapes of a series of digits at one-second intervals for 40 minutes, then reporting any three consecutive odd digits by writing them down on paper) no additional load on short-term retention was involved and, therefore, the older individuals performed as well as the young. The conclusion was that age, as such, does not affect the performance of auditory vigilance tasks unless there is an additional load on short-term memory. This, it was felt, could affect older adult performance on some tests where instructions given immediately before the test might be forgotten.
Wolfe and Davis (354) feel that for the older individual, a combination of auditory and visual instruction or stimuli will increase the performance abilities of the older subject. They found that auditory stimuli provided by a tape recorder where volume level could be increased at will plus visual stimuli resulted in a notable increase in co-operation and in sustained and serious effort on the part of the older subjects.

Wallis and Samuel (329), in experimental studies of radar operating, have suggested that more variability of performance is found among subjects engaged in prolonged visual performance than in prolonged auditory performance since, in the case of visual watch-keeping tasks (e.g. focus plus change of focus), the added factor of signal location contributes to a decline in performance. Therefore, before any more general conclusions about the effect of aging upon vigilance performance on the whole is justified, further data about visual vigilance in relation to age are required.

Birren (22), in summarizing the findings of Weiss on sensory functions (338), reports that the aged appear to have more difficulty in simultaneously monitoring two auditory channels compared with monitoring a single channel. Analysis of the correlation of auditory acuity and reaction time, suggests that there may
be a common element beyond that correlation which might be expected to arise from interference with the hearing of a stimulus to which a response is to be made.

**Auditory Impairment and Correction Devices**

An elderly person attempting to remedy his hearing difficulty may well encounter disappointment. Since auditory deficiency is experienced by more older people than is commonly known, the overcoming of this handicap is an important objective in the development of environmental modifications designed to help the aging person. It is of importance, too, that those who assume responsibility for continuing education have an awareness in depth of the complexity of the problem.

The literature is filled with attempted explanations, particularly on a clinical basis, for the cause and relief of perceptive deafness accompanying old age. It is of significance for the educator first to overcome the anxiety accompanying the realization that auditory impairment is in progress before attempting to instigate a programme designed to ameliorate the loss. There seems, too, to be a degree of social stigma attached to the wearing of a hearing aid.

Briskey *et al.* (52) noted that emotional disturbances, depression, personality disorders, etc., resulted in a high
incidence of reported hearing problems. People say they do not hear what they do not understand. The problems of comprehension difficulties responded but poorly to hearing aids until the emotional factors were brought under control. Zahn (358) confirms the observation that as a result of reduced comprehension, the older person may develop unpleasant personality quirks.

Farrimond (107) was the only source contradicting the belief that lip-reading supplements hearing:

Older people do not appear to compensate for their hearing loss by paying closer attention to the lip movements of the speaker. If anything, they are slightly poorer than younger people at lip-reading. (55:49)

Auditory deficiency can be overcome by amplification of the stimuli by means of electrical or transistorized devices, either at the source or at the ear of the person concerned. Kleemeier (178:400-51) proposes good sound-amplification systems for auditoriums and churches where a substantial number of elderly people comprise the audience, but this may be disturbing to persons with normal hearing. The acoustical properties of the auditorium also have a significant bearing upon auditory comprehension. Reflection of sound from hard walls, particularly if the speaker is a fair distance away, will add to the echo effect.

Hockberg (149) refers to the attenuation of high frequencies
in sounds coming from behind the listener so that the sounds change in quality as well as in loudness. This is explained by "sound shadows" created by the external ear which tends to soften or modify sound. The result is that the sound of "SH" heard when it is received from in front of the listener becomes "SS" when it comes from behind the listener. For adult education, groups in circles or around tables would be preferable to rows. This supplies but one further argument against the practicality of conducting adult education activities in classrooms with fixed seating arrangements.

Any measure which will reduce or mask background noise level will improve speech perception in both the normal and the impaired. R. M. Shaw (281:18) reports that air conditioning has aggravated the sound problem in modern office buildings because it has made them so quiet. Prior to air conditioning, most people had their windows open which let in traffic noises, fog horns, and other city sounds that tended to mask the interior noises of voices and typewriters. Unmasked office noise has contributed in a significant degree to typist errors, machine operators' errors, employee turnover, and absenteeism.

Reverberation might be said to relate to hearing as glare is related to vision; in all cases, performance is adversely affected, but to those suffering degrees of impairment, increased difficulties are experienced.
Kleemeier (178:425) refers at length to the electronic hearing aid citing Berry's (16) estimate that the average age of those who use hearing aids is 55 years. There are some disturbing estimates, too, on the number of people who purchase hearing aids and promptly discard them. It is repeatedly stressed that the hearing aid does not restore normal hearing. Mention is made in this connection to the fact that since the loss in hearing tends to be gradual, in many cases hardly perceived by the person himself, the memory of "normal" hearing is startlingly inaccurate. The skills of selectivity have atrophied to the point that when average extraneous sounds or noise are reproduced by the instruments, the effect is one of unfamiliarity. It would be asking a great deal of any manufactured hearing device to recreate for each individual the exact degree of stimuli selectivity he exercised at the peak of his auditory performance. Consequently, auditory correction, though adequate and sometimes very satisfactory, is considerably less than perfect.

Lederer and Marcus (201) urged that an effective hearing programme should be based first on examination followed by a comprehensive auditory evaluation, and that only ultimately should an attempt be made to salvage whatever residual hearing the patient may possess by means of a hearing aid "prescription". Concomitant to this process should be a form of "auditory education", designed
to acquaint the individual with the particular nature of his hearing loss, and to train him to a gradual development of tolerance for amplified sound so that he will be familiar with the discrimination of speech sounds under amplification.

Foulke and Stickt (110) have carried out experiments based on the listening rate preferences of various subjects. When people lose their acuteness of hearing, they also lose speed of hearing. By means of the Tempo Regulator, the listener can now control the word rate of the material to which he listens. It is possible by means of this instrument to reproduce previously tape-recorded speech at a desired word rate without distortion in vocal pitch or quality. An unexpected revelation arising from these experiments was some evidence to support the contention that a listener does not necessarily prefer the word rate that yields the most comprehension. Further support is provided here to the theory that the aged individual can only be assisted to hear and comprehend what has personal and social significance to him. A reversal of attitude to hearing loss might result from an adult training programme starting well before the anticipated onset of the deficiency, and continuing through the period of adjustment to a state of maximum benefit.
CHAPTER IV

VERBAL COMMUNICATION

Speech is the mirror of the Soul;

As a man speaks, so is he.

- Publius Syrus -

Disorders of speech, hearing, and language are found in all age groups, but advancing age increases the incidence of certain types of communication handicaps. (328) Nevertheless, studies of people between the ages of 18 and 65 disclose that, although muscular skill requiring power and speed decline with increasing age, there is not a similar decline in ability to meet verbal tasks. In fact, in some areas, there is improvement.

Verbal fluency, as well as the speed of writing and speaking, is lower for old than for young, but countless sources refer to the advantage of the aged individual in "stored" knowledge and verbal skills. Attention is now directed to the effects of age on the skills involved in verbal communication: changes in oral structure, voice, vocabulary, verbal fluency, discussion behaviour, together with the attitudes associated with these changes.

Speech Changes With Age

Healthy people in their sixties rarely show changes in
their manner of speaking, although those in their seventies and eighties may. Rothenberg (271:588) lists certain changes in speech which normally take place as people age:

1. Speech becomes slower.
2. Older people tend to articulate less clearly.
3. There is often hesitation in finding the right word, especially if it is one that is infrequently used.
4. Words may be slurred.
5. The voice may drop in volume toward the end of a sentence.
6. There may be stammering or, less often, stuttering.
7. Older people who spoke another language in their youth tend to revert to their native tongue. This peculiar phenomenon takes place mainly among those in their late seventies or eighties who are showing signs of cerebral arteriosclerosis.

Vocal changes with age are brought about in part by the hardening and decreased elasticity of the laryngeal cartilages, though these processes are usually complete by the age of 40. Bromley (55:50-51) reports that the voice becomes more highly pitched as the person progresses from middle to old age, although in the thirties and forties, vocal pitch appears to be lower than in adolescence and early adult life. In senescence, the voice grows
less powerful and restricted in range, becoming high and piping. He draws attention, too, to the fact that singing and public speaking which make greater demands upon vocal capacity show deterioration earlier than the normal speaking voice. Speech becomes slower, probably because of degenerative changes in "peripheral" mechanisms. Speech pauses become longer and more frequent. Slurring occurs in senile patients, and various kinds of speech disorder can arise from the effects of pathological changes in the brain.

Rothenberg (271:589), on the other hand, claims no deterioration in the public speaking abilities of those who have been accustomed to addressing large groups of people. Training in voice pitch and placement result in the retention of skills far longer in the trained than in the untrained.

Some Relations Between Speech and Hearing

Norton Canfield (65) discusses the interrelationship of speech and hearing in the following terms:

1. Our speech is partially controlled by what we, ourselves, hear of it.

2. The speaking voice of a person with normal hearing is more perfectly modulated than that of a person with an appreciable hearing loss.
3. Speech firmly fixed in a child's mind remains unchanged in adult life unless hearing impairment ensues. But when words are not heard properly, speech changes gradually and sometimes considerably. Some people with hearing loss speak in a louder voice, some in a softer, depending upon what they hear themselves say. When hearing is improved by medical or surgical means or through the use of a hearing aid, the voice changes again usually towards its original quality. It is softer, more pleasing, and much more tolerable.

4. Professional people who work with adults who have hearing and speech problems must display sympathetic understanding. There is never quite the same degree of comprehension between people who do not have a hearing loss and those who do.

Affective Factor in Structural Oral Changes

Certain structural changes in the oral cavity are frequently referred to in the literature dealing with reasons for the slowing down of social participation in the aging individual. In many instances, the complaints are of an emotional nature and self-conscious rather than clinical. Even so, many discomforts of varying severity do afflict the over-sixty group contributing in no small measure to speech handicaps. The discomfort of poorly fitting dentures might be mentioned as perhaps the least of these, or at any rate the most easily rectified. Senile changes in the tongue
can commonly cause pain at the tip and on its margin near the root since these regions are most exposed to injuries caused by the teeth during speaking or masticating. (9:531-38) With refinements in the preparation and selection of foods, there is an almost complete conservation of permanent teeth which Dahlberg (85:357-81) warns is not in all cases as desirable as it might seem. In the failure of modern man to wear down his teeth, dentistry has increasingly concerned itself with problems of occlusal disharmonies, rehabilitations, and disturbances of the supportive tissues. The most obvious aspects of the dental aging process are abrasion, attrition, discoloration, movement of teeth, changes in the supporting tissues, and in the structural character of the teeth. Receding gums resulting in partial exposure of basal root tissue can produce annoying sensation whenever sudden changes of temperature are experienced. Any of these progressive developments might be of significance to the older person's comfort in situations requiring him to take an active part in verbal expression.

