1979

Effects of Training and Practice on the Inductive Reasoning of Older Adults

Donna J. Goetz
Loyola University Chicago

Effects of Training and Practice on the Inductive Reasoning of Older Adults

by

Donna J. Goetz

A Dissertation Submitted to the Faculty of the Graduate School of Loyola University of Chicago in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

September

1979

ACKNOWLEDGEMENTS

I want to thank Dr. Jeanne Foley, the Director of my Dissertation Committee, for her encouragement and suggestions for improving the manuscript. I also wish to thank Dr. Emil Posavac and Dr. James Johnson for their helpful comments and support while I was completing this project.

My grandmother, Elizabeth Schmitt, and all the persons who volunteered to participate in this research deserve a special word of thanks for contributing their time for a project designed to increase our knowledge of the aging process.

I appreciate the help given to me by my parents, Norbert and Ingeborg Goetz, and by my husband, John Zwicky. They encouraged me to continue my studies and provided part of the financial support necessary to complete my graduate studies. I am also grateful for the financial assistance provided by Loyola University of Chicago in the form of assistantships and a doctoral fellowship. The completion of this project has truly involved the cooperation and contributions of many people.

VITA

The author, Donna Goetz, is the daughter of Norbert Goetz and Ingeborg (Schmitt) Goetz. She was born July 21, 1949 in Convington, Kentucky.

Her elementary education was obtained in parochial schools in Kentucky, and secondary education at Our Lady of Providence High School, Newport, Kentucky, where she graduated in 1967,

In September, 1967, she was awarded a one-year scholarship from Thomas More College, Fort Mitchell, Kentucky. In May, 1972, she received the degree of Bachelor of Arts with a major in psychology.

In September, 1972, she was granted an assistantship in psychology at Loyola University of Chicago. In February, 1975, she was awarded the Masters of Arts in Psychology. She was an instructor of psychology at Alverno College in Milwaukee, Wisconsin from 1977 to 1979.

In June, 1978, she presented a paper, "Benefits of an Intergenerational Discussion Group" at the Allied Health Conference on Aging, at the University of Wisconsin at Milwaukee. She is a co-author of "Coffee consumption of hospitalized alcoholics: An unobtrusive index of distress" with Gerald Mozdzierz, Robert DeVito, William Davis, and Roger Semyck. This article will be published in the International Journal of the Addictions in 1980.

On April 15, 1978 she married John F. Zwicky in Chicago, Illinois.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
VITA	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
CONTENTS OF THE APPENDIX	viii
INTRODUCTION	1
REVIEW OF THE LITERATURE AND HYPOTHESES OF THE PRESENT STUDY	4
The Task of Developmental Psychologists	6
Traditional Methods of Developmental Research	9
Age-appropriate Measurement	12
Statistical and Sampling Issues	16
Research Strategies for Developmental Research with Older Adults	18
Intelligence and Aging: Research Findings	23
Differential patterns of performance on the Wechsler Adult Intelligence Scale	23
Fluid intelligence versus crystallized intelligence	25
Terminal drop	28
Experimental Studies: Training on Cognitive Tasks	31
Use of operant conditioning	31
Use of verbalization and self-instruction	33
Hypotheses of the Present Study	37
METHOD	39
Subjects	39
Experimenters	41
Materials	42
Demographic questionnaire and health rating	42
Problem Solving Test	43

Page

Letter Sets Training Booklet and Letter Sets Test 47
Standard Progressive Matrices 48
Control group task 48
Design 49
Procedure 50

RESULTS 56

Descriptive Statistics 56
Planned Statistical Analyses to Test the Four Hypotheses of the Present Study 59
Relationships Among the Cognitive Tests 66
Results of the Multiple Regression Analyses 68

DISCUSSION 73

Characteristics of the Participants in the Present Study 74
Comparison of the Present Study and the Labouvie-Vief and Gonda Study 76
Preferred Style of Problem Solving 77
Difficulty Level of the Cognitive Tasks 79
Individual Differences 80

SUMMARY 82

REFERENCES 86

APPENDIX 93

LIST OF TABLES

Table		Page
1.	Demographic Characteristics of the Participants . .	40
2.	Means and Standard Deviations for the Problem Solving Test by Condition and Initial Level of Problem Solving Ability	51
3.	Means, Standard Deviations, and Ranges for Both Items of the Problem Solving Test	57
4.	Means and Standard Deviations for Letter Sets Test by Treatment Condition and Problem Solving Level	58
5.	Comparison of Means on the Letter Sets Test and Standard Progressive matrices Obtained by Labouvie-Vief and Gonda (1975) and by the Present Study	60
6.	Means and Standard Deviations for Standard Progressive Matrices by Treatment Condition and Problem Solving Level	61
7.	Summary Table of the Analysis of Variance of the Letter Sets Test Scores	63
8.	Analysis of Variance of the Standard Progressive Matrices by Treatment Condition	65
9.	Dunn Contrasts on Training Task for Immediate and Delayed Posttests and on the Transfer Task for the Delayed Posttest	67
10.	Matrix of Pearson Correlations of Cognitive Tests for the Total Sample	69
11.	Regression Analyses on the Letter Sets Test, Standard Progressive Matrices, and the Problem Solving Test	70

LIST OF FIGURES

Figure Page

1. Item 1 of the Problem Solving Test 44

2. Item 2 of the Problem Solving Test 45

CONTENTS OF THE APPENDIX

		Page
1.	Demographic Interview	94
2.	Health Status Checklist	95
3.	Problem Solving Test Recording Form	96
4.	Weights for Questions of Item 1 of the Problem Solving Test	97
5.	Weights for Questions of Item 2 of the Problem Solving Test	98
6.	Training Booklet for Letter Sets Test	99
7.	Scoring Key for Training Booklet	105

INTRODUCTION

This paper describes an experiment conducted to investigate some factors associated with intellectual performance in older adults and reviews the recent literature on age and intellectual performance. A summary of the present experiment is presented in this preface. The introduction reviews the current literature and discusses the methodological issues in the field of aging and cognition. The remaining sections of the paper describe the present experiment in detail and conclude with an interpretation and discussion of the results of this research.

The present experiment was designed to compare the effectiveness of training and practice on two tests of inductive reasoning administered to older adults of three levels of problem solving ability. The present research attempts to clarify issues of strategy formation and strategy interference raised by Labouvie-Vief and Gonda (1975). The purpose of this experiment is to determine the effects of training and practice on persons who initially scored high, average or low on a test of problem solving strategy. Individual differences may make one type of training more appropriate for a particular person than another type of training or practice. People already functioning at a high level of

intellectual competence may benefit more from practice while people initially functioning at a low level may benefit more from self-instructional training which provides strategies for them to imitate.

In the present study, participants were randomly assigned to one of three conditions: training, practice, or control. Participants were pretested to measure their initial problem solving ability and after all the data were collected they were assigned to one of three groups on the basis of their pretest scores: high, middle, and low. The data were analyzed to determine the relationship between level of problem solving ability and type of training or practice received.

The following hypotheses were tested: (a) both the training practice groups score significantly higher on the Letter Sets Test on the immediate and delayed posttests than the control group; (b) both the training and practice groups score significantly higher on the Standard Progressive Matrices than the control group; (c) the high-scoring group on the Problem Solving Test is already able to use efficient strategies, therefore, practice adds more to the high-scoring group's performance on the Letter Sets Test than self-guidance training; and (d) the low-scoring group on the Problem Solving Test initially possesses relatively inefficient strategies for problem-solving and the provision of strategies for them, as in the self-guidance training, adds

more to their performance on the Letter Sets Test than practice does. The results of the experiment are reported in full in later sections of this paper.

REVIEW OF THE LITERATURE AND HYPOTHESES OF THE PRESENT STUDY

There is a controversy over the relationship of chronological age and intellectual functioning (Kuhlen, 1963; Schaie & Strother, 1968). Traditional cross-sectional designs have shown that older people do more poorly on intellectual tasks than younger people. On the other hand, longitudinal studies have shown that intellectual processes remain relatively stable throughout the life span. Four research studies have shown that intellectual decline is less related to chronological age than to distance from death (Jarvik, Eisdorfer, & Blum, 1973; Kleemeier, 1961, 1962; Riegel & Riegel, 1972). These studies indicate that there is no simple relationship between chronological age and intellectual performance.

The lack of psychological models which adequately explain intellectual performance in the later years of life was noted by Baltes and Labouvie (1973). They stated that the belief that advanced age leads to intellectual decline has precluded research examining the relationship of environmental factors to cognitive functioning in old age. Schaie (1977) described three models of aging which underlie most research studies in the field, "irreversible decrement, stability, and decrement with compensation" (p. 40). Schaie

observed that the model of irreversible decrement has been the most widely used. This model assumes that a maximal level of functioning is reached at some point in adulthood, then functioning declines with the decline accelerating at the upper ages of the age span. The stability model described by Schaie postulates the relative stability of psychological processes throughout adulthood until the few years preceding death. Schaie noted that the stability model is the most common in personality studies and suggested it may also be applicable to the concept of crystallized intelligence which refers to stored information such as vocabulary. The "decrement with compensation" model is used by the researcher who attempts intervention with the aged. The model assumes decrement related to age but supposes that these decrements can be ameliorated by environmental changes and experimental intervention. This third model has been the least commonly used and relatively few studies have attempted to improve intellectual performance among older adults.

The current issues in the development psychology of adulthood and aging and the limitations of the traditional cross-sectional and longitudinal designs are discussed in this paper. New research strategies, results of efforts to assist the aged in improving their performance on intellectual tasks are reviewed, and the present experiment is described in detail.

Recent articles on aging and cognition can be

classified into three major categories: studies using the traditional cross-sectional and longitudinal methods of development psychology, articles focused on methodological issues, and experimental studies of factors associated with intellectual performance in the aged. The discrepancy in findings between longitudinal and cross-sectional designs has led to an increased concern and sophistication in methodology. Experimental studies in the field of aging and cognition have been rare in the past, but there is now an accelerated interest in such studies in an attempt to understand the processes underlying observed changes in intellectual functioning with age. It appeared useful, therefore, to describe the current literature in the field of cognition and aging to put the present experiment in perspective.

The Task of Developmental Psychologists

Baltes and Goulet (1970) stated "Human life-span developmental psychology is concerned with the description and explication of ontogenetic (age-related) behavioral change from birth to death" (p. 13). The definition implies that change occurs throughout the entire life span and that developmental psychologists must do more than describe the changes but must specify causes as well. Buss (1974) presented a three-dimensional model to show how various research strategies relate. The model presents developmental psychology as the study of differences between individuals,

intraindividual differences, and intraindividual changes over time.

Wohlwill (1970) distinguished between age differences and age changes. Age differences are the observed differences between two age groups at one point in time. Age differences are obtained by the cross-sectional method. Age changes are changes within one individual over time and longitudinal studies yield this type of information. Use of the cross-sectional design allows comparison of groups of different ages at one point in time and is useful for measuring interindividual differences. The longitudinal design measures intraindividual changes over time and can be used to measure intraindividual differences as well. Developmental psychology includes the study of patterns of change as well as the study of individual differences and variations in patterns of development.

The status of age as a variable in developmental research and the adequacy of age functions relating changes in abilities to age has been called into question. A prominent researcher in the field, Birren (1959), wrote that aging is "closely related to chronological age but not identical with it" (p. 6). Birren suggested that age could sometimes be an independent variable and at other times age could be a dependent variable. He specified three kinds of aging to clarify the issue: "biological age" (length of life),

"psychological age...adaptive capacities...based upon both the achievements and the potentials of the individual" and "social age...acquired social habits and status...filling the many social roles or expectancies of a person of his age in his culture and social group" (p.18).

These three kinds of aging may be illustrated with examples from cognitive development to show their relevance. Biological health was found to be extremely important to the intellectual functioning of aged persons (Botwinick & Birren, 1963). The factor of general ability (measured by intelligence tests) was found to be influenced more by the amount of education a person had than by that person's biological age (Botwinick, 1973). Cultural and social expectations can facilitate but more often seem to hinder intellectual pursuits for older persons (Labouvie, Hoyer, Baltes, & Baltes, 1974).

In contrast to Birren who stated that age could sometimes be an independent variable, Wohlwill (1970) stated that age is not an independent variable but should be used as a dependent variable in developmental research. Wohlwill argued that when age is used as an independent variable the researchers are studying "age <u>differences</u> rather than age <u>changes</u>" (p. 49). According to him such research is not developmental and age is only a shorthand for the set of variables occurring over time. In other words, age itself is not the cause of development, but the factors that occur

during the time interval that we call age are the causes of development.

Wohlwill further stated that the mapping of age functions for various abilities is only the first step in developmental research. Age functions are descriptive but do not actually explain the causes of development and that explication is the end goal of developmental theory.

Traditional Methods of Developmental Research

The cross-sectional and longitudinal methods have been the traditional research designs used to collect information on human development. Each method has advantages and disadvantages. Some difficulties are of a practical nature, but more serious problems are those involving interpretation of the results.

One concern is the representativeness of the sample. The longitudinal method involves following a group of individuals over a period of years. It has the advantage of allowing intensive study of these individuals over time, but the method requires a long-term commitment on the part of the subjects as well as the researchers. It is expensive to recontact subjects and sometimes subjects are lost because they move without leaving their forwarding addresses or withdraw their agreement to participate in the study. Related to this practical problem of subject dropout is the theoretical issue of representativeness of the sample of remaining

subjects. Participants in longitudinal studies are likely to be more educated and more motivated than average. As subjects participate in the study they are given tests and interviewed repeatedly over a period of years. Even if a sample of subjects was representative at the beginning of the study, the testing procedures and intermittent periods of scrutiny could affect the subjects' perception of their development.

In dealing with aged subjects the issue of selective drop-out is more serious due to the loss of some subjects to death. Since every longitudinal study has the problem of subject attrition, individuals remaining in the sample are not representative of the population from which the subjects were originally selected. Birren (1959) discussed some reasons why longitudinal data may artifactually make older persons appear to be more competent or more stable in intellectual functioning than they actually are. Birren cited evidence to indicate that long-term participants are significantly more healthy and better in many aspects of functioning than participants who drop-out because of death, lack of interest, or other reasons. Riegel and Riegel (1972) found that participants who withdrew from their longitudinal study were statistically more likely to be near death and that a sharp decline in intellectual performance often occurred shortly before natural death. Therefore, persons with poor health and impaired functioning will not be represented as often in later testings of the

long-term studies. Those studies will present an overly optimistic picture of the relationship of age and intellectual functioning.

A second concern of researchers is social change. Cross-sectional studies involve the comparison of groups of individuals of various ages at one point in time. The problem of selective drop-out that was a disadvantage for the longitudinal design is not an issue for cross-sectional studies. One theoretical issue is whether or not the age differences observed are due to universal patterns of development or due to the unique historical-cultural events which affect each cohort differentially. Kuhlen (1940) first raised this issue when he warned that social changes over time might account for a large proportion of the variance that researchers report as due to age. For example, the number of years spent in formal education by young people in the United States has greatly increased since the beginning of this century. Age differences between subjects who are 80, 60, 40, and 20 years of age will be influenced by this factor of formal schooling, as well as more subtle factors not as easily quantifiable as years of schooling.

In 1963 Kuhlen advised that longitudinal studies as well as cross-sectional studies were affected by cultural change. Kuhlen suggested longitudinal studies may find older persons scoring better than when they were younger because of

increased stimulation due to the media. Cultural change probably affects different age groups in different ways. One of the solutions for this problem recommended by Kuhlen will be discussed in a later section of this paper.

Age-appropriate Measurement

The construction of instruments to measure specific attributes in various age groups is both a practical and theoretical concern. Schaie and Gribbin (1975) asked whether observed age differences between groups indicate real differences or only that the researchers are measuring different attributes. Researchers need to insure that instruments are comparable if they use different instruments for different age groups. If researchers administer the same instrument to different age groups, they still might not achieve comparability because the instruments could be perceived differently by the various age groups.

Kohlberg (1973) applied the distinction between competence and performance to the field of cognition and aging. Competence can be inferred from observation of performance but one cannot infer lack of competence from failure to observe a specified performance. Motivation is a factor in performance. An individual needs to perceive incentives to demonstrate certain behaviors. This distinction means that the aged may be more competent than their performance would indicate. There are many reasons why older persons may score poorly on

tests of intellectual functioning even though they may have high ability. Some of the factors contributing to poor performance are the content of the test, physiological factors, mental set, motivation, familiarity with the testing situation, and level of formal education completed. These factors are highlighted in the following discussion.

The content of the test may not be suitable for older persons. The first intelligence test, the Binet-Simon Scale of 1905, was developed to determine which children could benefit from formal schooling (Anastasi, 1968). Today the intelligence tests are heavily weighted with items related to academic achievement. Demming and Pressey (1957) pointed out that IQ tests are biased against the aged on the basis that the items are not appropriate for aged persons in terms of their day to day functioning.

The presence of chronic disease increases with age (Timiras, 1972). With age there are impairments of sight and hearing (Kimmel, 1974). Tests of reaction time indicate the more complex sensorimotor skills such as tracking a moving target show an increased reaction time for elderly persons. Furry and Baltes (1973) reported that the performance of the aged is more affected by fatigue than the performance of younger persons.

Mental set can affect performance on an intelligence test. Botwinick (1967) observed that older persons were more

likely to withhold a response that might be correct than to risk giving an incorrect response. Some researchers have suggested that part of the increase in time needed for performance is due to the slowing of the central nervous system while part might be due to a general slowness in movement. Part of the slowing of response might be due to mental set factors, such as cautiousness. Kimmel (1974) discussed the mental set of the aged and pointed out that cautiousness and avoidance of unnecessary risks may be adaptive strategies for the elderly as a means of coping with their decrements in perceptual speed and slowness of movement. It is easy to understand how such responses would be adaptive especially in large cities with risks associated with everyday occurrences, such as crossing busy intersections or getting onto fast moving escalators. Although these coping strategies may reduce the risk of injury in the outside world, they may serve to increase reaction time and work to the disadvantage of the aged in laboratory tests or standardized tests.

There may be a lack of motivation on the part of the aged subjects to perform well (Hoyer, Labouvie & Baltes; 1973). Younger subjects may be motivated by the values of doing well in school or obtaining entrance to a school or career (Lindsley, 1964). The content of the test may seem childish or irrelevant to the aged person because they associated tests with school.

Younger persons are accustomed to taking tests and have more experience and sophistication in test-taking than older persons. If the test has a computer graded score sheet, the aged may be at a disadvantage because of vision, speed, and lack of familiarity with such tests. They may be more likely to show anxiety when required to perform in an unfamiliar situation (Murrell, 1970). Test-taking situations are unusual events in the daily life of an older person and may arouse anxiety due to apprehension about being evaluated, especially since older persons are aware of the widespread belief that there is a natural decline in intellectual processes in old age (Tuckman & Lorge, 1952). The majority of healthy aged persons who were interviewed by Tuckman and Lorge agreed with the statement that "the elderly cannot learn new things" (p. 339).

Level of education was found to be highly correlated with the general component of overall intellectual ability as measured by the Wechsler Adult Intelligence Scale (Birren & Morrison, 1961). The aged population as a whole has had fewer years of formal schooling than the younger generations. When intellectual functioning is assessed in a cross-sectional study, these generational differences may give the appearance that intelligence decreases with age. In the past, formal schooling at the lower grades relied more heavily on memorization so the type of schooling may have a subtle effect

on how appropriate a particular task is for comparing the performance of different generations.

Statistical and Sampling Issues

Birren (1959) reported that elderly subjects are more different from one another than are young adults subjects. This makes it difficult to identify a representative sample of the aged and also affects any statistical analyses of the data. Birren contrasted two types of research design: the representative (ecological) and the experimental. Representative designs require representative samples, environments, and time samples. Research should include institutionalized aged as well, or should be restricted to either institutionalized or the noninstitutionalized and the conclusions restricted in their generalizability. Birren noted that generalizations based on cross-sectional designs have a built-in survivorship bias. Since death does not occur randomly, the survivors will be systematically different from nonsurvivors.

Birren also highlighted problems that occur when a researcher must use volunteer subjects, as is often the case when healthy noninstitutionalized adults are the participants in the research. The use of volunteers presents difficulties in generalizing to the entire population. Volunteers tend to be physically and psychologically healthier than nonvolunteers.

Studies using change scores may lead to spurious conclusions due to the phenomenon of regression to the mean (Cronbach & Furby, 1970). How seriously regression to the mean may affect the interpretation of change scores was demonstrated by Baltes, Nesselroade, Schaie, and Labouvie (1972). They performed two separate sets of statistical analyses on data from a cross-sequential design. The first analysis of variance yielded an Ability Level by Occasion interaction, which indicated that persons scoring high on the first testing tended to decline on the second test and persons scoring low on the first test tended to increase their scores on the second testing. The second analysis used a time-reversed control analysis as suggested by Campbell and Stanley (1963). This analysis involved dividing the data from the second testing into three ability levels and comparing performance on the second test to the first test. These results showed that persons scoring highest on the second test had increased their scores from the first testing and persons scoring lowest on the second test had declined from the first testing. Persons in the middle ability group showed little change. These inconsistent age trends are found when the changes in scores are due to fallible measurements and regression effects. Subjects who scored high at either testing were influenced by large positive errors of measurement, while subjects who scored low were affected by large negative errors of

measurement. The middle scores are more stable and not as affected by errors of measurement. If the researchers had used only the analysis of variance without the time-reversed controls, they might have reached a false conclusion as to differential changes of persons of various ability levels.

Research Strategies for Developmental Research with Older Adults

In this section solutions to some of the problems stated above are discussed. Research strategies appropriate for life-span studies are: (a) cross-sequential designs, (b) a multiple-measure approach, (c) the development of age-appropriate measurement, (d) age-simulation and age-manipulation, and (e) the ecological analysis of intellectual behavior. Each strategy is described and suggestions for future data collection in the field of cognition and aging are reviewed.

Difficulties in the interpretation of the cross-sectional and longitudinal designs have led to a renewed interest in methodology in developmental research. After noting the difficulty with interpreting the effects of social change, Kuhlen (1963) stated that researchers should combine cross-sectional and longitudinal methods by adding cross-sectional data collection to longitudinal studies. Schaie (1965) discussed a more detailed plan combining the cross-sectional and longitudinal methods which he called a cross-sequential

design. This plan uses the advantages of each method while the disadvantages of each method are lessened. Schaie proposed a sophisticated statistical procedure to separate the confounded factors of age and cohort. Schaie and his colleagues have used this cross-sequential approach and the results obtained by this method are discussed in a later section of this paper.

Baltes and Goulet (1970) expressed the need for the measurement of multiple determinants of behavior. Subsequent articles (Baltes & Nesselroade, 1973; Nesselroade, 1970; Nesselroade, Schaie, & Baltes, 1972; Neugarten, 1977) have addressed the same issue. There is also a need for a multiple-dimension approach for the measurement of aspects of intelligence. Data indicate that there are differential patterns of aspects of intellectual functioning throughout the life-span (Horn & Cattell, 1966; Schaie & Strother, 1968a, 1968b). Some aspects remain relatively stable, some decline with age and some increase with age. There is a need for a multiple measure approach at least for the area of intelligence.

Baltes and Labouvie (1973) raised the issue of age- and cohort-specific validities for instruments used to measure intellectual performance. They concluded that intelligence tests developed for academic selection are not applicable to older groups. Demming and Pressey (1957) constructed an

intelligence test for older adults. They included questions of a practical nature that would measure a person's knowledge of the world. For example, some questions were on how to use the yellow pages of the phone book, some on how to obtain legal assistance, and other information that a person learns through experience rather than formal schooling. Aged adults scored higher on this test than did young adults, even if those aged adults had scored lower on the conventional tests. Although the Demming and Pressey test has been used to illustrate the advantages of age-appropriate measurement, this test has not been widely used in research studies.

Baltes and Goulet (1970, 1971) recommended that the status of age as a developmental variable be re-examined since chronological age is a nonpsychological variable. In line with Birren's (1959) suggestion of using the concepts of biological age, sociological age, and psychological age, they recommended exploration of age as a variable. They reported that researchers have used hypnotic age regression to simulate age manipulation. Related work has been on the perception of age and the attribution of qualities to persons based on their perceived age.

Bijou and Baer (1963) and Baer (1973) recommended the use of behavior modification techniques to induce development within a short time span so that the process can be observed more closely. They stated that development appears to be

ordered by age because in the usual environment, contigencies occur at specific ages to reinforce those behaviors which are termed developmental. Wohlwill (1970) criticized Bijou and Baer's position for trying to deal with the concept of age by attempting to program developmental change directly by subjecting individuals to specific histories of reinforcement. These attempts have by necessity used narrowly limited responses and specific stimuli. Wohlwill stated his disapproval of this method and stated his belief that it is not a viable approach because many developmental changes, especially in perception and cognition, occur in uniform sequences and at similar rates under diverse environmental conditions. A particular environment affects the rate and level of development but no one specific environment is necessary for that developmental change to occur. Wohlwill specifically excluded such skills as swimming, reading, and writing because these skills require special training and are not usually considered developmental.