**Verbal Fluency**

Birren, Riegel, and Robbin (31:95-96) investigated age differences in verbal fluency. Differences had been previously reported based on the number of words beginning with specified letters that subjects wrote in a fixed time, but in these instances,
it was thought that the physical task of writing could have influenced unduly the outcome of the tests. This study employed recordings of spoken words, the subjects being asked to repeat as many words as they could think of beginning with a specified letter. Here, again, the results upheld the tendency of the older group to take a longer time in the spoken word association than did the younger group. In a preliminary formulation, Riegel and Birren referred to emergency time and selection time in word association with such time factors being thought to be differentially affected by age. Earlier work had shown that advancing age is accompanied by slower word associations, but it was not clear whether the slowness was the result of an increase in the number of words known. Allowing for the admitted tendency of the aged towards slower speed, Birren et al. favour an explanation based on the associative processes rather than one relating to the rate of speech.

Increased probabilities of certain word associations and increased total word knowledge do not appear to be sufficient to explain the differences with age in verbal behaviour, i.e., speed of emergence and selection of associations. It may prove necessary to regard control factor or set which gives direction to the mind or associations as a relevant variable in aging; the purposive nature of association may independently change with age. (31:110)

Another study by Riegel and Birren (262:125-30) on age differences in verbal behaviour have shown that the number of words
stored in a relatively passive manner and the number of different words actively used in writing rises slightly during the whole life span. The total amount of writing declines with age, but the daily amount of reading and listening seems about constant through the adult years with variation, however, in the type of material consumed. Age differences in verbal performance depend on:

1. The nature of the task.

2. The set of the individual searching his store of knowledge.

3. The organization of the information required.

Eisdorfer, Busse, and Cohen (103) assume that differential life experiences, e.g. sex, race, socio-economic status, intelligence level, and mental health status, would influence relationship of verbal and performance scores. Research supported the assumption that no matter which of these variables were examined, a consistent superiority of the verbal over the performance I. Q.'s was noted.

Birren (22) in his summary to Human Aging recognized evidence supporting the theories that verbal abilities were related to health differences. In verbal intelligence, the healthy aged subjects were significantly superior to young adults. The significantly lower performance of the less healthy group was interpreted by the view that this group had lost some superiority from a previously
higher level of verbal achievement as a consequence of disease.

The same author at a later date (24:99-120) affirms that most studies using measures of vocabulary and information show a continuing increase over the adult years. Yet, evidence seems convincing that association time becomes longer with advancing age. If the search rate is slower and yet verbal output remains high, some change is implied in the organization and utilization of stored information. One way the organization of information might change, claims Birren, is through the use of broader concepts which embrace previous discrete elements. Such an hypothesis would be consistent with the expectation that adults cope with their expanding information by the use of abstractions. There is a tendency with increased age to embrace larger amounts of information under broader concepts. Vocabulary, information, and comprehension show little if any decline in performance with increasing age after early maturity, and there are many reasons for supposing that performance in them improves at least up to middle-age, and possibly later for well-educated people with verbal interests. (55:212)

Group Discussion

Palermo (243) focuses on the association processes of words in speech and print. Normal conversation flows at a rather
fast, continuous rate, and a thought not put into words quickly enough is lost. There is the common experience of losing a thought which was not inserted into the conversation with alacrity. ("I forgot what I was going to say!") Such instances are, perhaps, a manifestation of the decay of associations.

Rothenberg (271:589) suggests some helpful routines to be followed by older people who have difficulty with speech:

1. They should write down the essential things they want to say before they are confronted with the need to say them.

2. If they are to give a speech, they should read it rather than speak extemporaneously.

3. If there is impairment of vision, the speech should be written in capital letters or should be printed in large block letters on cards.

4. Companions of older people should explain to others that there is need for particular attention lest the speaker be upset or confused by inattentiveness.

Although it hurts the pride of an older person to have someone speak for him, it is helpful if those who have contact with older people can be tolerant and permit them plenty of time in which to make themselves understood. Further help can be given by asking others within earshot of the speaker to be quiet. A missing
word when it can be anticipated can be supplied on occasion.

Scheidel (278), in illustrating personality and discussion behaviour, examines certain personality needs and values in small-group discussion. There was a notable relationship between such personal characteristics as self-confidence, independence, dominance, affective need, etc., and the dimensions of discussion behaviour.

Some reference to "set" or expectancy as it relates to the mature individual's performance in a group discussion environment is relevant at this point. Anyone whose experience dates from the early days of radio broadcasting is familiar with the typical older actor's "freeze" at the microphone when receiving a too-sudden visual cue to speak. When insufficient time was allowed for vocal reaction, compulsive swallowing, motor reflexes, and indecision resulted in delays which, although momentary in actual seconds, were of disastrous proportions so far as the effectiveness of the programme was concerned. The implication here refers to an adult's need for time to consider his response or verbal contribution in the group setting. Even though hesitation or "freeze" is hardly noticed by the other members of the group, it is distressingly apparent to the speaker himself who is temporarily distracted and may withdraw from further participation.

Kidd (175:207ff.) stresses the importance of communication
in the adult learning situation:

How men express themselves, how they talk with each other, how ideas are exchanged, how feelings are aired and shared, these are crucial matters for learning.

The Scandinavian Folkehøjskule rely almost exclusively on the discussion-group method and group discussion techniques. But whether in a group or out of it, the adult intent on learning is confronted with the need for verbal communication skills. Evidence is cited by Kidd (175) and others that many people lack confidence about their speech and vocabulary. Part of this seeming insecurity can undoubtedly be placed on the doorstep of ignorance of the physiological processes involved in the aging of the speech mechanisms where a slowing down of reaction time and a hesitancy of spoken conclusion are falsely interpreted as a progressive inadequacy. The fact that the adult learner, at any stage of his development, has within him the capability of worthwhile contribution to the group setting, provided the members of the group have the patience to listen at varying speeds, has long been accepted in residential adult education circles. Here, the emphasis is on comfort and relaxation expressly for the purpose of allowing the more mature members an atmosphere in which to contribute.

Birren (22) in his summary of Human Aging mentions some characteristics of an emotional block to verbal communication:
1. Reduced tempo of stream of thought.
2. Impoverishment of ideas.
3. Difficulty in maintaining attention and set.
4. Decreased interpersonal interaction.
5. Less direct immediate affective expression.

Certainly, verbal behaviour in aging is a complex function involving not only experience but temperament as well. However, Birren claims that present concepts and methods of study of language seem useful in describing life-long trends in verbal behaviour.
CHAPTER V

SHORT-TERM MEMORY, PERCEPTION, AND LEARNING

Memory is the art of attention.
- Samuel Johnson -

An examination of the peripheral sensory receptors leads inevitably to the processing of the harvest; the integration of random impressions into knowledge. Reference has already been made to the eye, the ear, and the verbal-speech mechanism. The convergence, now, of the physiological condition with mental performance will serve to illuminate the basic conditions of learning.

Computer Analogy

The sense organs act as transducers of physical energy, transforming them into coded patterns of nerve impulses in the associated nerve tract. These patterns of impulses will eventually reach the appropriate primary sensory area of the brain where perception may occur. The brain has frequently been likened to a computer--even to the point of suggested, as Christopher Evans of Britain's National Physical Laboratory recently did, that sleep is nothing more than the means by which a human being disconnects himself from the world of the moment so that re-programming can take place. An essential point of departure from the computer
analogy might exist in the area of immediate memory as it relates to the physiological aging processes.

Welford's familiar stages of the learning process and Gagne's conditions of learning emphasize the particular character of the short-term storage of material until retention occurs. A failure to "process" incoming data, i.e. to hold the sensory cues in focus until such time as they can be organized and integrated with the knowledge derived from past experiences, is frequently mentioned as an age-associated decrement. It is possible that a retardation of incoming signals as a result of reduced physiological activation with age contributes to some missed connections. It is possible that other factors not yet determined intervene at this admittedly crucial stage of learning. At any rate, the contention of Hannah (134) based on his research is that the learning deficit found in elderly persons may be the result of an impairment in the short-term memory process.

Relation to Intelligence Measurement

Although in general there is a decline with age in total scores earned on tests of general intelligence, Donahue (95:56) questions these findings on the basis that few old people of today have had experience with psychological tests. They distrust them and fail to respond to the motivations effective with younger groups. Heron (143) and Nyiró (240) refer repeatedly to low-score
achievement on intellectual measurement scales as a result of the older individual's failure to organize efficiently the signals received. Bromley (55:65) reports that there are innumerable occasions when a person's failure to solve a problem is chiefly due to over-heavy demands on short-term memory, and that the very activity of comprehension itself may well be attributed to the same function.

Reed and Reitan (258) report that testing procedures which require the subject to engage in active, problem-solving behaviour are apparently more influenced by age than are tests which require the reinstatement or recall of stored information. They demonstrated that older subjects were inferior to younger subjects on tests which require immediate adaptive ability, but tended to equal, if not excel, the younger group on tasks judged to require stored information or prior experience. Younger groups were clearly superior to older groups on tests requiring immediate problem solving ability, but much less significant differences were revealed between the older-younger groups on tests dependent upon previously accumulated experience. The findings here would seem to suggest to adult education that courses should be based on previous learning and experience.

Stieglitz (298:243) has suggested that frequently, the
older mind is absorbed with placing new facts in relation to others previously acquired. This naturally distracts attention from the fact itself, and such correlation becomes more significant than mere retention of isolated impressions, or quick answers to seemingly irrelevant quiz-type questions. The mature mind is increasingly concerned with relating the past to the future; in contrast, the present becomes insignificant.

Fitzhugh, Fitzhugh, and Reitan (109) discuss ability changes and age by noting many reports have indicated that effects of advancing age are reflected in changing patterns of abilities and in decrements in performance on a wide variety of psychological test measures. Deficit performances have been reported on tasks such as those dependent upon perceptual and motor speed (344), abstraction ability, ability to learn new material, and complexity of performance (163).