Wohlwill's and Bijou and Baer's positions can be conceptualized as the organismic and the mechanistic approaches, respectively (Reese & Overton, 1970). The philosophical bases for the two approaches are incompatible and are reflected in the terminology, data collection methods, and interpretations of results. According to Reese and Overton these differences are so pervasive that they cannot be settled by empirical

research because each side would interpret the research differently. The two approaches exist side by side, each offering different insights into the complexity of developmental processes.

Wohlwill (1970) called for more descriptive research relating behavior to the environment in a broad sense. He criticized Bijou and Baer (1963) for studying narrowly limited aspects of behavior and instead recommended that researchers look for qualitative change. Wohlwill stated that developmental research requires "(a) that substantial, reasonably situationally independent age changes occur with respect to the given behavior and (b) that the changes are not easily explained by highly specific experience" (p. 62) such as a particular learning history or practice. In his definition, Wohlwill seems to be specifically ruling out the research method recommended by Bijou and Baer (1963) and Baer (1973) by stating that such methods do not produce true developmental changes. Wohlwill (1970) called for basic and applied research on person-environment relations.

Labouvie, Hoyer, Baltes, and Baltes (1974) stated their belief that intellectual deficits in advanced adulthood and old age are largely due to reinforcement and practice deficiencies as well as cohort effects. They called for more research aimed at modifying the intellectual performance of the elderly. They suggested that an operant analysis of the

environment of the aged person would be useful for a description of the aging process and for modifying behavior to optimal levels.

Bijou, Peterson, and Ault (1968) recommended the use of frequency of occurrence measures to integrate descriptive and experimental field studies. A descriptive-field study uses frequency measures that (a) specify in objective terms the situation in which the study is conducted, (b) define and record behavioral and environmental events in observable terms, and (c) allow for measurement of observer reliability. Field- descriptive studies could be used to reveal relationships in the usual ecological settings and provide cues for experimental studies. Field-experimental studies would suggest the need for describing new interactions in specific natural situations.

Intelligence and Aging: Research Findings

In this section the most widely cited articles on aspects of intellectual functioning in the older adult are reviewed. Many of the researchers who were noted in the section on methodology have also been active in the field of intellectual functioning of the older adult.

Differential patterns of performance on the Wechsler Adult Intelligence Scale. Many researchers have used the Wechsler Adult Intelligence Scale (WAIS) which contains 11 subtests in two categories, the verbal subtests and the

performance subtests. On the WAIS, the elderly show little decline in verbal ability and stored information as they grow older. However, psychomotor skills which involve speed and perceptual-integrative skills decline more rapidly (Berkowitz, 1965; Hallenbeck, 1964; Norman, 1966). This pattern of more decline on the performance subtests than on the verbal subtests has been replicated by many researchers so Botwinick (1977) has termed this a "classic aging pattern" (p. 584). Norman and Daley (1959) studied intellectually superior women and Botwinick and Birren (1963) studied exceptionally healthy elderly men and both teams found the same pattern of results. Botwinick and Birren emphasized the extreme importance of physical health and physiological factors. Even slight alterations of optimum health adversely affected intellectual functioning in their subjects. Elderly persons who are diagnosed as psychotic also show the pattern of verbal scores being higher than performance scores (Botwinick & Birren, 1951).

Reed and Reitan (1963) administered 11 of the Wechsler-Bellevue subtests and 18 other subtests to test their hypothesis that there would be smaller differences between age groups on tests of stored information and greater differences between age groups on tests of problem solving skills. Their hypothesis was supported by the data.

Fluid intelligence versus crystallized intelligence. Cattell (1963) proposed a theory of intelligence which has two major dimensions: fluid and crystallized. The fluid dimension is based on genetic potential which is developed through interaction with the environment. The crystallized dimension is based on learned information and is greatly affected by formal schooling. The two dimensions are correlated (Horn, 1968) but the correlation has been found to decrease with age, as the factor of experience influences the crystallized dimension to a greater degree than the fluid dimension (Cunningham, Clayton, & Overton, 1975; Horn, 1970).

Horn and Cattell (1966) presented data from a cross-sectional study which showed that fluid intelligence increases up to young adulthood and slowly declines while the crystallized intelligence increases up to late adulthood and only shows a slight decline afterwards. Fluid intelligence is closely related to genetic factors and is measured by such tests as Inductive Reasoning and Figural Relations. Crystallized intelligence is dependent on learning and is measured by tests such as Verbal Comprehension and Vocabulary. These findings are consonant with the differential patterns of performance by the aged on the verbal and performance subtests of the WAIS.

Schaie had observed the discrepancy between conclusions reached from research using the longitudinal and the

cross-sectional methods and in 1956 he began a project to determine the cause of this discrepancy. In a series of articles (Schaie & Labouvie-Vief, 1974; Schaie & Strother, 1968a, 1968b) Schaie and his colleagues reported results of two cross-sequential studies using a stratified random sample of adults aged 20 to 70 years. The adults were tested on Thorndike's Primary Mental Abilities Test and Schaie's Test of Behavioral Rigidity. Participants were retested 7 years after the original testing and retest data were obtained from 301 of the 500 original subjects. The factor-analysis of the data yielded four general factors: (a) crystallized intelligence which is a combination of skills that are learned through education such as verbal comprehension, number skills, and reasoning; (b) cognitive flexibility which is the ability to shift from one way of thinking to another, (e.g. to provide the synonym or antonym for a word depending upon whether the word is typed in large or small letters); (c) visuo-motor flexibility which is the ability to move from visual to motor skills and back again (an example is a task to copy words but to make large letters small and small letters large); (d) visualization which is the ability to process visual material and make sense of it (an example is to find a simple picture in a complex one). For Schaie's study there was a decline in only one factor due to age and that was in visuo-motor flexibility. In fact, for two of the

factors, crystallized intelligence and visualization, there was an increase in scores even for people over 70. Schaie analyzed the data with two different methods and found different results which can explain why studies using different methodologies can lead to different conclusions. When Schaie and his colleagues analyzed the data as if only cross-sectional data were available, a comparison of different age groups gave the pattern of systematic decline with age. However, when the data were analyzed longitudinally, there was a decline on only one of the four factors, visuo-motor flexibility.

Schaie and Strother (1968b) and Schaie and Labouvie-Vief (1974) acknowledged the problem of selective drop-out of subjects that may have affected the above results. To deal with the problem, they compared data from their cross-sequential design to an independent random sample of persons from matched age groups. This independent random sample was only tested once and therefore would not be affected by selective drop-out. The patterns of results obtained by the cross-sequential and the independent random sample were similar; therefore the researchers concluded that subject attrition had not adversely affected the representativeness of the cross-sequential data. Schaie and Strother (1968b) suggested that the effort usually spent in longitudinal studies could

be better spent in selecting representative samples with more members of each age group.

There are two lessons to be learned from Schaie and his colleagues' work. First, we must examine more closely the differences between longitudinal and cross-sectional methods of research. Second, we need to be more specific about what type of intellectual functioning is being discussed rather than just calling the topic intellectual functioning since there are some abilities that increase, some that remain stable, and some that decline with age (Rosenfelt, Kastenbaum, & Kempler, 1964).

Terminal drop. Riegel and Riegel (1972) conducted a longitudinal study of intellectual functioning of 380 German men and women between the ages of 55 and 75. The first testing session was in 1956. In 1961, the Riegels retested 202 of the original subjects. Some of the individuals had died and some individuals refused to be retested. The Riegels noticed that the 1956 test scores of the deceased subjects were, on the average, lower than the scores of the survivors. The third testing session took place in 1966, 10 years after the first testing and 5 years after the second testing. Persons who died between the second and third testing, tended to have lower scores than average on the second testing. In addition to these findings, persons who had died between 1961 and 1966 performed more poorly on their

second testing than they had on the first testing. There was a decline in intellectual performance that began in the years preceding death. This decline was named the terminal drop. People who refused to be retested in 1961 were more likely to die before the third testing in 1966 than people who agreed to be retested. The Riegels hypothesized that these individuals were aware of the decline in their abilities and therefore refused to be tested again.

In the case of the study by Riegel and Riegel the reason for the subjects' dropping-out (death or refusal to be retested) is systematically related to the variable under consideration (intellectual functioning). Riegel, Riegel, and Meyer (1968) stressed the difficulties in interpretation of results that occur when remaining subjects in a sample are no longer representative of the population from which they were drawn.

Another researcher, Kleemeier (1961, 1962) found similar results from a longitudinal study. Kleemeier administered the Wechsler-Bellevue to 13 elderly men four times in a period of 12 years. Test scores declined over time. The performance for each man declined over time but the rate of decline varied. Four of the 13 men died shortly after the final testing. When the performance curves of these four were compared to the performance curves of the surviving men, a sharp drop in performance was observed for the deceased and a gradual decline was observed for the survivors.

Kleemeier (1962) analyzed data from another study of 70 elderly men after about half of the individuals were deceased. The rate of decline on the performance subtests of the Wechsler-Bellevue differentiated those of the survivors from the nonsurvivors. The verbal subtests did not have discriminative value.

Riegel and Riegel (1972) and Kleemeier (1961) speculated that there may be a drop in intellectual functioning before death due to biological decline. Baltes and Schaie (1974) warned that psychological variables may contribute to both the intellectual decline and the biological death. Because Kleemeier's samples were very small, Berkowitz (1965) replicated the study using a sample of 184 men whose average age was 56 at the first testing and 65 at the second testing. Berkowitz's data contained some trends in the same direction as Kleemeier's data but some trends were opposite. Performance on the Wechsler-Bellevue declined in the group that died in the 10 months following the second testing; however, none of the differences was statistically significant. Berkowitz also analyzed the data with respect to initial level of ability as measured by the first testing. Survivors with low IQ scores at the first testing showed a less steep decline on the full score and on the performance subtests than nonsurvivors. Survivors with high IQ scores at the first testing showed more decline in verbal subtests than did

the nonsurvivors. This can best be explained as due to regression to the mean of the extremely high scores.

Experimental Studies: Training on Cognitive Tasks

Recently there has been an increase in the number of studies designed to investigate factors related to age and intellectual performance. In the past, few researchers tried to improve the intellectual functioning of older adults, possibly because of the widespread belief that intellectual decline is inevitable. Recently, however, several researchers have successfully demonstrated that older adults can improve their performance on intellectual tasks through practice or training to improve their test-taking skills. When older adults significantly improve their performance on a cognitive task after a short training session, this dramatic increase in performance supports the view that the original poor performance was partially due to the older adults' unfamiliarity with the testing situation. In this section the results of several studies designed to improve the test-taking skills of the older adult are reviewed. The subsequent section shows how questions raised by these training studies were addressed by the design of the present experiment.

Use of operant conditioning. Researchers have trained older adults to improve their performance on both cognitive and performance tasks. Hoyer, Labouvie, and Baltes (1973)

reinforced elderly women for increasing their speed in marking standardized answer sheets. This simple training enabled these persons to improve their scores on 11 tests of intellectual functioning.

Three studies were focused on the effectiveness of reinforcers. Hoyer (1973) emphasized that reinforcers need to be specified for different individuals and for different age groups. The direct comparison of three types of reinforcers for the aged was studied with a problem solving task (Coleman, 1963). He compared a social reinforcer (a positive verbal statement), an immediate monetary reward, and a delayed monetary reward for each correct response. All groups who received reinforcement improved significantly compared to the control group. No differential effect was found due to type of reinforcement and no generalization was observed to similar tasks. An unusual but very effective reinforcer for the elderly was the use of Green Stamps to reward faster performance in canceling letters and similar tasks (Baltes, Hoyer, & Labouvie; cited in Baltes & Schaie, 1974).

Murrell, Powersland, and Forsaith (1962) found a greater difference between younger and older subjects on a novel performance task than on a practiced task. Murrell (1970) expressed the belief that differences found between younger and older subjects on a novel task may be affected by differences in the ability to deal with an unfamiliar

situation as well as initial differences in the skill itself. Murrell provided extensive practice for younger and older subjects on a task of reaction time. The older subjects showed the most improvement on the task with practice. The amount of practice required to eliminate initial age differences was related to the complexity of the task.

Use of verbalization and self-instruction. A recent review of research in learning and aging concluded that "older individuals (at least in the experimental situation) tend not to use mediators spontaneously" (Arenberg & Robertson-Tchabo, 1977, p. 445). They also found that when older individuals are instructed to use mediators, they do so less efficiently than younger persons and older persons have more difficulty using mediators supplied by the experimenter. Rabbitt (1977) reviewed research on the performance of the aged on concept formation tasks. He concluded that the aged, compared to younger persons, have more difficulty making shifts in a discrimination task if the task becomes complex. Older persons tend to organize material to be remembered less well than younger persons and older people tend to use simpler strategies. He did not find enough evidence to support the view that the aged tend to cling to inappropriate strategies when faced with new tasks.

Rabbitt articulated two methodological strategies for examining the performance of older people on complex tasks,

such as problem solving. The first strategy is to alter the task to see how performance may be improved; the second strategy is to alter the instructions or provide training to see which variations improve performance. The first strategy is useful in memory research. If interference is thought to inhibit memory in older people, then a study could be designed to compare the performance of various age groups on tasks which have different levels of interference (Craik, 1977). The second strategy entails the provision of instructions and/or training designed to remedy the hypothesized cause of poor performance by the older person. Studies which illustrate the use of the second strategy are discussed in this section.

Training in self-instruction helped elderly persons improve their performance on tasks of concept formation, problem solving, and inductive reasoning. Crovitz (1966) trained aged individuals to talk aloud and to verbalize the principles involved in a concept formation task. Their performance on the task improved significantly compared to a control group who received no training. Meichenbaum (1974) suggested that elderly individuals could be trained to use self-instructional statements to help them attend to the relevant stimulus while they work on a task. First the experimenter would act as a model and say appropriate self-instructions aloud while working on a task. Then the

learner would imitate the experimenter by repeating the same self-instructional statements while working on the task. Later, the learner would be told to whisper the instructions to himself or herself and, finally, the learner would be directed to use the statements without visible lip movements while working on the task. Meichenbaum and his colleagues successfully used this procedure to help hyperactive school children (Meichenbaum & Goodman, 1971) and schizophrenic patients (Meichenbaum & Cameron, 1973). Meichenbaum recommended that this procedure be used with the aged since many studies show they often lack appropriate mediational strategies.

Labouvie-Vief and Gonda (1975) used the self-instructional procedure developed by Meichenbaum (1974). The training helped elderly women improve their performance on two tests of inductive reasoning, the Letter Sets Test (French, Ekstrom, & Price, 1963) and the Standard Progressive Matrices (Raven, 1958). The Letter Sets Test presents the individual with five sets of four letters. The task is to induce the rule relating the four letters within each set to one another and to mark the set which does not fit the rule. The Standard Progressive Matrices was used as a transfer task to demonstrate generalizability of training. Labouvie-Vief and Gonda compared four treatment conditions: (a) self-instructional training, (b) practice, (c) self-instructional

training combined with anxiety reduction training, and (d) a control condition which provided practice on an irrelevant task of word fluency. After training, practice, or working on the control group task, the groups were administered two tests of inductive reasoning, the Letter Sets Test and a transfer task, the Standard Progressive Matrices. Both types of training as well as practice were helpful in raising performance on the Letter Sets Test compared to the control group. However, the anxiety training did not increase performance on the Standard Progressive Matrices. The practice group most consistently performed better than the control group on both administrations of the Letter Sets Test as well as on both administrations of the Standard Progressive Matrices. Labouvie-Vief and Gonda (1975) concluded that the practice group's superior performance was due to the fact that many adults possess their own problem solving strategies and the training imposes the experimenter's strategy which may interfere with the individual's using or forming her own strategy.

The present research study was designed to clarify the issue of strategy formation and strategy interference raised by Labouvie-Vief and Gonda (1975). The purpose of the present experiment was to determine the effects of training and practice on persons who initially scored high, average, or low on a test of problem solving strategy. Individual

differences may make one type of training more appropriate for a particular person than another type of training or practice. People already functioning at a high level of intellectual competence may benefit more from practice; people initially functioning at a low level may benefit more from self-instructional training which provides strategies for them to imitate.

In the present study, participants were randomly assigned to one of three conditions: training, practice, or control. Participants were pretested to measure their initial problem solving ability and after all the data were collected they were assigned to one of three groups on the basis of their pretest scores: high, middle, or low. The data were analyzed to determine the relationship between level of problem solving ability and type of training or practice received.

Hypotheses of the Present Study

The following hypotheses were tested: (a) both the training and practice groups score significantly higher on the Letter Sets Test at both the immediate and delayed post-tests than the control group; (b) both the training and practice groups score significantly higher on the Standard Progressive Matrices than the control group; (c) the high-scoring group on the Problem Solving Test is already able to use efficient strategies, therefore, practice adds more to the high-

scoring group's performance on the Letter Sets Test than self-guidance training; and (d) the low-scoring group on the Problem Solving Test initially possesses relatively inefficient strategies for problem solving and the provision of strategies for them, as in the self-guidance training, adds more to their performance on the Letter Sets than practice does.

METHOD

Subjects

Seventy-four older-adult volunteers were interviewed and tested. Fourteen individuals were recruited from a senior citizens' activity center on the northeast side of Chicago, Illinois and eight were recruited from a senior citizens' apartment building in the same community. Thirty-four other volunteers were recruited in Chicago, 11 volunteers were from northern Kentucky, and seven from Dubuque, Iowa.

The age range of the individuals tested was from 57 to 80 years and the mean age was 67.5 years. Fifty-four volunteers were female and 20 were male. Most were married or widowed and all but one had worked outside the home. Approximately 35% had continued their education after high school and 53% had worked at or were still working at white collar jobs. Seventy-three percent were retired at the time of the interview. A summary of the demographic characteristics of the participants is presented in Table 1.

All individuals tested were relatively healthy and able to live independently in the community. On a self-rating of health with 120 being a perfect score, the mean health rating was 114.20. A rating of 114 would be given to

Table 1

Demographic Characteristics of the Participants (N=74)

Age (years)	Mean	67.5
	SD	6.7
	Range	57-80
Education	Some grade school	1
	Graduated 8th grade	17
	Some high school	7
	High school graduate	20
	Some college	19
	College graduate	4
	M.A.	1
	Business or technical training	5
Marital Status		
	Single (never married)	4
	Married	34
	Remarried	2
	Divorced	4
	Widow/er	30
Living Arrangement		
	With family or spouse	41
	With others	2
	Alone	31
Present Work Status		
	Retired	54
	Working Part-Time	10
	Working Full-Time	10
Past or Present Occupations		
	Professional with advanced degree	2
	Teacher, nurse, counselor	6
	Managerial, administrative	5
	White collar, sales	39
	Artist, musician	1
	Technician, skilled	6
	Semiskilled or unskilled	14
	Never worked outside the home	1

an individual who indicated they had a mild problem with eyesight or hearing and, in addition, a mild problem with a chronic disease (such as arthritis or diabetes) and/or mild problems with circulation or mobility due to some illness. The health rating is described in more detail in the next section of this paper.

Fourteen individuals had a major life change within the 6 months preceding the testing. The death of a spouse or close relative, or moving to a new community were defined as major life changes for this study. Sixty volunteers reported no such major life change in the 6 months before testing.

The fourteen individuals recruited from the senior citizens' center were offered a payment of $7.00 to participate in two hours of testing. Only 11 individuals accepted payment. An analysis of their scores showed that their scores were not significantly different from the scores of the volunteers who did not receive payment.

Experimenters

Four female graduate students in psychology tested the senior adults in the present study. The author completed 69% of the interviews and trained the three assistant researchers. The assistants were only told that the three types of training were being compared. The assistants were not informed of the hypotheses of the present study until all the data were collected. Analyses of variance on both

administrations of the Letter Sets Test and on the Standard Progressive Matrices showed no significant main effect due to the experimenters.

Materials

All individuals completed six different tests or interview schedules: the demographic questionnaire, a self-rating of health (Murphy, 1976), 2 items from the Problem Solving Test (adapted from Hill, 1962), the Letter Sets Training Booklet or a control group task (designed by the experimenter), the Letter Sets Test (French, et al., 1963), and the Standard Progressive Matrices (Raven, 1958).

Demographic questionnaire and health rating. The demographic questionnaire and the self-rating of health are in the Appendix. The results of the demographic questionnaire are summarized in the preceding section and in Table 1. The self-rating of health (Murphy, 1976) listed 19 of the most common health problems faced by the aged, and one space marked "other" which could be used to describe a problem not listed. Each person rated himself or herself on a 6-point scale ranging from "no problem" (rated "5") to "serious problem" (rated "1") and "total disability" (rated "0"). A perfect score of 120 was obtained by persons listing no health problems at all. The mean health score was 114.20 (SD = 4.92) and the range of all scores was 99 to 120.

Problem Solving Test. A Problem Solving Test was used to measure the initial level of problem solving strategies of the participants. This test used a technique developed by Rimoldi (1955) to record the successive steps used to solve a problem. Rimoldi's technique involves presenting the information necessary to solve a problem on separate cards in a question-answer format. As the problem solver selects a pertinent question, the card may be turned over to show the answer which is typed on the reverse side. The examiner records the order of the questions selected to measure the efficiency of the strategy used by the problem solver. Since the Problem Solving Test focuses on the process rather than on the solution, the test is ideal for examining the strategies used by the individual (Hill, 1962; Rimoldi & Haleny, 1962).

The Problem Solving Test used in the present experiment was based on the Rimoldi technique. The test consisted of two items (see Figures 1 & 2), one devised by Hill (1962) and the other devised by the present experimenter using the same format as Hill. The problems were presented to the individual on 3 X 5 inch cards. The information necessary to solve the problem, as well as irrelevant information, were presented in a question-answer format with the question typed on one side of the 3 X 5 card and the answer typed on the reverse side.

Figure 1

Item 1 of the Problem Solving Test

Item 1[a]

Instructions

The Jones family and their relatives live together in a large house. You are to find out how many female children live in this house. You will be able to do this by asking any of the following questions. Try to solve the problem by asking as few questions as possible.

Questions	Answers
1. How many people are in the Jones family?	1. Ten people altogether
2. How many men and boys are in the Jones family?	2. Seven men and boys altogether
3. How many adult women are in the Jones family?	3. Two adult women
4. How many men are in the Jones family?	4. Three men
5. How many boys are in the Jones family?	5. Four boys
6. How many women and girls are in the Jones family?	6. Three women and girls altogether

[a]Adapted from Hill (1962) with slight rewording of the instructions and answers.

Figure 2

Item 2 of the Problem Solving Test

Item 2[b]

Instructions

John owns a farm. He has black race horses and white race horses. John has black farm horses and white farm horses. I want you to figure out how many black farm horses there are. Try to solve the problem by asking as few questions as possible.

Questions	Answers
1. How many horses does John have?	1. Twenty horses altogether
2. How many white horses does John have?	2. Seven white horses
3. How many black horses does John have?	3. Thirteen black horses
4. How many white racing horses does John have?	4. Five white racing horses
5. How many black racing horses does John have?	5. Five black racing horses
6. How many white farm horses does John have?	6. Two white farm horses

[b]Written by the present researcher in the format developed by Hill (1962).

The examiner recorded which questions were selected by the participant, the sequence of the questions selected, and the time in seconds that the decision required. The items from the Problem Solving Test were used because the process of problem solving can be closely examined by noting the sequence of the chosen questions. A measure of the efficiency of the problem solving strategy was obtained by comparing the individual's choice of cards to the most direct logical sequence.

The scoring system on the Problem Solving Test was based on the Rimoldi technique (1955) which was further developed by Hill (1962). The highest score is obtained by asking the fewest number of questions necessary to solve a problem and by asking those questions in a logical order. Scores are determined by allocating weights to each sequence of questions. The more direct and logical sequences are assigned high weights and sequences consisting of irrelevant or redundant questions are assigned low weights. The weights are adjusted so that the selection of a relevant question early in a sequence yields a higher score than the selection of that same question later in a sequence. Weights are assigned to sequences so that the sum of the weights of all possible sequences equal 1.00.

To find the score for an individual, the weights of the questions selected are added together and the sum is

divided by the total number of questions asked as a penalty for choosing any redundant questions. (See the Appendix for the weights for questions of Items 1 and 2 of the Problem Solving Test.)

Letter Sets Training Booklet and Letter Sets Test. An alternate form of the Letter Sets Test (French et al., 1963) was used for the training and practice groups in the first testing session. The alternate form of the Letter Sets Test was developed by the present researcher and contains items that are parallel to the original items. This alternate form of the test was developed with the permission of Educational Testing Service. The training booklet and instructions were constructed according to the guidelines outlined by Labouvie-Vief and Gonda (1975) so that the results of the two experiments could be compared. This alternate form of the Letter Sets Test was used only for the purposes of training and practice. The Training Booklet and the rules for each item are in the Appendix.

The Letter Sets Test was administered to all groups at the conclusion of the first testing session. The Letter Sets Test is a test of inductive reasoning that is one test of the Kit of Reference Tests for Cognitive Factors (French et al., 1963) based on the factor analysis of abilities. The test presents five sets of four letters each in an item. The task is to find the rule relating the four letters within each set

to one another, and to mark the set which does not fit the rule. The score on the test is the total number of sets correctly marked, minus the number wrong divided by four in order to correct for guessing.