Wigdor (351) spends considerable time on the aging memory and intelligence, and concludes that memory function in the aged seems to be an important capacity which may well be related to various other cognitive tasks. Severe memory defect is not a necessary accompaniment of aging but is, probably, due to brain pathology, while mild memory defect—varying considerably in degree from occasional momentary forgetfulness to
more difficulty in the recall of very recent events or of new data—
is the more usual pattern. This, it is stressed, may not occur
until well into the seventies.

Klonoff and Kennedy (179), in reporting results from the
Wechsler Memory Scale Test on healthy, well-preserved 80 to
90 year-old adults, made the following observations:

1. There was a greater loss in immediate or short-
term memory as compared to the loss in remote memory.

2. Rote memory was superior to logical memory.

3. Auditory retention was superior to visual retention.

Donahue evaluates the situation of age-related changes
and intelligence measurement in the following terms: (95:57)

To what extent... differences depend upon changing mental and neurological functions and to
what degree they are the results of cumulative ex-
perience and continued exercise or non-exercise
of abilities remains for future research to deter-
mine.

**Attitude, Selectivity, and Attention**

Stieglitz (298:58) cites the experiments of Dr. Carl Camp
who claims that the over-fifty group tends to be apprehensive about
memory lapses, and this very apprehension interferes seriously
with short-term retention. His experiments involved the compara-
tive testing of healthy men of 35 and 72. He observed that there
was no significant difference in the accuracy of their memories when his observations were made without their knowledge. But when they submitted to a test making direct comparison, the young men required considerably less time to memorize than did the older men, but the older men made fewer errors. Dr. Camp concludes that often there is no difference in the efficacy of memory for recent events, or in the ability to learn with advancing years, but that a sense of inferiority and a desire for accuracy rather than for speed may constitute emotional handicaps which distort the results of tests measuring the rate of learning. It is suggested that one forgets more when there is more filed away mentally to misplace or overlook. Youngsters forget too, but they don't blame it on age or worry about it as a sign of decline. Donahue (95:58) paraphrases this as follows:

Older people complain more frequently about memory failure than about any other psychological impairment, and it therefore constitutes an important problem with reference to their adjustment. From middle age onward, most of us accept every failure in the instantaneous recall of a specific name or event as unquestionable proof of mental decline heralding old age. By the time a person is old, he has practised auto-suggestion regarding age and memory so many times that the belief has become firmly established. No amount of persuasion can disabuse him of it, and it thus becomes a mental hazard to learning.

Age seems to have a selective effect on memory. Something in the aging process seems to bring out the obscure occurrences which had been stored in the uncommitted cortex and the individual
remembers incidents from way back. The elderly person may recall long-past events, according to Hunter (155) partly because he chooses to live in the "rosy" past rather than in the "murky" present. He can also sometimes gain and hold an audience if he remembers way back. Stieglitz (298:243) suggests that inattention can contribute to the impairment of memory for recent events. As we grow older, we tend to distinguish between those items which we want to remember and those which we want merely to observe without remembering. Those items regarded as unimportant seem miraculously to dissolve, a phenomenon which has prompted more than one mature citizen to define the word "memory" as "that thing we forget with". Significantly, the ability to learn is intimately linked with the sense of importance with which we endow that which is to be retained in the mind.

Miller (227:34), in his discussion of teaching the adult learner, remarks:

Cognitive behaviour is the outcome of the individual's response to the flow of information coming to him through his senses, how he selects from the flow those items to which he pays attention, and how he applies meaning to it, and how he manipulates it.

Interference and Consolidation

Hulicka's (153) investigations with respect to age differences
and retention suggest that as a person ages, he becomes increasingly susceptible to interference. This is frequently offered as an explanation of the impairment of short-term memory that is usually associated with the aging process. This study tested the association of occupations with names. After having learned to connect certain names with certain occupations, the subjects were informed that they had moved to a new locality and would now be required to learn a new set of names for the same occupations. Hulicka's conclusions follow:

Observed increases in interference effects with advanced age are due primarily to an age-related decrement in efficiency of learning the original material, but when the original material is well learned by the oldsters, they retain it as well as the young, even with the interference factor occurring.

Belbin and Downs (13) report on retroactive inhibition which is the interference effects of new material being introduced while previous data still are being held in the immediate-memory circuit. Activity, especially learning activity, inhibits the retention of previously learned tasks. There is evidence, too, that elderly people are more susceptible than young to the interference effects of activities that intervene during a period wherein retention is in progress. The interference effects of any activity undertaken between learning and subsequent testing some days later were examined in an industrial
situation, e.g. postal clerks learning to associate and pair names, towns, districts, etc. It was found that the performance of those in middle age suffered significantly more from intervening learning of new material than it did from intervening work activity. The performance of trainees in their 20's was not affected to the same extent by interpolated new learning than was that of the older subjects. Belbin and Downs (13) found that middle-aged people benefitted considerably when their learning sessions were interspersed with self-testing sessions. By consolidating learning in this way, it was found that within the same time limits, the information learned by middle-aged recruits in an industrial training school was retained better and was less susceptible to retroactive inhibition than when specific learning periods were distributed with other learning tasks.

McFarland et al. (217) point to the more serious difficulty of short-term retention for older people which appears when they have to take in a certain amount of data and hold it for a few seconds while doing something else. This kind of memory difficulty becomes of special importance in tasks where there must be a search over a continuously changing display of information for small cues for action. The cues change from time to time and assume relevance in conjunction with previous events. Older subjects tended to give most of their attention to one or another of the tasks but could not cope adequately
with both. The relevance of this type of "dynamic" situation is apparent and should be further investigated in relation to age and education.

**Function in Language Acquisition**

In the theories of Piaget and Penfield interrelating short-term and stored memory so far as the acquisition of a second or "other" language is concerned, it is claimed that stored memory in the form of vocabulary, sounds, inflections, phrases, etc., is maintained in adulthood and, by means of education, even extended into old age. Therefore, the acquisition of a second language, based on the recollection of stored material, is to a great degree simplified since the introduction of new material can be anchored on already existing storage "pegs".

Frequently, the adult is discouraged from learning a new language since it is introduced solely on the short-term memory basis. There is little opportunity to consolidate or to consign the incoming data to a conservation process. Even granting opportunity, there are no pegs on which to hang the acquisitions as they appear. This has prompted Nelson Brooks (56) to refer to the learning of a foreign language as "not a subject, but a process; a change in performance--essentially a problem in psychiatry." It has prompted Penfield (245) and Piaget (249) to claim that kindergarten is not too early to start
planning for old age.

Since so many adult learners express interest in the mastery of a second language, and since large numbers of those who are initially interested but become discouraged and drop out in the early stages of learning, it may be pertinent to review the reasoning of Dr. Wilder Penfield, who has been strongly influenced by the theories of Piaget, with reference to language acquisition involving both the long-term storage and short-term memory principles: (245:14-16)

The brain of a child under 10 is a living, growing, changing mechanism. It deposits within the brain language units (pegs) which it will later utilize for all additions to vocabulary. These are the units of pronunciation and also of understanding. The unit is recorded in the nerve cells of the brain for use in that language immediately or at some later time. . . A child who hears three languages instead of one, early enough, learns the units of all three. These units are stored in the brain ready to respond at any other level of language acquisition.

Penfield's argument here, based on the developmental learning theories of Piaget, is that the more languages a child hears before he starts to think about them (the Cognitive Stage), the better able he will be to acquire these languages later on. Being able to reproduce the French "u" or "r", or the German or Gaelic "ch", or the Norwegian "kj" would likely remain for life even if the structures and vocabulary of the languages themselves faded through lack of use. With these "pegs" available, the argument is that new sounds and
vocabulary would be more easily transferred from short-term memory to long-term retention and ultimate consolidation.

If Penfield's theory is indeed valid, then even our latest experiments with the Saint Cloud Voix et Images and programmed laboratory study may be subject to greatly restricted application, not only for adults but for children as well, on the assumption that too great a strain is placed on short-term memory for assimilation to be attained efficiently.

Warfel (330) considers language acquisition as a behavioural science, and concludes that the older the person, the more difficult he finds the task of learning new sounds since he has missed the training practise level of "babbling". Both the brain and the speech tract, he claims, are capable of handling all human speech sounds and, therefore, all languages. The average person's speech tract normally produces only one code because it hears only one code--the one thrust upon him at birth. He has not had the opportunity to hear other language sounds and so he has not made them. To focus then on foreign-language acquisition by the adult, Warfel recommends hearing the differences between phonemes which are not used in one's native language, and learning to make the motor movements adequate to proper production of the foreign phonemes rather than learning to respond, however effortlessly, to verb drills and patterned sentence drills.
Impairment, Perception, and Set

Kral (187) discusses impairment of memory function in aged people as occurring in two forms, both significantly related to increasing age. The malignant type has to do with the loss not only of relatively unimportant data but with the loss of whole recent experience and orientation, while the benign type depends to some degree on the amount of attention or interest involved at the time of reception at the immediate memory level. When, after having committed to long-term memory certain material, a sudden change of circumstances requires that a name, a place, or a date be produced and it is found not to be available on demand, the individual experiences impatience or even anxiety. In an instance of this nature, the individual will frequently make compensatory gestures to offset the shortcoming.

Welford (347) discusses the dynamics of short-term memory and cites the Craik hypothesis that the essential feature of thought is not the mind, the self, or the sense data, but a form of symbolism involving selection of data from what is presented, classification, short-term memory storage, the building of conceptual models, decisions, and checking. But these processes, Welford feels, are more the results of thinking than the central core of the process whereby data are co-ordinated and recognized.
Short-term retention seems to enter into a number of complex performances, enabling events and actions over a period of time to be co-ordinated, but Welford (347) that there are indications that several different types of storage are involved, operating on different time-scales from a fraction of a second up to a few minutes. To date, most studies in relation to age and immediate memory have been confined to the retention of digits or similar material over a few seconds. There is need, according to Welford, in the study both of aging and of human performance in general, to consider other types of short-term storage of data.

One type of short-term retention seems to be the basis of perception combining visual, auditory, kinaesthetic, and tactile data, all integrated over periods of time. Welford cites Szafran (302) to point out "that frameworks of perception based on the above data may be impaired in senility, but there is little knowledge beyond a few exploratory studies of how they are built and maintained and the extent to which they change in the normal course of aging."

Vernon (323) writes:

". . . perception is never instantaneous. Even in the case of the primary memory image, scanning takes place. There is evidence to show that faulty perception occurs less from the original intake of information than from the necessity of storing it in memory for more than a very short period of time.

The degree to which acuity of the senses can relate to the
compilation of knowledge is dependent upon the "set" or the state of expectancy of the learner, and also upon his emotional state or his preferential bent. This is perhaps another way of saying that perceptual efficiency is dependent on a state of positive interest being aroused. Vernon comments as follows: (323:165)

"... it seems that an observer's perception of the field, or any particular aspect of it, may be made more rapid and accurate in so far as his attention is directed towards it."

Many experiments have been made in coaching, training, or improving perceptual skills. Aids to concentration and the ability to disregard or eliminate distractions have been, in some instances, effective, whereas in other cases, perception is facilitated by means of relaxing of efforts and release of tension. Vernon (323:166-67) mentions an experiment involving the use of a light or sound signal:

"It is customary to give the observer such a signal, a light or a sound, at a regular interval of time before presenting the stimulus of threshold intensity. Recent experiments have shown, however, that the lowest thresholds are obtained if the warning signal is given simultaneously with the stimulus; and and also that thresholds may be lowered, though to a less extent, by a signal given after the stimulus."

Vernon further clarifies this result by explaining that, in the above instance, it is not a simple alert signal but also a "message" to the short-term retention centre to consider the material it has just received as significant.
Function in Learning

Bromley (55:215-16) sketches the plan of the conversion of incoming data through the processes of reception to the incorporation of knowledge:

Short-term memory sets up a temporary trace and involves a definite effort to remember. Long-term retention, on the other hand, provides a more durable record which appears to involve little or no further effort once the information has been committed to memory, except the effort required for its retrieval. Learning involves a transfer process whereby information is held in temporary store until a permanent record can be established.

The amount of learning necessary for a piece of information to become permanently recorded depends upon many things. Sometimes trivial things can be remembered effortlessly and without practice, whereas other material is learned slowly after many repetitions. Short-term memory, as has been previously stated, declines with age. To this information, Bromley (55) adds that long-term memory is relatively unaffected by age, except by disuse. Temporary systems of ideas are built up, used and discarded in many intellectual activities, but the more complex the process, the more likely it is to be impaired as age advances, except where added experience counteracts the effect. Older people may not appear to be less competent, because most tasks in everyday life are not intellectually demanding; but if the task involves a lot of information and a complex pattern of mental activities,
and especially if the conditions are paced, immediate memory carries a heavy load and is liable to fail.

An example of immediate-memory failure would be the reading of an involved and complex sentence or paragraph. If the reader has forgotten parts of the previous sentence, as a result of short-term retention gap, he is obligated to start again from the beginning. The moral, claims Bromley (55) is obvious; when writing for older people, sentences should be short and simple, and the material should be presented in a way which makes it easy to grasp and assimilate.

Immediate memory enters into most, if not all, intellectual activities. If it is impaired by aging, some decrement in intelligence is likely to occur. By using his experience and by reorganizing his approach, an older person may be able to compensate for his reduced capacities. Mnemonic devices have been found to delight the more mature learner when he is confronted with new material not easily linked with stored knowledge. Adults gain confidence as each challenge is successfully met, and the challenges of this nature, particularly if reinforced, embrace a high degree of success. Most people already employ many different forms of mnemonic aids which have been developed gradually over the years to compensate for the gradual realization that the function of short-term memory was on
the decline.

Nyiro (240:710) disagrees with the notion of some authors that memory can be disassociated from intelligence and summons Thorndike for support:

It is high time that physiology should free itself from the misconception of regarding human mind as a machine, the diverse elements of which have the power of sensation, perception, discernment, imagination, memory, understanding, association, reasoning, selection, habituation. . . . there are only connections between the various elements of human intelligence.

Our mental functions, Nyiro believes, comprise, among others, perception as the basis of concrete cognizance, and attention through which the thing perceived is converted into the thing conceived. The energetic drive of this activity is greatly enhanced by interest. All these processes are prerequisites of forming faithful and deep impressions. But learning is something more: (240:710)

. . . . the capacity of connecting our impressions with past experience and of retaining them until recalled, has further prerequisites, such as purposive, volitional activity, interpretation of the impressions received, logical, purposeful thinking, abstraction, recapitulation, and consistency.

Old age does not necessarily imply a decline in the faculty of understanding or in the intellectual functions. This is accepted today as a psychiatric truth, since many elderly people are still capable of admirable mental performance in spite of a very advanced age. Yet,
in many elderly persons, a decline in certain mental functions be­comes noticeable. There is no regularity whatsoever in the suc­cession of the various mental functions. In some elderly people, the perceptive faculty is first affected, in others it is the memory, in others again, the integrative capacity. The various defects may remain isolated for a long time without influencing the global mental performance, and it may even occur that the old person recognizes his defect and is still capable of overcoming it.

Mental decline arising from sensory defects is generally not serious. Psychiatrists report depressions arising from a realiza­tion of sensory decline which adversely affect performance on intelligence tests, but there is little assurance that what is being reported is an actual decline of intelligence. (21:298) Fatigue arising from the considerable strain of trying to compensate for physiological losses in age undoubtedly create anxieties which can interfere with the functions of attention and thus confuse, in turn, the learning issue. Failure of retentiveness is practically always encountered in elderly people for the names of places, people, dates, and similar material. Vocabulary suffers little, if at all; many sources, indeed, incline towards the belief that continuous learning supports the continuous development of vocabulary well into old age. The German psychologist, Peters, believes that a healthy, mature vocabulary must necessarily be rich in synonyms which spring automatically to
bridge the gaps. Hunter (155:324) notes that long and arduous inquiry into the functioning of human beings has resulted in discoveries relating specifically to memory and learning:

. . . 'memory improvement' is the problem of organizing the learning task with special regard to three aspects, namely, surveying the requirements of the task, organizing the material, and repeating what has been learned.
CHAPTER VI

ADULT PERFORMANCE FACILITY

Say not thou 'what is the cause that the former days were better than these?' for thou dost not inquire wisely concerning this.

- Ecclesiastes VII, 10 -

The one popularly recognized physiological change associated with age is a change in speed coupled with increasing difficulty in task performance. (306:370) There is a slowing down of motor and cognitive performance with age, but there is little agreement concerning the causes, effects or even implications of the change, and there is no agreement whatsoever concerning the age at which the expectation of decrement can or usually does occur. The concept of youth and age has changed over time. Thorndike considered the ages of 20 to 24 to be young while anything over 35 was thought to be old. At present from 20 to 45 is considered young with age 65 and over as the age at which one might expect to find measurable decrement in performance. Cumulative data provide a basis for optimism pertaining to the fundamental capacities of the aged to manipulate acquired information and to learn new performance skills. The salient point to bear in mind when considering the facility and
flexibility of performance in an older individual is that he is an individual before he ages and he will remain an individual while he ages; it is his individuality more than his age that must remain in focus. Korenchevsky (185:471) writes:

Mentally, the old persons of today can be, in general, represented by two extreme types which differ from each other in every mental capacity and in every trait of character. In one type, mental abilities are preserved in a surprising way while in the other they are greatly impaired, almost lost. Between these two extremes, there are numerous intermediate types of old age.

This chapter will consider the changing nature of motor and cognitive response in age together with the resultant effects on the nature of the adult learning experience.

Interdisciplinary Nature of Adult Performance

In discussing the cognitive and adaptive processes and resources of people in general, Wigdor (351:549-556) stresses the occurrence of marked individual differences as well as the varying degree to which each individual is able to compensate for actual biological or physiological deficit. Lorge (207:173-79) proposes that speed obscures sheer mental power in older adults and concludes that the correction for the penalty of age may be a correction for remoteness from formal schooling, for disutility of function, for lack of motivation, or for other physiological, educational, or psychological changes. To these must be added a correction for
sociological changes since our present culture enforces the elderly citizens to premature disengagement, a situation which triggers emotional reactions well recognized as inhibitors of prompt or efficient performance. (356:301ff., 219, 351) Yarrow (356:293) reports poorer daily functioning as a result of changes in self-image. These considerations clearly point to the need to probe further into the environmental as well as the psychological and physiological bases for the decline in psychomotor speed and in mental ability shown by some individuals in later life. Alternately, they point equally clearly to a need to search for the bases for maintenance of high-level capabilities of motor and mental performance. Granick and Friedman (122) affirm that deficit performance involving psychomotor speed and sensory efficiency would almost certainly be associated with biological decline. Still, no one single factor is likely to account for the highly individualized kinds of psychometric test performances manifested by the aged. In this area, Granick points out that the biologic factor undoubtedly plays a significant role, but that the psychological factors must be given serious consideration also, particularly with respect to such areas as: accumulated intellectual attainments, changes of motivation and interests, recent experiences, and consolidation of habits. The study of age in
relation to speed or reaction time must be, then, essentially an interdisciplinary study.

Change in Motor Performance

Thumin (310) reports that among the most reliable facts known about human aging, are the tendencies toward psychomotor slowness. Riegel and Birren (263) trace age differences in the pattern of the growth of interest in simple and choice reaction times starting with the experiments of Galton, through the interpretations of Ruger and Stoessiger in 1927, to the analyses of Miles in 1931 who attributed the differences in reaction and movement time, primarily, to a decline in speed of movement in the latter years of life. More recently, Crossman and Szafran (82), citing Welford (345) and Griew (125), have studied age differences in reaction time as a function of response uncertainty.

Birren and Botwinick (27) reported that highly practised skills such as handwriting and typing become increasingly "segmented" in old age so that patterns of movements once made as smooth, connected sequences become disjointed. La Riviere and Simonson (199) used these findings as the basis for a series of experiments to try to relate age and occupation to writing speed. They made a detailed analysis of subjects in the 40 to 69 age range, as these are the years in which many motor skills are declining, and investigated the influence which occupation had on the rate at which this slowing occurred.
The research task was to copy a prescribed series of numbers as quickly as possible while maintaining legibility. The subjects were arranged into groups according to occupation with three age levels within each group: 40 to 49; 50 to 59; and 60 to 69. The experimental Group 2 was set up against two control groups as follows:

Group 1: Professional and business men in executive, supervisory, or managerial position.

Group 2: Railroad clerks, secretaries, bookkeepers, timekeepers, clerks.

Group 3: Railroad laborers, manual laborers.