Standard Progressive Matrices. The Standard Progressive Matrices (Raven, 1958) was used as a transfer task to estimate the generalizability of the training and practice. This is a test of inductive reasoning as is the Letter Sets Test. The Standard Progressive Matrices consists of designs which have a part of the design removed, similar to a jigsaw puzzle with one piece missing. The individual must choose the missing insert from six or eight given alternatives. The Standard Progressive Matrices was administered and scored according to the test manual.

Control group task. A word fluency test developed by the present researcher was given to the control group during the first testing session in the place of training or practice on the Letter Sets Test. The word fluency test requires the individual to emit in writing the largest possible number of words beginning with a specified letter within a limited time period. The participants were to write words beginning with the following letters: s, c, m, p, and b. There were 30 blank spaces for each letter. Participants worked on the word fluency task until they completed 30 words for each letter or until 45 minutes were passed. Practice on this

task was not expected to improve the individual's score on the Letter Sets Test nor on the transfer task because those tests are measure of inductive reasoning and differ qualitatively from the word fluency task.

Design

A 3 X 3 blocked design was used. There were three levels of scoring on the Problem Solving Test (high, middle, and low) and three conditions (training, practice, and control). At the time of testing individuals were randomly assigned to either the training, practice, or control group. All 74 individuals were prested on the Problem Solving Test to assess their initial use of efficient strategies in the problem solving process. On the basis of their pretest scores individuals were assigned to the high, middle, or low-scoring group after all the data were collected.

The method of scoring of the Problem Solving Test leads to a limited number of possible scores and consequently there were many tied scores. The experimenter empirically determined the boundary scores for the low, middle, and high problem solving strategy groups. Boundary scores could not be fixed until all the data were collected. Individuals with a total score of .02500 to .15510 on the two items were assigned to the low problem solving group. Individuals scoring between .15740 and .21528 were assigned to the middle problem solving strategy group. Those who scored between

.22187 and a perfect score of .26388 were assigned to the high problem solving group. Table 2 shows the mean and standard deviation of each group on the Problem Solving Test. Twenty-three individuals were assigned to the low scoring group, 27 to the middle group, and 24 to the high scoring group. The participants were divided into the three groups but due to the tied scores, the groups differed slightly in size. This provided a safeguard against experimenter bias. At the time of testing the experimenter was not aware of the strategy group to which the individual would be assigned, with the exception of extremely high or low scorers.

Procedure

All persons were tested individually in two separate sessions. The following introduction was read to each participant to explain the purpose and the procedure of the testing session:

> There have been many studies about children but we know less about adults. I want to learn more about adults and how they solve problems. I am trying to teach people how to learn something new. We will work on three types of problems. I'll explain each one to you so you can be sure you know what we are doing before we go on. I'll be interviewing many other people and I'm interested in how people as a group solve these problems. Each individual score will be kept confidential.
>
> Do you have any questions? (Pause.) If you get tired of sitting, tell me and we can take a break. Before we get started, I would like to know more about you.

The examiner completed the demographic questionnaire for each person and assisted the person in completing the self-rating

Table 2

Means and Standard Deviations for the Problem Solving Test by Treatment Condition and Initial Level of Problem Solving Ability

Level or Problem Solving Test	Treatment Condition								
	Training			Practice			Control		
	M	SD	N	M	SD	N	M	SD	N
Low	.11	.03	8	.09	.04	7	.12	.03	7
Middle	.19	.02	8	.19	.02	9	.18	.02	11
High	.26	.01	8	.26	.02	10	.26	.02	6

of health. The Problem Solving Test was administered next. The following introduction was read to the participant to explain the Problem Solving Test:

> First we will work on some problems which need to be solved. These problems are like the parlor game Twenty Questions or the TV show "What's My Line?" because you must ask questions to get at the answer indirectly. (The examiner spread the cards containing the questions in front of the participant.) These are the questions you can use to solve the problem. (The examiner gave the card containing the problem instructions to the participant and allowed time for the person to read the card.) Now take your time to figure out a plan that will allow you to solve the problem by asking the least number of questions possible. Some of these questions are useful and some are not. When you are ready, point to the question you want to ask first. (When a question was chosen, the examiner noted the number of the question and recorded the time in seconds.) All right. The answer is typed on the back of the card. (The examiner turned over the card to reveal the answer.) Here is the answer. (Many individuals selected the next card by themselves. If the individual hesitated, the examiner said: It's too early to solve the problem now. We still need more information. Which question will you ask now?) This procedure was repeated until the individual solved the problem or chose all 6 questions.

After Item 1 was completed, the same procedure was used for Item 2 of the Problem Solving Test.

If the person had been randomly assigned to either the training or practice group, they worked with the Letter Sets Training Booklet.

The following instructions were read to the training group before they began working on the Letter Sets Training Booklet:

> These are all practice problems. I will do the first page to show you what to do. You will work on the second

set of problems while you are talking out loud and I will be here to help you.

First problem set

Now we'll work on the first problem. Let's see 'What do I have to do?' I want to find the rule in each set and mark the set that is different. These letters look like they are in alphabetical order but some of the letters are missing. Now I see. The second letter is missing in each set. But in the fourth set there are two letters missing. This fourth set is different so I will mark it with an X. (The examiner can elaborate on this explanation if necessary by showing how all but the fourth set follow the rule.)

On this second problem I see that the same letter is repeated twice in each set. 'What is the rule in this set?' Oh. I see that in most of the sets there is only one letter between the two Ks but here in the third set there are two letters between the Ks. So I will cross out the first set because it is different.

'What idea can I try on this set?' The letters are too mixed up to be in alphabetical order. But the first set looks different. I know, the first set is made up of all vowels and all the other sets are consonants. The first set is different, so I will mark it with an X. (Examiner explains which letters are vowels, if necessary.)

'What is the rule in this set?' (pause) The letters are in alphabetical order but the middle letter is always missing. Now I see that in the third set there are two letters missing. The third set is different so I will mark it with an X.

'What idea can I try?' Now in this series for number 5, I see a lot of the same letter. The letter T is in every set but the first set. This one does not fit, therefore I'll mark it with an X.

'What is the rule in this set?' The letters look like some of them are in alphabetical order. I see the middle letters of each set follow one another in the alphabet. But the last set does not follow the rule, so I will mark it with an X.

Second problem set

> Now I want you to work on the next set of problems. Talk out loud and ask yourself questions just like I did to help you concentrate on the problem. I will help keep you on the right track. (Individual works on the problem talking aloud and experimenter monitors the verbal statements. The experimenter gives feedback and explains the rule if the individual is unable to solve the item.)

Third problem set

> Now I want you to talk aloud to yourself while you work on the problems. That is fine.

Fourth problem set

> Now I want you to work on these problems while you are whispering the instructions and questions to yourself.

Fifth problem set

> Now I want you to work on these problems. You can give yourself instructions about what to do but I do not want you to whisper out loud. Try to work on these problems without moving your lips.
>
> Okay you did very well. I know this is a difficult set of problems but you worked very well. These were the practice problems. Now I want you to work on some similar problems but there will be a time limit. Try not to worry about the time but just do the best you can. Don't get stuck on one problem if you can't figure out the rule. You can skip to the next problem. Do you have any questions?

The practice group received only the standard instructions for the Letter Sets Test which were printed on the cover of the Training Booklet. They were told "I am interested in how well people can figure out the answers to these problems. Do the best you can." The practice group was reinforced each time they marked a set with an X, but were not told if they

had marked a correct or an incorrect set. Some of the individuals asked to be told if they were doing the task correctly. They were told "I'm interested in what you can figure out on your own. You've been doing well so far."

If the person had been randomly assigned to the control group, he or she worked on the word fluency task. Individuals were permitted to work on the Training Booklet or the word fluency task until they completed all the items or until 45 minutes had passed. In pilot tests 45 minutes seemed to be the maximum time the participants could give their full attention to the tasks and training procedures. At the end of the first session, all three groups were given the Letter Sets Test under standard timed conditions.

Approximately two weeks after the initial session, participants were retested on the Letter Sets Test under standard timed conditions. Then the Standard Progressive Matrices was administered to assess the generalizability and the long-term effects of training or practice.

RESULTS

Descriptive statistics, tests of the hypotheses of the present study and planned statistical analyses are presented in this section.

Descriptive Statistics

There was a wide range in scores and in length of time required to complete the Problem Solving Test. The mean scores, the ranges, and the standard deviations are shown for each item in Table 3. One individual received a score of .00 on item 1 yet 25 persons received a perfect score on the same problem. The mean time required to solve item 1 was 2.32 minutes and to solve item 2 was 2.52 minutes. The time required to solve item 1 ranged from .20 to 9.98 minutes. Length of time required to solve the problem was inversely correlated with performance for item 1 ($r(72) = -.31$, $p < .004$). As noted previously, the scoring method was not based on length of time required for solution but only on the sequence of questions asked and the total number of questions selected.

The mean numbers of correctly solved items for the Letter Sets Test for each condition and each problem solving level are listed in Table 4. A comparison of the mean scores for each condition of the present study to the mean scores

Table 3

Means, Standard Deviations, and Ranges for Both Items of the Problem Solving Test (N = 74)

	M	SD	Range
Item 1	.096	.04	.00000 - .13194
Item 2	.089	.04	.02500 - .13194
Total Score	.185	.06	.02500 - .26388

Table 4[a]

Means and Standard Deviations for Letter Sets Test by Treatment Condition and Problem Solving Level

Time of Testing / Problem Solving Level	Training M	Training SD	Practice M	Practice SD	Control M	Control SD
	Treatment Condition					
Immediate Posttest						
Low	10.22	4.05	9.21	8.98	7.71	4.27
Medium	9.06	3.05	9.89	7.05	10.43	5.16
High	11.38	5.75	15.50	4.46	12.42	3.80
Total	10.22	4.34	11.86	7.15	10.14	4.76
Delayed Posttest						
Low	8.94	4.49	7.64	8.56	8.29	5.56
Medium	8.72	3.23	11.53	6.64	11.21	5.76
High	11.59	5.35	15.28	4.33	13.08	5.20
Total	9.75	4.45	11.92	6.94	10.82	5.63
Combined						
Low	9.58	3.80	8.43	8.71	8.00	4.89
Medium	8.89	3.03	10.71	6.34	10.82	5.24
High	11.48	5.29	15.39	4.01	12.75	4.40
Total	9.98	4.12	11.89	6.75	10.48	5.06

[a]The Ns for Training for low, medium and high Problem Solving Level were 8, 8, 8; for Practice, 7, 9, 10; and for Control, 7, 11, 6.

reported by Labouvie-Vief and Gonda (1975) shows that the mean scores for the present study were higher for each condition for the Letter Sets Test (see Table 5). The same table shows that the means for the present study were significantly higher on the Letter Sets Test for the practice condition and for the control condition than those reported by Labouvie-Vief and Gonda.

The mean numbers of correctly solved items for the Standard Progressive Matrices for each condition and each problem solving group are shown in Table 6. Table 5 shows that the mean number correct on the Standard Progressive Matrices was significantly higher for the control group of the present study than for the control group of the Labouvie-Vief and Gonda study.

The group means on the Standard Progressive Matrices for the treatment conditions of the present study are in the 70 - 83 percentile range according to norms published by Raven (1960). The group means for participants in the Labouvie-Vief and Gonda study are in the 48 - 66 percentile range according to the published norms.

Planned Statistical Analyses to Test the Four Hypotheses of the Present Study

The data were analyzed for short- and long-term effects of training. The extent to which the training and the practice were task-specific or generalizable was also

Table 5

Comparison of Means on the Letter Sets Test and Standard Progressive Matrices Obtained by Labouvie-Vief and Gonda (1975) and by the Present Study

		Labouvie-Vief & Gonda[a]		Present Study[b]		
	Condition	M	SD	M	SD	t obs.[c]
Letter Sets Test[d]	Training	8.17	5.73	9.98	4.12	1.06
	Practice	8.07	3.59	11.89	6.75	2.36*
	Control	5.50	3.94	10.48	5.06	3.43**
Standard Progressive Matrices[e]	Training	28.13	13.11	31.17	7.99	0.81
	Practice	29.80	9.71	32.77	11.38	0.88
	Control	23.27	6.73	35.58	9.47	4.75**

[a] N = 15 for each group

[b] N = 24 for Training and Control; N = 26 for Practice

[c] df = 23

[d] Immediate and Delayed Posttests Combined

[e] Delayed Posttest

* $p \leq .01$ (Two-tailed test)

** $p \leq .001$ (Two-tailed test)

Table 6

Mean Number of Correctly Solved Items and Standard Deviations for Standard Progressive Matrices by Treatment Condition and Problem Solving Level

Problem Solving Level	Training			Practice			Control		
	M	SD	N	M	SD	N	M	SD	N
	Treatment Condition								
Low	30.75	7.87	8	25.71	12.34	7	32.57	6.85	7
Medium	29.13	7.08	8	31.89	8.98	9	34.91	11.94	11
High	33.63	9.26	8	38.50	10.53	10	40.33	5.35	6
Total	31.17	7.99	24	32.77	11.38	26	35.58	9.47	24

examined. There were two measures of the dependent variable, inductive reasoning: the Letter Sets Test and the Standard Progressive Matrices. The Letter Sets Test was administered twice, once during the first testing session and once during the second testing session two weeks later. Therefore, a repeated-measures analysis of variance was used. A 3 X 3 X 2 (Problem Solving Test level X condition X first vs. second testing) analysis of variance with repeated measures over the time of testing was performed on the data.