The study suggests that there is a decrease of speed with increasing age and that this decline becomes apparent sometime after the mid-fifties. In Group 2, the writing speed of 60 to 69-year olds was no slower than that of the men in the 40 to 49-year category. The absence of slowing in this group may be partially because the skill tested was one which the subjects have used daily for many years. Older men in clerical occupations may also be motivated to perform well at such a task in order to show that they could do as much as a younger clerk, or to demonstrate to themselves that "they are still as good as they were 15 years ago." These conclusions reinforce Thorndike's claim that the rate of decline in motor performance is more rapid for tasks which are more meaningless than for those which are useful. Most investigators observing the elderly in
experimental situations have recorded the impression that the aged make more effort to perform optimally, although they may "psych-out" or intentionally disqualify themselves from competition at times when the quality of their performance does not satisfy them in order to avoid a reduced self-image. (41:301)

Wigdor (351) reports a tendency to slower performance in speeded tasks and in motor skills after age 50, but factors of habit and experience frequently help to compensate for this deficit. A contributory factor in this slowing of response time may be due to reduction in sensory input due to slower sensory acuity. She claims that if effector response time were the only factor, older individuals would show quicker reactions in self-initiated tasks or responses. The evidence does not indicate this but rather that all behaviour tends to be slower in the aging organism. The view most generally favoured, according to Wigdor, is that slowness of behaviour is the principal manifestation of a primary process of aging in the central nervous system. This may be due to loss of cells and other age changes in the physiological properties of nerve cells and fibres. It is felt that in instances of lengthened reaction time, such as those involving discrimination and choice, the central nervous system is involved. Birren (22) comments that while relatively simple reflexes may be slower with advanced age, the differences
in time are small compared with the time differences found in voluntary activity.

Weiss (339:155) writes as follows:

Older subjects tend to have sensory limitations and are also slow in responses. In many situations where the task requires operation on or manipulation of symbolic materials, it is not clear whether the slower output and errors result from the necessity to take additional time to perceive the pertinent information, or whether the older organism is less 'activated' or 'energized'.

Further analyses of the data in relation to the physiological and personality aspects of the individuals are required. Within the limitations of the present data, it is not clear to what extent older subjects are slow because:

1. They require more time to perceive externally presented information; the deficiency being perceptual and the time change an adaptive consequence.

2. They do not 'need' to be slow but are so because of a commonly adopted set or habit pattern.

or

3. They are slow because of a lower level of activation.

The concept of a less activated older organism may be further refined to allow for distinctions in behaviour which result from less interest, therefore lower motivation.

Jarvik and Falek (159) made a longitudinal study of 78 elderly
subjects over a twelve-year period. The subjects, at least 60 years of age at the time of the first testing, were given a battery of tests on three different occasions within the test period. A decrease in score on the speeded motor tasks was shown by 60 percent of the participants, while over 20 percent increased on vocabulary. On the remaining tasks of the test battery, i.e., similarities, block design, and digits (forward and backward), 42 to 63 percent failed to demonstrate a change in performance in a ten-year period between first and last testing. The intellectual changes observed on longitudinal testing seem to be influenced to only a limited extent by chronological age as such. With those who suffered critical decline in intellectual performance, subsequent demise was listed as a result of cerebrovascular or cardiovascular disorder. A positive relationship was found between five-year survival and stability scores on vocabulary, digit symbols, and similarities. Persons who showed a critical loss on two or all three of these tests had a significantly higher mortality rate than did subjects with a critical loss on less than two tests.

Although education is important in performance, and the incremental effects of education are greater than the decremental aspects of aging, the results of Granick and Friedman's experiments were that there was little or not significant correlation with education on tests of biological efficiency, particularly in the visual and sensory acuity area such as near and far visual acuity, flicker-fusion, colour
vision, depth vision, and two-point tactile discrimination. (122:192)

Botwinick and Birren (44:97-108) have quoted Welford to suggest that humans over 60 may approach perceptual motor tasks with a reduced level of confidence. They perform poorly in serial tasks, tending to review too many factors before making responses. Responses were slow to both auditory and visual stimuli, but the slowing was thought to rest in the function of particular muscle response groups; e.g., the effector responses of finger, jaw, foot, and speech reactions which have all been shown to be involved.

**Reaction Time**

Reaction time is a measurement of the time interval elapsing between the application of a stimulus and the manifestation of some arbitrary motor response. A variation in reaction time may be due to some change in the receptor system, in the conducting mechanism, in the central relay, in the efferent path, or in a combination of all of them. As the rates of aging on these components are dissimilar, an understanding of what happens is correspondingly difficult. Until motor response and perceptual demands can be nullified, it will be difficult to settle once and for all the extent to which senility may slow down some of the afferent portions of human reactions to stimuli. The study of reaction time has been prominent in the effort to understand the aging processes.
Brinley and Botwinick (51) conducted experiments to discover factors in aging related to the slowing of psychomotor processes. Response times of two age groups (19 to 32) and (65 to 81) were measured in conditions which varied the duration of the interval between a warning light and an auditory signal for response. Simple response times were measured for warning intervals of 0.5, 1.0, and 4.0 seconds. In other conditions, the subjects were required to choose from either two or four alternative responses during the same warning intervals. Age differences in response time were increased significantly in both the simple and the choice conditions when the interval between light and auditory signal was 0.5 seconds. A small amount of practice reduced the age differences in both simple and choice conditions even at the 0.5 level. Older individuals may experience difficulty in learning to prepare for a response during such a brief interval. Birren and Botwinick (28) suggested that the decrease in performance with age is, in part, due to increasing difficulties in perceiving stimuli.

Botwinick and Brinley (41:301) arrived at the following admittedly inconclusive hypotheses relating to certain aspects of reaction time:

1. The elderly need more time than the young to organize a response for a coming event.
2. The elderly need more time to re-organize ready for the next response.

3. With age, there is an over-all slowing of processes.

4. The warning signal sometimes in itself is distracting to older people.

There was some difference noted between men and women, but the evidence was inconclusive.

Hodgkins (150) studied reaction speed in girls and women aged from 6 to 84. It was found that the fastest times were recorded by subjects in their 20's, and the speed of reaction of college women was significantly faster than that of any younger age group. The findings with regard to reaction time tend to suggest that perhaps the age at which maximum speed is reached by women is slightly earlier than that of men. There is some evidence to show that girls reach their maximum speed of movement at an earlier age than do boys. Speed of reaction increases with age until about age 19, and then decreases; but, up to the age range of 70 to 84 years, reaction time remains faster than it is at age 6. Speed of movement increases with age to approximately age 15; begins to decrease at approximately age 26; and, by 80 to 84, the speed of movement is approximately the same as at age 6. Maximum speed of movement in females is reached at an earlier age than is the maximum speed of reaction. Reaction time
Reaction time improved with age up to age 19; remained constant to age 26; and then decelerated with age. Movement time improved with age up to age 15, remained constant to age 19, and then decelerated thereafter.

Talland and Cairnie (306:370) noted that the effect of aging on speed in simple reaction time seems to be pronounced by the late sixties. With older people, the immediate effect of any alerting signal is inhibitory—and more markedly so in old age. In the same study made three years later, Talland modified his earlier findings. While still of the opinion that speed of response tends to decline with age, and while agreeing that it is unlikely that this effect can be halted, Talland concluded that certain expedients might soften its impact. Forewarning at suitable intervals could conceivably offset the effect of aging if these should stem principally from a need for longer preparation. Earlier studies showed negative results in the use of preparatory signals. Alerting signals helped the young subjects to speed up response but not the older subjects on whom they seemed to produce an inhibitory effect. In old age, the optimal condition was that provided by auditory warning followed by a visual response signal. In youth, the reverse combination resulted in the best response. Older individuals gained rather than lost in speed with longer alerting intervals. The suggestion that longer foreperiods, whether by allowing
for more efficient preparation or for the dissipation of inhibitory responses, would restore this effect of age on reaction time proved incompatible with the findings.

McFarland, Tune, and Welford (217) studied movement, response, and reaction speed in older citizens entrusted with the handling of vehicles in ever-increasingly complex traffic situations. The percentage of driving licences held by those 65 years of age and over has tended to increase and will likely continue to do so. Accidents are relatively high in the age groups above 60 or 70. The most common faults of the over-65 drivers are:

1. Failure to give the right of way.
2. Improper turning.
3. Ignoring the road signs—particularly the stop signs.
4. Improper starting.

The writers feel that adult education has a responsibility to investigate age changes which render old people less capable than the young or exercising the necessary skill to avert some traffic accidents. As people grow older, they tend to compensate for their failing capacities by more and better use of experience. Nevertheless, driving requires a person to scan a continually changing display of information, and to select what is relevant and then to make judgment and to act. As the complexity of the situation increases, more time is required or else
more errors are made. Slowing with age can show as longer time to make decisions or, if decision time is limited, errors result.

Some results of slowness are:

1. Longer time to observe traffic conditions so that when looking both ways at an intersection, the information from one direction will be stale by the time information from the other direction is received.

2. When an older person is forced to make a decision too quickly, he may select only those signals he deems important. (Griew and Tucker (128) found that older machine operators used fewer of the available controls on the machines than did younger operators.)

3. When events occur rapidly, inadequated decisions can result in errors.

4. Corrections to misjudgement take longer to make. The older person is not so quick to change a perception already reached.

Change in Cognitive Performance and Perception

Early studies of cognitive processes in the elderly were almost solely descriptive investigations. More recently, descriptive data have been analysed with respect to mechanism or antecedent conditions. For example, when intelligence tests are given to elderly adults, it is found that general information and vocabulary abilities rise or are maintained while decline is seen in functions that require
speed (44) but even in verbal skills, it has been shown that differential changes occur with age. (259, 260) There is, therefore, the task of explaining why some psychological functions increase and others remain the same or decline with age. When age changes in speed of response are investigated, it is found that central nervous processes may be involved. Birren (21) et al. concerned themselves with a comparison of healthy, non-institutionalized, aged men with a group of seemingly healthy but early-disease suspect individuals to try to determine true aging if possible. From this study it is impossible to state whether the behaviours which seem intimately associated with aging are simple or multiple phenomena. Loss of speed, for example, may result from a change in component capacities rather than in a general overall loss. In advanced age, does one hear less well because one cannot put words together sufficiently rapidly, or does one hear less well because one cannot receive the input? In the former case, a general mediating process is implied, and in the latter case, a deficiency in a specific sensory modality is suggested.