Hypothesis A stated that both the training and practice groups score significantly higher on the Letter Sets Test than the control group at both the immediate and delayed posttests. This hypothesis was not supported by the results of this study since there was no significant main effect for treatment condition, $\underline{F}$ (2, 65) $=<1.0$, $\underline{p} \leq .61$. The training and practice groups did not perform differently than the control group on the Letter Sets Test. There was a significant main effect, however, for level of scoring on the Problem Solving Test, $\underline{F}$ (2, 65) = 4.42, $\underline{p} \leq .02$. Persons who performed well on the Problem Solving Test also tended to perform well on the Letter Sets Test. A summary table of the analysis of variance on the Letter Sets Test scores is presented in Table 7.

Hypothesis B stated that both the training and practice groups score significantly higher on the Standard

Table 7

Summary Table of the Analysis of Variance of the Letter Sets Test Scores

Source of Variation	MS	df	F
Treatment of condition (T)	28.14	2	1.00
Level on Problem-Solving (P)	245.65	2	4.42*
T X P	30.45	4	1.00
Subjects (S)	55.58	65	
Letter Sets Test (L)	9.92	1	1.00
T X L	4.06	2	1.00
P X L	6.53	2	1.20
T X P X L	3.12	4	1.00
L X S	5.43	65	

* $p \leq .02$

Progressive Matrices than the control group. This hypothesis was not supported by the data. The analysis of variance for the Standard Progressive Matrices scores showed no significant main effect due to condition, F (2,71) = 1.26, $p \leq .29$. The training and practice groups did not score significantly differently from the control group on the Standard Progressive Matrices. A summary table of the analysis of variance for the Standard Progressive Matrices scores is presented in Table 8.

The third hypothesis stated that the high-scoring on the Problem Solving Test is already able to use efficient strategies, therefore practice alone adds more to the high-scoring group's performance on the Letter Sets Test than self-guidance training. Hypothesis D stated that the low-scoring group on the Problem Solving Test initially possesses relatively inefficient strategies for problem solving and the provision of strategies for them, as in the self-guidance training, adds more to their performance on the Letter Sets Test than practice does. Neither hypothesis was supported because of the lack of a significant interaction between level of scoring on the Problem Solving Test and treatment condition for Letter Sets Test scores, F (4, 65) = < 1.0, $p \leq .70$ (see Table 7). Level of problem solving ability was not related to whether practice or training would be more helpful in raising scores on the Letter Sets Test.

Table 8

Analysis of Variance of the Standard Progressive Matrices by Treatment Condition

Source of Variation	MD	df	F
Between Groups	120.14	2	1.26
Within Groups	95.35	71	
Total	96.03	73	

Pair-wise directional contrasts devised by Dunn (Kirk, 1968) were used to increase the power of the analysis. As researchers have indicated (Birren, 1970; Labouvie-Vief & Gonda, 1975) intersubject variability among the aged is often so great that it is difficult to demonstrate treatment effects. The Dunn contrasts allow one to compare each of the training and practice groups to the control group. These contrasts were used by Labouvie-Vief and Gonda and were planned statistical tests for the present study. These contrasts were formed separately for the immediate and delayed posttests and the findings summarized in Table 9.

Although the pair-wise Dunn contrasts are theoretically more sensitive to small differences among the group scores, the Dunn contrasts also show that there was no significant difference between the training group and the control group nor between the practice group and the control group on either the Letter Sets Test or the Standard Progressive Matrices. Training or practice on the Letter Sets Training Booklet was not more effective than working on the control group task, as measured by subsequent performance on the Letter Sets Test or the transfer task, the Standard Progressive Matrices.

Relationships Among the Cognitive Tests

All the cognitive tests used in the present study correlated significantly with one another; however, the

Table 9[a]

Dunn Contrasts on Training Task for Immediate and Delayed Posttests and on the Transfer Task for Delayed Posttest

	Comparison	Posttest[b] Immediate	Delayed
Training Task	Control vs. Training	.08	1.07
(Letter Sets	Control vs. Practice	1.72	1.10
Test)	Training vs. Practice	1.64	2.17
Transfer Task	Control vs. Training	----	4.41
(Standard	Control vs. Practice	----	2.81
Progressive	Training vs. Practice	----	1.60
Matrices)			

[a] Values listed in the table are the absolute value of the differences between the group means.

[b] Critical values are: Training Task, $\underline{d} = 3.88$ ($\underline{p} < .05$)
Transfer Task, $\underline{d} = 6.96$ ($\underline{p} < .05$).

relative size of the correlations (see Table 10) is consistent with expectations based on what the tests were designed to measure. The highest correlation was obtained between the two administrations of the Letter Sets Test, r (72) = .84, $p \leq .001$. Examination of Table 10 shows the next highest correlations were obtained between the two administrations of the Letter Sets Test and the Standard Progressive Matrices, which are both measures of inductive reasoning, r (72) = .64 and r (72) = .60, respectively. The Problem Solving Test correlated significantly with both administrations of the Letter Sets and the Standard Progressive Matrices, but the correlations were more modest, rs (72) = .28, .34, and .34 respectively, $p \leq .001$. These more modest correlations indicate that the Problem Solving Test does measure somewhat different cognitive skills than the two measures of inductive reasoning.

Results of the Multiple Regression Analysis

Table 11 shows the results of a multiple regression analysis. "Dummy" variables were created for the purpose of doing the multiple regression analysis for the variables consisting of nominal data (Kim & Kohout, 1975). This procedure involves using each category as a separate variable and assigning a code to indicate the presence or absence of each category for each case. The number of dummy variables created for each nominal variable is determined by the number

Table 10

Matrix of Pearson Correlations of Cognitive Tests for the Total Sample (N = 74)

	Letter Sets Test Delayed Posttest	Standard Progressive Matrices	Problem Solving Test
Letter Sets Test Immediate Posttest	.84*	.64*	.29*
Letter Sets Test Delayed Posttest		.60*	.34*
Standard Progressive Matrices			.35*

* $p \leq .001$

Table 11[a]

Regression Analyses on the Letter Sets Test, Standard Progressive Matrices, and the Problem Solving Test

Dependent Variables	Multiple Regression	Independent Variables	Beta	F	df
Letter Sets Test Immediate Posttest	.70	Education	.50	26.87**	4,64
		Age	-.35	14.78**	
		Practice Condition	.17	3.52*	
		Occupation	.15	2.54*	
Letter Sets Test Delayed Posttest	.72	Education	.43	20.39**	5,63
		Age	-.39	18.75**	
		Practice Condition	.15	2.89*	
		Level of Problem Solving Strategy	.15	2.58*	
		Occupation	.15	2.40	
Standard Progressive Matrices	.45	Level of problem-solving strategy	.25	4.78**	3,65
		Age	-.25	4.77**	
		Occupation	.19	3.07*	

[a] Only the factors with a significant F ratio are printed in this table.

* $p \leq .05$
** $p \leq .01$

of categories minus one, since the value of the last dummy variable is determined by the preceding variables (Kim & Kohout, 1975).

For the purpose of analysis, education was coded into seven levels (see Table 1). The category of "business or technical training" was treated as the equivalent of a high school education. Education was the most salient variable for performance on the immediate and delayed posttests of the Letter Sets Test. Educational level completed was more closely related to performance than the variable of age. Age was negatively related to performance and was the second most important variable contributing to performance on both administrations of the Letter Sets Test as well as on the Standard Progressive Matrices.

Problem solving strategy level (high, middle, or low score on the Problem Solving Test) was considered to be a subject variable and was analyzed as an independent variable for the multiple-regression analyses. Level of problem solving strategy was positively related to performance on the second administration of the Letter Sets Test as well as on the Standard Progressive Matrices. Persons who performed well on the Problem Solving Test also tended to perform well on both tests of inductive reasoning at the time of the second testing.

Occupation was coded into eight categories and the categories were ranked in order according to the amount of education or experience required. Persons of high occupational status tended to perform above average on both administrations of the Letter Sets Test and the Standard Progressive Matrices.

Having been assigned to the practice condition was positively related to performance on the Letter Sets Test at both administrations. The practice group in the present experiment did have higher mean scores than the training and control groups, but both the analyses of variance and the Dunn contrasts indicated that these differences were so small that the differences were probably due to chance.

DISCUSSION

Four hypotheses were tested in the present study: (1) both the training and practice groups score significantly higher on the Letter Sets Test than the control group at both the immediate and delayed posttests; (2) both the training and practice groups score significantly higher on the Stanard Progressive Matrices than the control group; (3) the high-scoring group on the Problem Solving Test is already able to use efficient strategies, therefore practice adds more to the high-scoring group's performance than self-guidance training; and (4) the low-scoring group on the Problem Solving Test initially possesses relatively inefficient strategies for problem solving and the provision of strategies for them, as in the self-guidance training, adds more to their performance than practice does. Although the results of the present study indicated that level of problem solving ability was positively related to performance on the measures of inductive reasoning, there were no significant differences among the training, practice, or control groups on the Letter Sets Test or on the Standard Progressive Matrices. The predicted interaction between initial level of problem solving ability and treatment condition was not observed. Therefore, the four hypotheses were not supported by the results of this study.

In this section of the paper, reasons why the hypotheses may not have been supported are discussed. Reasons why the findings of the present study differed from the findings of Labouvie-Vief and Gonda's study and implications for future research are suggested.

Characteristics of the Participants in the Present Study

The mean scores on the Standard Progressive Matrices for all treatment groups in the present study were higher than average according to norms published by Raven (1960), i.e., means in the 70-83 percentile range. This indicates the participants in the present study were above average in their intellectual functioning compared to the national norms for persons of their age. The control group, which had no training or practice on the Letter Sets Test, scored on the average, at the 83rd percentile on the Standard Progressive Matrices. When participants in a study perform above average without training, it is difficult to demonstrate improvements related to training because of ceiling effects.

No attempt was made to get individuals who were considered above average in intelligence to participate in the present study and no direct assessment of IQ was made. However, since all the participants in the present study were volunteers, there may have been some self-selection with the result that highly intelligent people volunteered more often. As noted previously, volunteers tend to be above average in

intelligence and self-confidence (Birren, 1959). Results based on such studies may not be generalizable to all individuals of that age group.

Only two persons who agreed to participate withdrew their consent. Both did so early in the first testing session and their decision seemed to be due to their discovery of the difficult nature of the tasks. One individual was from the training group and one was from the control group so there was no systematic withdrawal from the various treatment conditions. The woman who withdrew from the training group said that she did not see the importance of answering all these questions (of the Problem Solving Test) and if that was what people studied in school now, then they are wasting their time. This individual did not understand the instructions to the Problem Solving Test and the researcher had to repeat the instructions several times. The woman's frustration and embarrassment probably contributed to her negative evaluation of the task and her refusal to participate any further. The woman who withdrew from the control group said that she was an artist and wanted to be interviewed about her art but did not like to do puzzles (the Problem Solving Test). Every person who completed the first testing session also completed the second testing session.

Comparison of the Present Study and the Labouvie-Vief and Gonda Study

As noted, the participants in the present study scored higher than those in the Labouvie-Vief and Gonda (1975) study on both administrations of the Letter Sets Test as well as on the Standard Progressive Matrices. There are two possible explanations for the difference: either the training or practice conditions were not conducted in the same manner or the two samples were not equivalent. Every effort was made to use the procedure and instructions that were used by Labouvie-Vief and Gonda so that the results of the two studies could be compared. Instructions were reconstructed from the article published by Labouvie-Vief and Gonda (1975) and the present researcher contacted the senior author by telephone regarding details of the procedures used. There are indications, however, that the two samples of participants differed in three characteristics: (a) ability, (b) age, and (c) income. The fact that higher scores were also obtained by the control group of the present study than for the Labouvie-Vief and Gonda study suggests the two samples were probably not equal in ability. The mean age of participants in the present study was 67.5 years compared to the mean age of 76 reported by Labouvie-Vief and Gonda. Age was found to be negatively related to performance on the Standard Progressive Matrices and the Letter Sets Test among

participants in the present study. The participants of the present study may have scored higher than Labouvie-Vief and Gonda's participants partly because they were younger. All of Labouvie-Vief and Gonda's participants were recruited from senior-citizen housing for low-income persons and were offered $9.00 to participate in the testing. In the present study most of the seniors were not paid for their participation and most did not live in senior-citizen housing. Early in the data collection there was extreme difficulty in locating participants and so the experimenter offered $7.00 for 2 hours of testing to members of a senior-citizens center. Only 11 persons accepted the offer (15 percent of the total number of subjects) and the offer of money did not appear to attract subjects more than talking to persons and asking them to recommend others. After the data collection was completed, the scores of the participants who were paid were compared to those who were not paid. There was no statistical difference between the scores on either administration of the Letter Sets Test or on the Standard Progressive Matrices, so all the scores were analyzed together.

Preferred Style of Problem Solving

Participants often demonstrated they had a particular style or preferred method of approaching the training and practice items in the Letter Sets Training Booklet. Some individuals in the training group wanted to solve the

problems independently and the examiner had to continually prod them to use the self-instructional statements. On the other hand, some individuals in the practice group continually asked the examiner for the correct answer even though they were instructed that the researcher was interested in how well they could work the problems on their own. Individuals in the practice group were reinforced for working each problem without correcting their errors. Some individuals objected when they realized that the examiner would not tell them whether their answer was right or wrong. A few individuals even suggested the examiner was being hypocritical for praising them for working the problem even if the answer was wrong. The examiner replied that she was interested in seeing how well they could do on their own by practicing. Many individuals seemed to have strong preferences for a problem-solving style, many attempting to solve the problem their own way without following the examiner's instructions and others wanting feedback and approval for each answer. It often seemed that the more capable individuals wanted to solve the problems independently and that those of lesser capability or lesser self-confidence sought more guidance from the researcher. The most difficult aspect of conducting the experiment was reminding the participants of how they were to approach the task and why it was important for them to do their best to follow the instructions. The examiners

had to continuously prompt the participants of the training group to use the self-guidance questions.

Difficulty Level of the Cognitive Tasks

The Letter Sets Test is a difficult task and for that reason it was chosen by Labouvie-Vief and Gonda (1975). They stated that it would be more impressive to show an increase in performance on a difficult task than on a simple task. This may be the case, but it seemed that the difficult nature of the tasks exacerbated the anxiety and fear of making a mistake for some participants in the present study. The nature of the training task in itself was so difficult that attempts to have the participant repeat the self-guidance questions seemed to be confusing to many persons in the training group. The self-guidance questions themselves seemed to make the training more complex by increasing the amount of material that the individual was required to remember. Rabbitt (1977) noted that when a task becomes extremely complex, a person will tend to perseverate with a simple strategy rather than use no strategy at all. He also stated that older persons will tend to use simpler strategies when both simple and complex strategies are available. The persons in the training condition of the present study seemed to prefer their own simple strategies to the rather complicated strategies modeled by the experimenter.

Labouvie-Vief and Gonda concluded that their practice group performed better than the other groups because they were free to form their own strategies and that the training group was prevented from forming or using their own strategies because the experimenter's strategy was imposed on them. The present researcher's opinion is slightly different from their conclusion. It seems that the combination of a difficult task and complicated self-guidance statements made the training task so complex that the individuals assigned to the training group resisted the experimenter's strategy and preferred their own more simple strategies. The interference seems to be due to the task complexity. The practice group may have performed slightly better because they were required to learn only one new task rather than the two tasks required of the training group.

Individual Differences

There was a wide range in scores on all the tests used in the present study. There were also differences in the conduct of the participants. Some individuals seemed confident and said they enjoyed working on the tests and would participate in future studies if they could. Other individuals began the first testing session with a comment such as "now you'll see how dumb I am." Anxiety and fear of making mistakes were not only observed in the practice and training groups who worked on the difficult Letter Sets Training

Booklet, but in some members of the control group who practiced the easier task of word fluency. Some individuals in the control group continually asked the examiner to "check" their words to see if they were doing the task correctly. The present study was designed to examine the effect of individual differences in problem solving strategies which are cognitive in nature. It seems that personality factors such as self-concept or anxiety may be important to investigate as well. Future research on cognitive performance should systematically investigate how such factors as these are related to performance in older adults.

SUMMARY

The present study was designed to clarify the issue of strategy formation and strategy interference raised by Labouvie-Vief and Gonda (1975). They compared the performance of four groups of elderly women on the Letter Sets Test and on the Standard Progressive Matrices. They compared self-guidance training, practice, anxiety training, and a control group and found that the practice group most consistently scored higher than the other groups. Labouvie-Vief and Gonda concluded that the practice group's superior performance was due to the fact that many adults possess their own problem solving strategies and the training imposes the experimenter's strategy which may interfere with the individual's using or forming her own strategy. The hypotheses of the present study were designed to determine the relationship between initial level of problem solving ability and type of training or practice received.

The present study examined the effects of training and practice on performance on two tests of inductive reasoning for older adults of three levels of efficiency of problem solving strategy. All adult volunteers (mean age = 67.5 years) were relatively healthy and living independently in the community. There were 54 female and 20 male partici-

pants. Participants were randomly assigned to one of three treatments: self-guidance training (training to use self-instructional statements while working on a test of inductive reasoning, the Letter Sets Test), practice (on the Letter Sets Test with no training or feedback), or a control group which worked on an irrelevant task of word fluency.

During the first training session, all participants were pretested on the Problem Solving Test to determine the efficiency of their problem solving strategies. Participants were later assigned to one of three levels of problem solving ability on the basis of their pretest scores. After the pretest, participants of the training, practice, and control groups worked on their respective tasks. At the end of the session, participants were tested on an alternate form of the Letter Sets Test. Two weeks after the training session, participants were retested on the Letter Sets Test to determine the long-term effects of training and practice and were also tested on a transfer task, the Standard Progressive Matrices to determine the generalizability of training and practice. Four hypotheses were tested: (a) both the training and practice groups score significantly higher on the Letter Sets Test than the control group at both the immediate and delayed posttests; (b) both the training and practice groups score significantly higher on the Standard Progressive Matrices than the control group; (c) the high-scoring group

on the Problem Solving Test is already able to use efficient strategies, therefore, practice adds more to the high-scoring group's performance on the Letter Sets Test than self-guidance training; and (d) the low-scoring group on the Problem Solving Test initially possesses relatively inefficient strategies for problem solving, therefore, the provision of strategies for them, as in the self-guidance training, adds more to their performance on the Letter Sets Test than practice does.

The level of problem solving ability was positively and significantly related to performance on both measures of inductive reasoning and there were no significant differences among the training, practice, or control groups on the Letter Sets Test or on the Standard Progressive Matrices. The predicted interaction between initial level of problem solving ability and treatment was not observed. Therefore, the four hypotheses were not supported by the results of this study. Although the practice group did score slightly higher than the training and control group of the present study on the Letter Sets Test and on the Standard Progressive Matrices, there was no statistically significant difference among the three groups.

There were indications that the participants of the present study differed from the participants in the Labouvie-Vief and Gonda (1975) study on three characteristics:

(a) ability, (b) age, and (c) income. These differences between the two samples may be reflected in their performance and may have led to the difference in results found by the two studies. Participants in the present study were above average in their intellectual functioning compared to national norms for persons of their age. The control group, which received no training or practice on the test of inductive reasoning, scored, on the average, at the 83rd percentile on the Standard Progressive Matrices according to norms published by Raven (1960). When the participants are able to perform above average without training, it is difficult to demonstrate improvements related to training because of ceiling effects. Since all the participants of the present study were volunteers, there may have been self-selection with the result that highly intelligent people volunteered more often.

REFERENCES

Anastasi, A. Psychological testing (3rd ed.). New York: Macmillan, 1968.

Arenberg, D., & Robertson-Tchabo, E. A. Learning and aging. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold, 1977.

Baer, D. M. The control of the developmental process: Why wait? In J. R. Nesselroade & H. W. Reese (Eds.), Life-span developmental psychology: Methodological issues. New York: Academic Press, 1973.

Baltes, P. B., & Goulet, L. R. Status and issues of a life-span developmental psychology. In L. R. Goulet and P. B. Baltes (Eds.), Life-span developmental psychology. New York: Academic Press, 1970.

Baltes, P. B., & Goulet, L. R. Exploration of developmental variables by manipulation and simulation of age differences in behavior. Human Development, 1971, 14, 149-170.

Baltes, P. B., & Labouvie, G. V. Adult development of intellectual performance: Description, explanation and modification. In C. Eisdorfer & M. P. Lawton (Eds.), The psychology of adult development and aging. Washington, D. C.: American Psychological Association, 1973.

Baltes, P. B., & Nesselroade, J. R. The developmental analsis of individual differences on multiple measures. In J. R. Nesselroade & H. W. Reese (Eds.), Life-span developmental psychology: Methodological issues. New York: Academic Press, 1973.

Baltes, P. B., Nesselroade, J. R., Schaie, K. W., & Labouvie, E. W. On the dilemma of regression effects in examining ability-level-related differentials in ontogenetic patterns of intelligence. Developmental Psychology, 1972, 6, 78-64.

Baltes, P. B., & Schaie, K. W. The myth of the twilight years. Psychology Today, March 1974, 35-40.

Berkowitz, B. Changes in intellect with age: IV. Changes in achievement and survival in older people. Journal of Genetic Psychology, 1965, 107, 3-14.

Bijou, S. W., & Baer, D. M. Some methodological contributions from a functional analysis of child development. In L. P. Lipsitt, & C. C. Spiker (Eds.), Advances in child development and behavior.

Bijou, S. W., Peterson, R. F., & Ault, M. H. A method to integrate descriptive and experimental field studies at the level of data and empirical concepts. Journal of Applied Behavioral Analysis, 1968, 1, 175-191.

Birren, J. E. Principles of research on aging. In J. E. Birren (Ed.), Handbook of aging and the individual. Chicago: University of Chicago Press, 1959.

Birren, J. E. Toward an experimental psychology of aging. American Psychologist, 1970, 25, 124-135.

Birren, J. E., & Morrison, D. F. Analysis of the WAIS subtests in relation to age and education. Journal of Gerontology, 1961, 16, 363-369.

Botwinick, J. Cognitive process in maturity and old age. New York: Springer, 1967.

Botwinick, J. Aging and Behavior. New York: Springer, 1973.

Botwinick, J. Intellectual abilities. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold, 1977.

Botwinick, J., & Birren J. E. Differential decline in the Wechsler-Bellevue subtests in the senile psychoses. Journal of Gerontology, 1951, 6, 365-368.

Botwinick, J. & Birren, J. E. Cognitive processes: Mental abilities and psychomotor responses in healthy aged men. In J. E. Birren (Ed.), Human aging: A biological and behavioral study. U.S. Government Printing Office, 1963.

Buss, A. R. A general developmental model for interindividual differences, intraindividual differences, and intraindividual changes. Developmental Psychology, 1974, 10, 70-79.

Campbell, D. T., & Stanley, J. C. Experimental and quasi-experimental designs for research. Chicago: Rand McNally & Company, 1963.

Cattell, R. B. Theory of fluid and crystallized intelligence: A critical experiment. Journal of Educational Psychology, 1963, 54, 1-22.

Coleman, K. K. The modification of rigidity in the aged through operant conditioning. Dissertation Abstracts, 1963, 24, 2560-2561.

Craik, F. I. M. Age differences in human memory. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold, 1977.

Cronbach, L. J., & Furby, L. How should we measure "change" -- or should we? Psychological Bulletin, 1970, 74, 68-80.

Crovitz, E. Reversing a learning deficit in the aged. Journal of Gerontology, 1966, 21, 236-238.

Cunningham, W. R., Clayton, V., & Overton, W. Fluid and crystallized intelligence in young adulthood and old age. Journal of Gerontology, 1975, 30, 53-55.

Demming, J. A., & Pressey, S. L. Tests "indigenous" to the adult and older years. Journal of Counseling Psychology, 1957, 2, 144-148.

French, J. W., Ekstrom, R. B., & Price, L. A. Manual for the kit of reference tests for cognitive factors. Princeton, New Jersey: Educational Testing Service, 1963.