Wigdor (351) notes that age is involved with reaction time, and that it seems to become increasingly involved in complex choices and associative processes. While admitting that there is no great certainty as to the underlying causes of the neurophysiological slowing with age, she does not resist the increasingly common but
somewhat controversial theories related to reversibility. Although there can be some justification in accepting the modifiability of the aging processes, the major concern is their relationship to adult cognitive performance. Changes with age, according to Wigdor, in the primary ability to learn are small under most circumstances until over the age of 65 or 70. When differences do appear, they may be attributed to processes involving perception, set, attention, motivation, and the physiological state of the organism (including that of disease states.) The various abilities also show varying degrees and times of decline with verbal tasks such as vocabulary or information having little or no decline until very late in life, while visual-motor tasks, along with some types of abstract reasoning or arithmetic show somewhat earlier decline. Habituated tasks show slower decline than less familiar activities or tasks. Highly speeded tasks of any nature can begin to decline in the fifth decade. Adults of superior intelligence who do not become the victim of a disease process show better retention of intellectual capacities than individuals of originally lower intellectual capacity. Finally, Wigdor draws attention to some recent studies which relate to Piaget's theories of the maturational aspects of higher cognitive processes. It is the capacity for certain types of abstract reasoning—which Piaget claims are not fully developed until about the ages of 12 to 17—which seems to be first impaired in the
aging individual.

In learning tasks on which older persons perform less well than younger people, the differences appear to be of degree rather than kind. Sensory processes and movements in skill, according to Bromley (55:193), are relatively unimportant in comparison with the covert translatory operations which mediate between them. When a certain sequence of circumstances have been learned according to a set of rules which have governed reasonably successful performance for a length of time, the previous learning must first be negated before new learning can take place. In other words, the old sequence must be "translated" or modified into a new sequence. Illustrations of this phase of learning can be observed whenever a typist switches from a manual to an electric typewriter or when a driver switches from an automatic transmission back to a gear-shift mechanism. The older person experiences more difficulty than does the younger in learning where old performance must be translated into new procedure. Leh­man (202) describes it in these terms:

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. . . When a situation requires a new way of looking at things, the acquisition of a new tech­nique or even new vocabularies, the old seem stereo­typed and rigid. To learn the new they often have to unlearn the old, and that is twice as hard as learning without unlearning. But when a situation requires a store of past knowledge, then the old find their advan­tage over the young.
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The effects of age on the learning process have been subjected to
considerable investigation. The study of Wiersma and Klausmeier (350) was to ascertain:

1. Whether groups of three different ages were able to attain concepts with equal speed,

and

2. Whether the degree or number of errors committed during the acquisition process differed significantly as a function of age.

The ages in groups were: 20 to 24; 25 to 34; and 35 to 51. The findings resulting from this study were that there is a decline in the speed of concept attainment with increasing age, and that a possible explanation for this decline might be sought in the "Disuse Theory" of Wimer. (353) The disuse theory would attribute the decreased efficiency to a lack of practice in learning situations. Thus the disuse of new learning experiences may be reflected in the "forgetting how to learn" phenomenon experienced by older individuals.

A substantive result of the Wiersma and Klausmeier study is that the older group required significantly more time than either of the younger groups to identify the concept which is possibly an indication of a rather sharp decline at some age between the ages of 35 and 51. This study wishes to induce further that old teachers may experience difficulty with novel or complex tasks encountered in the
in-service type of education as well as regular college work; therefore not only adult education but all education should be aware of the difficulty which is inherent in changing once-established concepts.

Susceptibility to "set", or difficulty in surmounting its effects, appears to be greater for elderly adults than for younger ones in perceptual behaviour as well as in problem-solving behaviour. Botwinick, Robbin, and Brinley (43) in experiments utilizing the ambiguous and non-ambiguous sketches of "my wife" and "my mother-in-law" demonstrated that older individuals tended to hold tenaciously to their expectations and were not capable of reorganizing their perceptions as readily as did the younger ones. They interpreted these findings in terms of a generalized deficit in modifying or inhibiting ongoing tendencies.

Riegel and Birren (263) discuss recent theories concerning the tendency in older people to become less capable of thinking in abstract terms. There tends to be some renewed interest in some earlier findings which inclined to support a theory that age differences in verbal behaviour are a result of a shift during aging from abstract to concrete behaviour and conceptualization. Bromley (54) presents the same theory in slightly different terms with reference to the impairment through normal aging of the cognitive mechanisms involved in conceptual thought. Older people become not only less
able to form abstract principles but also less able to recognize them when they occur. When they are offered a choice of interpretations in a multiple-choice test, they more often choose the literal, particular, and concrete answers.

An extremely important area to explore more fully might be the conditions under which adult learning capacity can be kept at its optimum. The one recurrent theme interwoven throughout countless discussions of the changing nature of cognitive processes with age is that of the relationship of continuous education to continuous quality of intellectual performance. Granick and Friedman (122:191) in their discussion on psychometric testing and age, report that a decline in measurement speed of mental abilities is consistently demonstrated, but that the rates of decline are different for various educational and occupational groups. Moreover, some mental functions are found to decline relatively little in comparison with others which drop precipitously as aging proceeds. Education is an important condition in mental performance, and the incremental effects of education are greater than the decremental aspects of aging. The tests which they used involved cognition, attention, perception, visual-motor coordination, and sensory acuity. In all of these areas, the negative correlation of education with age was a significant factor in the functional decline associated with advancing age. Control of
this factor, therefore, will reduce, and in some instances, eliminate much of this apparent functional decline. The scores which continued to show significant decline with age were measures of sensory efficiency, psychomotor speed, perceptual flexibility, and abstract thinking. All types of timed tests consistently correlated negatively with age while no significant age-related decline was found in most of the untimed tests. Granick and Friedman (122:191) concluded that the decline of functioning with age is less extensive and slower in developing than is often reported.

**Affective Influence of Age on Performance**

It has been implied frequently that it is important to discover and recognize those factors in aging which are not necessarily inevitably or unalterably part of the aging process but are subject to preventive and therapeutic measures. Eisdorfer (104) reporting on an age-related decrement for rote learning, states that men aged 60 years or older do not learn as well as do younger men. Recent analyses of this decrement, however, have led to the conclusion that performance difficulty rather than a true learning decrement may be responsible. Aged persons are less likely to respond during rapidly-paced learning tasks than the young. Heightened task anxiety may be the basis of the response inhibition at faster speeds. The aged, at the same time, may apply a more cognitive approach to learning.
Birren (21:300) refers to an hypothesis than an interaction of hearing loss with reduced state of health results in a slowing down of performance. The relationships between cognitive and psychomotor capacities and the life situation of the aged subjects suggests a pattern of association between poor functioning and deprived circumstances. An explanation of these associations may lie in the relationship between losses and the individual's affective state. The effect of losses upon cognitive and psychomotor behaviour may be mediated through the depressive state of the individual. Although the mechanism underlying the relationship between speed and depression are still unknown, some speculation might be permitted as to a possible connection between (1) poorer scores on tests involving speed of response and (2) deficiency states introducing depressive trends in the lives of those being tested.

The principal hypothesis put forward by MacLeod (219) was that damaging degrees of deprivation brought about by various kinds of social isolation during critical life periods can seriously handicap the individual in learning. Since we isolate our older citizens, thus creating deficiencies, how then can we test them and expect to get a full-measured result or evaluation in mental capacities.

Granick and Friedman (122) spread the responsibility over a wide field of possible reasons for a decline in performance with age
noting that any single factor is not likely to account for the kinds of psychometric test performances manifested by the aged. The biological factor undoubtedly plays a significant role: psychological factors must be given serious consideration, particularly with respect to such areas as accumulated intellectual attainments, changes of motivation and interests, recent experiences, and consolidation of habits. Essentially it would seem that such complex factors as perceptual flexibility (rigidity) and abstract orientation are of both a biological and psychological nature. It would be difficult to try to differentiate these two categories or to assign causative roles to each. They conclude that there is probably interplay between these two broad factors with compensations and correlations between them being generated in various individuals. Thus some people might respond to sensory loss by increased motivation while others might become discouraged, depressed, and fall much below the level they can, in reality, attain.

Gouchman (120) feels that there is some support for relating anxieties arising from induced stress such as threat to reduced performance in reading speed, comprehension, and the delayed recall of reading material. With adults, the subjective analyses of their ability to achieve may significantly affect performance or even aspiration to perform. Fears of inadequacy and anxieties over present
and future living circumstances can serve as blocks against learning or adapting to change. The level of anxiety or feelings of stress are significant variables to consider in connection with learning. (182)

Lorge (206:49) notes:

Adults learn much less than they might partly because of the self-underestimations of their power and wisdom, and partly because of their own anxieties that their learning behavior will bring on unfavorable criticism.

**Effects of Aging on Job Training**

It has been assumed that individuals over 40 years of age do not train for new jobs as easily as do younger people. Murrell (233) suggests that the criteria by which success in training is judged frequently involve time-stress factors and therefore favour the younger trainees. He suggests, also, that success or failure in job training is often judged by the performance or knowledge acquired by the end of the job rather than on subsequent performance on the job. Murrell is inclined to evaluate the trainee not on how well or how quickly he has learned to reach passing standards of efficiency, but on how permanently and how reliably he performs from then on. In other words, the speed of the learning should not take precedence over the evaluation of the performance after the completion of learning. His research revealed that older trainees continue to improve in performance even after reaching efficiency standards.
A study of the performance of older workers on industrial retraining programs revealed the following information: (301)

1. There is no factual basis to justify barriers to the entrance of older workers to training programs.

2. Although younger trainees seemed likely to respond more readily and to learn more quickly, particularly when courses were short and emphasis was on rapid acquisition of perceptual-motor skills; when the training was in terms of longer courses, older workers more often performed as well as or better than younger workers.

3. Evidence contradicts the notion that older workers cannot learn or be retrained. The findings imply that age by itself is not a reliable or even a useful criterion for determining the suitability of trainees.

4. The findings reaffirm the importance of appraising a worker's adaptability on the basis of individual capacity and aptitudes rather than on chronological age.

5. The study revealed the importance of counselling in helping the worker, not only in an assessment of his ability, but also in allaying his apprehensions about training.

6. Fragmentary evidence suggests that lack of education may be a serious handicap for older trainees as compared to younger.
Specialized study of the problems of aging is in its infancy, therefore present programs designed for older groups must be considered "largely experimental". (319:292) An awareness that older adults in industry under retraining programs are experiencing special anxieties not shared by younger adults in a similar situation must be appreciated under the following terms:

1. For an older adult, success in the particular learning experience may be tantamount to his maintaining his present position, whereas failure might mean dismissal or relegation to a position of lesser dignity resulting in loss of prestige and self-esteem; to the younger adult, this may be only one of several opportunities he can expect to receive in the course of his career. Therefore, it is less of a "do or die" proposition for the younger trainee.

2. An older adult may force himself, through a compulsion to prove himself still worthy of promotion or, at least, to prove himself still of value to the firm, to perform optimally with resultant tension and early fatigue; a younger person can coast without undue strain, and he is more quickly and completely refreshed during periods of relaxation.

3. An older adult in training along with younger persons is more likely to be aware of the competitive nature of the situation; the younger person is less likely to consider the older adult a threat.
Bromley (55:186-90) refers to a tendency whereby older workers, without being aware of the process, tend to simplify a complex procedure by dropping out those parts which seem to be less essential. This, he claims, is a normal process, but it can lead to errors and omissions if the older person sheds an element of behaviour which is critical; for example, failing to make a safety-check at the appropriate time. In addition, the older person may lack the inhibitory capacity of a younger man, and may be unable to stop himself in time when he perceives that his action is inappropriate. Or, it is possible to switch one's attention too soon so that one fails to notice critical events which may result in accidents.

Human beings are exposed to two sorts of risk in judgement; they can ignore a cue when it is relevant, or they can pay attention to a cue when it is not. Both occupy time, and minimizing one risk increases the other. Older people, too, are slower to recover when thrown off balance, and slower to move out of the way of a moving object.

The older adult, then, has distinctive needs in the way in which he is introduced to and oriented towards training, and in the way in which he is taught. Where these needs have been catered for, if only in a partial and incomplete way, the measure of success has been high, the failure rate low. (14)
A learned man is an idler who kills time by study.

- George Bernard Shaw -

The concern of this paper has been with the specific nature of the age-related physiological changes as they might affect an adult's behaviour in a learning situation. The results of cross-sectional investigations have revealed no "typical adult", nor even a typical or an average progression in any aspect of physiological development, with the possible exception of visual acuity. It is possible to determine that, on the average, men of 30 learn more easily than do men of 60; but until such time as longitudinal studies are completed in sufficient quantity, there is little reason to assume that the average abilities to achieve which have developed under specific conditions are the only possibilities. Non-interrupted education is mentioned repeatedly as having a profound influence on the performance quality achieved by older adults in a variety of learning situations. Shock (288) reviews the problem by posing these questions:

1. What kinds of patterns occur with aging in different types of functions?

2. What are the educational problems of aging?
John A. Young (357:145 ff.) has this to say:

Each individual learns in his own way; each individual's learning style is as unique as his fingerprints. It is the adult educator's responsibility to be aware not only of the needs of his learners, but also of their manner of adapting and of compensating.

The evidence with the greatest impact for the education of adults lies in the areas of previous learning, recency of learning, and habits of learning. The recommendation evolving from a distillation of these findings might well be that the opportune moment to commence adult education is at the infant level.

In this concluding chapter, no attempt is made to deal with the volume of knowledge being accumulated in the field of learning. The concern here is with those references which deal specifically with the effect of aging on adult learning performance.

The labour force in Canada will expand from 58.5 per cent in 1961 to just under 62 per cent in 1971. In this number can be included a new wave of working wives. There are educational needs not now met by adult education, not the least of which is the need for understanding and use of the processes involved in physiological aging. Linked to understanding is the ability to communicate, which brings into focus the skills of reading, hearing, speech, voice, and language. People who have a problem in any of these areas are limited in their ability to communicate with others and, consequently, in the
development of understanding. There is little available data about the prevalence of communicative disorders in adults, but what is known warrants consideration. Some of the difficulties in the education of adults have been related to a gap between knowledge of physiological developments and the instructional processes which would serve to complement these developments.

That physiological changes with age can alter learning efficiency but not learning quality is a basic premise of the philosophy of continuing education theorists. In addition, it is well categorized that older people can learn and, under certain conditions, do learn. There is a widespread belief in professional circles that education, even for the very elderly, is needed and that it can achieve effective results, but declining energy levels and physical limitations imposed by chronic conditions serve to reduce the inclination of older people to engage in educational activity. The reality of physical slowing-up cannot be denied; it requires the individual to make a determined effort to set off on new undertakings. (335:20-22)

Adults are different learners and, therefore, require a different social and educational environment in which to learn. In this instance, physiological differences related directly to the skills of communication are selected for particular consideration so that an appreciation of some of the specific conditions under which continuing learning is operating can be realized. An awareness of these
differences will emphasize the need for adjustment of existing facilities for adult education and underline the urgency for establishing a learning environment more in harmony with adult needs.

**Vision**

1. **Developments**

   a) The near-point of vision recedes to a point where corrective lenses become mandatory for all visual tasks performed at close range. This stage is reached, normally, at the 45 to 55-age level.

   b) The pupils become smaller and their responses to changes in illumination decrease.

   c) Convergence of the lines of sight from both eyes is less efficient in later life.

   d) Ability to focus on a moving target (dynamic vision) creates increasing tension with resultant energy drain.

   e) Vigilance performance deteriorates.

   f) Dark adaptation and speed of recovery to light increase is retarded in aging.

   g) Critical Flicker Frequency declines with age.
h) There is a gradual loss of sensitivity for colour discrimination with age.

i) Speed of perception and ability to reverse the faculty of perception is affected adversely by age.

g) Presence of some evidences of cataract is observed in well over fifty per cent of "normal" individuals in the fourth and fifth decade.

2. **Significance to Adult Learning**

   a) As age increases, there is a corresponding need for increased illumination.

   b) The performance of visual tasks under adverse conditions quickly results in obvious tenseness which can, in turn, affect morale, confidence, and perception.

   c) The rate of involuntary blinking is established as a sensitive criterion of the ease of seeing.

   d) Reading under unrecognized adverse conditions may be interpreted, unconsciously, as dislike for, or lack of interest in a program. This can result in eventual default by withdrawal or drop-out.

   e) There is stress involved in switching from light to dark or from dark to light surfaces, e.g. from book to blackboard or vice versa.
f) Brightness-contrast between critical details of a visual task and their background is an important factor in visibility; e.g. the contrast between printing and the paper on which the printing appears.

g) Speed of presentation of visual material has a decisive influence on the amount of material perceived and retained.

h) Under adverse seeing conditions, attention declines.

i) The degree of surrounding brightness can affect the accuracy of vision.

j) The specular brightness of paper and ink depends upon the position and brightness of the light source.

3. **Recommendations for the Purposes of Adult Education**

   a) Rooms employed for the education of adults should be more highly illuminated than those presently employed for child-youth education. In addition, rooms in which visual attention to fine detail is required, for brief or prolonged periods, should be equipped with desks, cubicles, or tables provided with a supplementary light source which could be operated manually by the individual to
provide low, medium, or high quantities of light as the task dictated or as the individual deemed necessary.

b) Adults should be educated to realize that there is need for an increase of illumination as age increases.

c) Instructors should be aware of obvious signs of visual performance distress such as: fatigue, loss of attention, frequent shift of position of reading text, lack of interest, defensiveness or anxiety.

d) Assure that reading materials supplied for adults are prepared according to the following specifications:

   (i) use of low-gloss papers and inks.

   (ii) use of 10-point type on 12-point base for prolonged reading tasks.

   (iii) selection of clean, unembellished type; double space all typed material.

   (iv) use of mimeo or off-set rather than "ditto" reproductions.

e) Reduce the amount of reading expected.

f) White plastic board with black lithograph chalk is suggested to replace common blackboards in
order to increase the contrast of letters from their background.

g) Allow adequate time in presenting illustrative material so that no sense of time limit is implied.

h) Brightness of the environment should be similar to that of the task; extreme brightness surrounded by darkness is not advisable. Rear-screen projection would eliminate bright-screen viewing in a very dark environment.

i) Room lights should be raised and lowered gradually when altering general lighting for the purpose of showing visual aids.

j) Avoid the necessity of requiring adults to make sudden or too frequent changes of focus.

k) Whenever possible, assist adults to locate the desired points of focus before continuing the discussion, demonstration, or commentary.

l) Highly-polished surfaces or high-gloss paints, so frequently considered ideal for schools, are not suitable for adults in a learning situation.
1. Developments

a) In the age group 45 to 54 (White, U. S. A.), over 56 per cent of the population experiences some hearing loss for the cycles considered most essential for speech. (See Table IX, Page 73).

b) Reaction time to auditory stimuli increases with age.

c) Interpretation of speech sounds, even without hearing loss, becomes increasingly difficult.

d) There is an exceedingly wide range of auditory behaviour independent of actual acuity loss.

e) After age 65, there seems to be little further loss.

f) The median speech reception threshold and discrimination score are 40 decibels and 70 per cent.

f) The pressures of listening, discriminating, and performing within brief time intervals can result in "overload" situations and breakdown of effective response.

h) Affective factors such as feelings of insecurity, fear, anxiety, etc., closely interrelated with speech discrimination.

i) Anticipation or "set" can serve to facilitate cognitive
responses provided there is no "surprise" element involved.

j) A combination of auditory and visual stimuli helps to increase performance abilities of older persons.

k) The aged report more difficulty in monitoring two auditory channels compared with monitoring a single channel.

l) Some training is required for successful adjustment to electrical or transistorized hearing-aid devices.

m) Exposure to excessive noise is a contributive factor in loss of hearing.

n) There is a relationship between hearing loss and depression.

2. **Significance to Adult Learning**

   a) The most significant loss in hearing relating to adult learning is that of speech discrimination.

   b) Rapid speech creates a barrier to comprehension.

   c) Reduced comprehension in older persons sometimes results in unpleasant personality quirks, e. g. hearing problems give rise to suspicion and distrust.
d) In older people, the ability to comprehend the spoken word is markedly reduced by the presence of masking sounds.

e) When the masking sounds derive from a near-by conversation, the difficulty is compounded.

f) Maintenance of attention relates to speech comprehension.

g) There is a decrease in the ability of adults to recall long sentences.

h) Loss of high-tone acuity is rarely noticed by individuals until there is interference with upper speech frequencies.

i) Early detection of hearing loss could trigger a program of training for more successful adjustment, when necessary, to hearing-aid devices.

j) In spoken English, the consonants are of prime importance.

k) There may be some relationship between a deterioration in speech discrimination and reading comprehension and vocabulary.

l) In the learning of foreign languages, establishment of foreign phonemes prior to formal study aids in language acquisition.
m) There can be emotional blocks to auditory learning:
   e. g. older people tend to withhold response in the
   presence of threat to self-esteem.

n) The opportunity to control volume of auditory
   stimuli increases confidence.

o) The individual, himself, is unlikely to be the first
   to admit to, or even to be aware of, a hearing
   loss.

p) There is frequently a strong resistance to revealing
   hearing difficulties.

q) In general, people are selective in auditory reception;
   a tendency to rigidity reinforces this attitude.

3. **Recommendations for the Purposes of Adult Education**

   a) An average school classroom is unsatisfactory for
      adult auditory reception.

   b) Stations, or areas for all adult learning activities
      should be equipped with individually-controlled,
      augmenting devices for sound and speech. Something
      in the nature of a Tempo Regulator could
      be investigated. (See Chapter III, Page 86)

   c) Lecture-type techniques are not recommended as a
      means of obtaining maximum participation of
      older persons.
d) Reflection of sound from hard walls, particularly if the speaker is at a distance, creates a hearing difficulty. Smaller rooms are better suited to adult education requirements.

e) Private discussion rooms for each group are more suitable than one large room containing several discussion groups.

f) Those responsible for the planning of adult education centers should be familiar with the speech interference level scales. (See Table X, page 78)

g) The use of overhead projectors rather than wall boards will permit instructors to maintain a position facing the audience so that those who so desire may have the added security of lip-reading.

h) Strain on short-term memory retention can be eliminated if sentences are kept short and phrasing crisp.

i) Shouting only increases hearing difficulties. Clear enunciation, particularly at ends of words and sentences, is of greater value than increased volume which serves to increase overtones and echo.

j) Those who are hard of hearing do not wish attention to be directed towards them.
k) When sound stimuli come from different directions, time must be allowed for older persons to adjust to the new direction.

l) Hearing loss relates to speech changes.

m) Group discussions for the benefit of older people could be conducted at a slower pace than for younger persons. When observations or ideas are expressed simultaneously, the older members will miss some of the comments. Frequent summarizing would be helpful.

n) Older people experience a loss of flexibility so that constantly changing sound patterns can create comprehension difficulties.

o) Older people have difficulty in listening and performing simultaneously. Instructions should be given first, then performance, and finally, evaluation.

p) Older people are inclined to try too hard to follow what is being said or to understand what is being presented. The resultant tension negates success.

q) The correlation of ideas often presents greater difficulty than the hearing of ideas. Frequent pauses for assimilation are required.
When visual demonstration examples are given, older people have more confidence that they have heard correctly and are more likely to respond.

Air-conditioning and heating elements may create hearing difficulties for those with faulty hearing.

Verbal Communications

1. Developments

a) There is a decline in fluency and speed of writing and speaking in aging; although stored knowledge and vocabulary increase in strength.

b) Certain voice changes are noticeable in pitch and in power, but training and experience in public speaking tend to overcome such developmental deficiencies.

c) There are word-association processes relating to verbal fluency which suggest that time factors affect adversely an older person's abilities in discussion.

d) There is little difference in the amount of reading and listening in the adult years; there is difference only in the type of material consumed. This suggests a change of interest over the years.
e) There is a tendency with increased age to think in terms of concepts relating newly acquired material to already established knowledge.

f) The performance of well-educated people with verbal interests tends to increase in vocabulary, information, and comprehension.

g) Affective factors influence the dimensions of discussion behaviour.

h) Adults require time to consider response in a group setting.

2. Significance to Adult Learning

a) The ability to express and to share opinions is vitally important to adult education.

b) The ability for self-expression is not impaired with age.

c) Discomforts resulting from natural aging in the oral cavity can result in speech difficulties and a hesitancy to participate in verbal communication situations.

d) Older persons may have been conditioned to feel that their verbal contributions would have little value to others.
e) Some older people may be garrulous or argumentative, partly in order to avoid coming to grips with a too challenging issue.

f) Adults are not inclined to join in a discussion unless they sense an appreciative and understanding audience.

g) Sudden and unexpected demands for participation from older people can result in embarrassment and a "freeze" reaction.

h) Many adults lack confidence in their ability to make themselves understood.

i) Older persons may wish more time to consider what they wish to contribute to a discussion. They may wish to organize their thoughts and reactions before speaking.

j) Older adults may find difficulty in maintaining a state of attention and thus lose the thread of the discussion.

3. Recommendations for the Purposes of Adult Education

a) Group discussion has been acknowledged as an effective means for integrating learning with experience in order to bring about lasting behaviour change.
b) Normal conversation when interest has been aroused flows at a fairly fast and continuous pace. Educators must guard against handicap situations arising for older people.

c) Residential situations might be investigated as providing a more relaxed learning environment for older persons.

d) Older people may not feel comfortable in giving oral reports or in leading discussions if they have not previously had experience in public speaking.

e) Frequent rest periods should be scheduled for discussion groups involving adult learners.

Retention

1. Developments

a) Many similarities are recognized between the function of the human brain and that of a computer.

b) Short-term memory declines with age; long-term memory is relatively unaffected by age.

c) Short-term storage of incoming material is essential to learning.
d) The integration of incoming data depends on previous learning.

e) There is reason to suspect low intelligence ratings of adults as invalid.

f) Older subjects are frequently inferior to younger subjects in immediate adaptive ability.

g) Adults are superior to youth in the utilization of accumulated experience.

h) The concern of the mature mind is not to acquire new facts but to relate the past to the future.

i) Age has a selective effect on memory.

j) Intervening learning of new material affects adversely consolidation of new material to a greater extent than does intervening work activity.

k) Perception is never instantaneous. Faulty perception can occur when material in short-term memory storage deteriorates before integration can take place.

l) Some cue to indicate that incoming data are significant, given at the time of reception of material, has been found to improve retention.
2. **Significance to Adult Learning**

   a) Older people are conditioned to expect memory failure and customarily view the loss with varying degrees of alarm.

   b) Many adults find more satisfaction in remembering the past than in coming to grips with the future.

   c) Adults will make an effort to retain only such material as seems relevant to their needs.

   d) When a constantly fluctuating or "dynamic" environmental in-put situation exists, older people tend to concentrate on one special aspect of the situation rather than to try to cope with several cues.

   e) Unfamiliarity with foreign sounds inhibits "other" language learning.

   f) Forcing speed of retention will result in faulty connections as a result of arousing insecurity, challenging attention, and forcing the older person to disregard some vital cues.

   g) Fatigue from excessive effort results in anxiety which can hinder accurate perception.

3. **Recommendations for the Purposes of Adult Education**

   a) Any physical situation which interferes with attention can disturb the processes of short-term memory...
and, consequently, learning.

b) There may be grounds for some revisions in the facilities presently provided for the teaching of foreign languages.

c) Forcing of speed in the reading of complex printed material puts the older person at a disadvantage.

d) Reading texts for older adults should be prepared with simple sentence structure and brief paragraphs.

e) Aging individuals will rely more and more on mnemonic devices and on past experiences to compensate for reduced capabilities.

f) Confidence develops when challenges are successfully met.

g) Interests developed by purposeful motivation result in a greater degree of successful learning by older persons.

h) Old age does not necessarily imply a decline in the faculty of understanding or in the intellectual functions. Older people can contribute the benefit of wisdom and experience to a learning situation.
Performance Facility

1. **Developments**

   a) There is a change with age in the manner in which an individual performs.
   
   b) When differences do appear, they may be attributed to processes involving perception, set, attention, motivation, and the physiological state of the organism.
   
   c) Habituated tasks show slower decline than less familiar activities or tasks.
   
   d) Highly speeded tasks of any nature can begin to decline in the fifth decade.
   
   e) Age differences are present in simple and choice reaction times.
   
   f) Age relates to slowing down in complex associative processes.
   
   g) Age, by itself, is not a reliable criterion for determining the suitability of training older workers.

2. **Significance to Adult Learning**

   a) Changes with age in the primary ability to learn are small under most circumstances until over the age of 65 or 70.
b) Various abilities show varying degrees and times of age-related decline; verbal tasks such as vocabulary or information show little or no decline until very late in life, whereas visual tasks, motor tasks, types of abstract reasoning or arithmetic show somewhat earlier decline.

c) Each individual will react to performance facility decline in his own way and according to his past experiences.

d) The incremental effects of education are greater than the decremental aspects of aging.

e) Deficiency states introducing depressive trends can seriously handicap learning.

f) Decline in daily functioning with age is related to changes in self-image.

g) Anxiety or stress has the effect of preventing mobilization of responses to stimuli. There is some support for relating stress to reduced reading performance.

h) Age differences in reaction time can be attributed to response uncertainty.

i) What serves as motivation for youth might serve as distraction for adults.
j) The rate of decline in motor performance is more rapid for tasks which are meaningless than for those which are useful.

k) Old learning habits must first be negated or modified before new learning takes hold.

l) In older people, fears of inadequacy and anxieties over the future can serve as blocks against learning or adapting to change.

3. Recommendations for the Purposes of Adult Education

a) The concept of youth and age has changed considerably over the years.

b) Speed obscures sheer mental power in older adults.

c) Our present culture enforces the elderly into premature disengagement which inhibits efficient learning performance.

d) The decline in performance facility and lower energy levels experienced in aging suggests that for adults to perform maximally, needless routines leading to early fatigue should be eliminated; e.g., energy is consumed rushing from class to library to restaurant in order to meet arbitrary and, for older persons, unrealistic deadlines.
e) Driving accidents are relatively high in the age group 60 to 70. Adult education has a responsibility to investigate changes which render old peoples less capable than the young of averting traffic and industrial accidents, and an equally vital responsibility to disseminate the results of such investigations.

f) It would be profitable for adult educators to explore more fully the conditions under which adult learning capacity can be kept at its optimum.

Conclusion

In spite of the phenomenal growth of adult education in the past decade, it is popularly believed that an impetus is formulating which will explode in the very near future into proportions not yet dreamed of by the planners of today. Further refinement of already existing technologies will undoubtedly influence present concepts of learning, resulting in radical changes in content, methods, scope, and presentation of adult programs. The greatest change of all will be in the number of those demanding education--particularly the number of those over 60 years of age, since it is becoming increasingly evident that the senile adult of 70 or 80 years or over may soon be a rarity. It may be that the term "adult" education is, in itself, a
defensive rather than a definitive term, so that the concept of continuous learning can never be realized until the sometimes arbitrary, sometimes fluid chronological age barriers are discarded.
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