Furry, C. A., & Baltes, P. B. The effect of age differences in ability-extraneous variables on the assessment of intelligence in children, adults, and the elderly. Journal of Gerontology, 1973, 28, 73-80.

Hallenbeck, C. E. Evidence for a multiple process view of mental deterioration. Journal of Gerontology, 1964, 19, 357-363.

Hill, J. A. The aged person and psychobiological processes. Unpublished master's thesis, Loyola University of Chicago, 1962.

Horn, J. L. Organization of abilities and the development of intelligence. Psychological Review, 1968, 75, 242-259.

Horn, J. L. Organization of data on life-span development of human abilities. In L. R. Goulet & P. B. Baltes (Eds.), Life-span developmental psychology: Research and theory. New York: Academic Press, 1970.

Horn, J. L., & Cattell, R. B. Age differences in primary mental ability factors. Journal of Gerontology, 1966, 21, 210-220.

Hoyer, W. J. Application of operant techniques to the modification of elderly behavior. Gerontologist, 1973, 13, 18-22.

Hoyer, W. J., Labouvie, G. V., & Baltes, P. B. Modification of response speed and intellectual performance in the elderly. Human Development, 1973, 16, 233-242.

Jarvik, L. F., Eisdorfer, C., & Blum, J. E. (Eds.), Intellectual functioning in adults. New York: Springer, 1973.

Kim, J., & Kohout, F. J. Special topics in general linear models. In N. H. Nie, C. H. Hull, J. G. Jenkins, K. Steinbrenner, & D. H. Bent (Eds.), Statistical Package for the social sciences (2nd ed.). New York: McGraw-Hill, 1975.

Kimmel, D. C. Adulthood and aging. New York: John Wiley & Sons, 1974.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, California: Brooks/Cole, 1968.

Kleemeier, R. W. Intellectual change in the senium or death and the IQ. Presidential address, Division 20 of the American Psychological Association, New York, September, 1961, p. 501.

Kleemeier, R. W. Intellectual changes in the senium. Proceedings of the Social Statistics Section of the American Statistical Association, 1962, 290-295.

Kohlberg, L. Continuities in childhood and adult moral development revisited. In P. B. Baltes & K. W. Schaie (Eds.), Life-span developmental psychology: Personality and socialization. New York: Academic Press, 1973.

Kuhlen, R. G. Social change: A neglected factor in psychological studies of the life-span. School and Society, 1940, 52, 14-16.

Kuhlen, R. G. Age and intelligence: The significance of cultural change in longitudinal vs. cross-sectional findings. Vita Humana, 1963, 6, (3).

Labouvie-Vief, G., & Gonda, J. N. Cognitive strategy training and intellectual performance in the elderly. Paper presented at the meeting of the American Psychological Association, Chicago, 1975.

Labouvie, G. V., Hoyer, W. J., Baltes, M. M., & Baltes, P. B. Operant analysis of intellectual behavior in old age. Human Development, 1974, 17, 259-272.

Lindsley, O. R. Geriatric behavioral prosthetics. In R. Kastenbaum (Ed.), New thoughts on old age. New York: Springer, 1964.

Meichenbaum, D. Self-instructional strategy training: A cognitive prosthesis for the aged. Human Development, 1974, 17, 273-280.

Meichenbaum, D., & Cameron, R. Training schizophrenics to talk to themselves: A means of developing attentional controls. Behavioral Therapy, 1973, 4, 515-534.

Meichenbaum, D., & Goodman, J. Training impulsive children to talk to themselves: A means of developing self-control. Journal of Abnormal Psychology. 1971, 77, 115-126.

Murrell, F. H. The effect of extensive practice on age differences in reaction time. Journal of Gerontology, 1970, 25, 268-274.

Murrell, F. H., Powesland, P. F., & Forsaith, B. A study of pillar-drilling in relation to age. Occupational Psychology, 1962, 36, 45-52.

Murphy, D. Sex-role identity in the aged. Unpublished doctoral dissertation, Loyola University of Chicago, 1976.

Nesselroade, J. R. Applications of multivariate strategies to problems of measuring and structuring long-term change. In L. R. Goulet & P. B. Baltes (Eds.), Life-span developmental psychology. New York: Academic Press, 1970.

Nesselroade, J. R., Schaie, K. W., & Baltes, P. B. Ontogenetic and generational components of structural quantitative change in adult cognitive behavior. Journal of Gerontology, 1972, 27, 222-228.

Neugarten, B. L. Personality and aging. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold, 1977.

Norman, R. D. A revised deterioration formula for the Wechsler Adult Intelligence Scale. Journal of Clinical Psychology. 1966, 22, 287-294.

Norman, R. D., & Daley, M. F. Senescent changes in intellectual ability among superior older women. Journal of Gerontology, 1959, 14, 457-464.

Rabbitt, P. Changes in problem solving ability in old age. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold Company, 1977.

Raven, J. C. Standard Progressive Matrices. London: H. K. Lewis Company, Ltd., 1958.

Raven, J. C. Guide to Standard Progressive Matrices. London: H. K. Lewis Company, Ltd., 1960.

Reed, H. B., Jr., & Reitan, R. M. Changes in psychological test performance associated with the normal aging process. Journal of Gerontology, 1963, 18, 271-274.

Reese, H. W., & Overton, W. F. Models of development and theories of development. In L. R. Goulet & P. B. Baltes (Eds.), Life-span developmental psychology. New York: Academic Press, 1970.

Riegel, K. F., & Riegel, R. M. Development, drop, and death. Developmental Psychology, 1972, 6, 306-319.

Riegel, K. F., Riegel, R. M., & Meyer, G. A study of the dropout rates in longitudinal research on aging and the prediction of death. In B. Neugarten (Eds.), Middle age and aging. Chicago: University of Chicago Press, 1968.

Rimoldi, H. J. A. A technique for the study of problem solving. Educational and Psychological Measurement, 1955, 15, 450-461.

Rimoldi, H. J. A., & Haley, J. V. Sequential evaluation of problem solving processes. Chicago: Loyola University, 1962.

Rosenfelt, R. H., Kastenbaum, R., & Kempler, B. "The untestables": Methodological problems in drug research with the aged. Gerontologist, 1964, 4, 72-74.

Schaie, K. W. A general model for the study of developmental problems. Psychological Bulletin, 1965, 64, 92-107.

Schaie, K. W. Quasi-experimental research design in the psychology of aging. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold, 1977.

Schaie, K. W., & Gribbin, K. Adult development and aging. Annual Review of Psychology, 1975, 26, 65-96.

Schaie, K. W., & Labouvie-Vief, G. Generational versus ontogenetic components of change in adult cognitive behavior: A fourteen-year cross-sequential study. Developmental Psychology, 1974, 10, 305-320.

Schaie, K. W., & Strother, C. R. A cross-sequential study of age changes in cognitive behavior. Psychological Bulletin, 1968, 70, 671-680. (a)

Schaie, K. W., & Strother, C. R. The effects of time and cohort differences on the interpretation of age changes in cognitive behavior. Multivariate Behavior Research, 1968, 3, 259-294. (b)

Timiras, P. S. Developmental physiology and aging. New York: Macmillan, 1972.

Tuckman, J., & Lorge, I. The effect of institutionalization on attitudes toward old people. Journal of Abnormal and Social Psychology, 1952, 47, 337-344.

Wohlwill, J. F. The age variable in psychological research. Psychological Review, 1970, 77, 49-64.

APPENDIX

DEMOGRAPHIC INTERVIEW

Date_____

Name_____ Number_____

Age_____

Education: 1. some grade school
2. grade school
3. high school
4. some college
5. college graduate
6. some graduate school
7. M.A.
8. Ph.D.
9. other_____

Education_____

Marital Status:
1. single
2. married
3. remarried
4. separated
5. divorced
6. widow

Marital Status_____

Living Arrangement:
1. with family or spouse
2. with others
3. alone

Living Arrangement_____

Present Work Status:

1. retired
2. working part-time
3. working full-time

Past Occupations List:

Past Occupations_____

_____

_____

_____

Did you have any major change in your life in the past six months?
1. yes 2. no

Major Change_____

If yes, then what was the change?_____

HEALTH STATUS CHECKLIST

	No Problem	Very Mild Problem	Mild Problem	Serious Problem	Very Serious Problem	Total Disa-bility	Comments
1.Eyesight							
2.Hearing							
3.Speech							
4.Heart							
5.Liver-Kidney							
6.Stomach Intestinal							
7. Teeth							
8.Respira-tory-Lungs							
9.Blood Pressure							
10.Blood Count							
11.Circu-lation							
12.Arthri-tis							
13.Diabe-tes							
14.Cancer							
15.Tumor							
16.Memory							
17.Mobil-ity							
18.Stroke							
19.Edema							
20.Other							

Problem Solving Test Recording Form

Date_____

Name_____ Number_____

Jones family

Sequence of questions						
Question value						
Divided by _____						
Cumulated values						

Time

Initial appraisal (read problem and questions)	
Time when first question selected	
Time when second question selected	
Time when third question selected	
Time when fourth question selected	
Time when fifth question selected	
Time when sixth question selected	
* * * * * * * * * * * * * * * * * * TOTAL TIME	

Horses

Sequence of questions						
Question value						
Divided by _____						
Cumulated values						

TIME

Initial appraisal (read problem and questions)	
Time when first question selected	
Time when second question selected	
Time when third question selected	
Time when fourth question selected	
Time when fifth question selected	
Time when sixth question selected	
TOTAL TIME	

Weights for Questions of Item 1
of the Problem Solving Test[a]

Order of Selection	Questions 1	2	3	4	5	6	Sum
1.	.13887		.13888			.12500	.40275
2.		.11111	.13888	.02776		.12500	.40275
3.	.01388		.12499	.01388			.15275
4.					.04164		.04164
Sum	.15275	.11111	.40275	.04164	.04164	.25000	.99989

[a]This table of weights was devised by Hill (1962, p. 73).

Weights for Questions of Item 2
of the Problem Solving Test[a]

Order of Selection	Questions 1	2	3	4	5	6	Sum
1.	.13887		.12500		.13888		.40275
2.		.11111	.12500	.02776	.13888		.40275
3.	.01388			.01388	.12499		.15275
4.						.04164	.04164
Sum	.15275	.11111	.25000	.40275	.04164	.04164	.99989

[a]This table of weights was constructed by the present experimenter in the format developed by Hill (1962, p. 74).

Name_____

Training Booklet

Letter Sets Test

Each problem in this test has five sets of letters with four letters in each set. Four of the sets of letters are alike in some way. You are to find the rule that makes these four sets alike. The fifth letter set is different from them and will not fit this rule. Draw an X through the set of letters that is different.

> Note: The rules will not be based on the sounds of sets of letters, the shapes of letters, or whether letter combinations form words or parts of words.

Examples:

A.	NOPQ	DEFL	ABCD	HIJK	UVWX
B.	NLIK	PLIK	QLIK	THIK	VLIK

In Example A, four of the sets have letters in alphabetical order. An X has therefore been drawn through DEFL. In Example B, four of the sets contain the letter L. Therefore, an X has been drawn through THIK.

These are practice problems. Do not guess at the answers but try to figure out the rule that makes the four letter sets look alike and then find the fifth letter set that does not fit the rule.

Training booklet
Page 2

1.	ACDE	FHIJ	KMNO	PRST	UXYZ
2.	KBKR	EKTK	KHKU	KDSK	PKZK
3.	AEOU	DSWP	GVLR	BFPM	TPKV
4.	ABDE	KLNO	FGJK	QRTU	UVXY
5.	UDAS	TFCU	YHET	JTRA	LYTI
6.	RCDS	UGHV	XLMY	AJKB	ETYF

Training booklet
Page 3

7.	CDFE	GIHJ	KLNM	OPRQ	STVU
8.	WCAJ	SMKK	TCET	OHBB	YDFY
9.	ACPR	JLRT	DFVX	CNEP	FHNP
10.	CDDC	SRRS	KLLK	HIIH	XYYX
11.	FEFF	JIJJ	OOPO	SSST	YYZY
12.	BAIX	BEUX	BEIX	BSTX	BAUX

Training booklet
Page 4

13.	MCDP	OGHR	SLMV	HRSJ	BTYF
14.	BAAB	FEEF	STTS	LKKL	JIIJ
15.	CFQX	IKTY	LPSZ	LRTW	XSPN
16.	BCDV	FGHV	JKLV	PQRV	STUX
17.	BGCH	FKGL	HLIN	QTRU	SYTZ
18.	CDFE	JKGI	MNPO	QRTS	STVU

Training booklet
Page 5

19.	FFUU	HHWW	VVGG	JJYY	IIXX
20.	DCBA	HGFD	HIJK	MNOP	UTSR
21.	RJGC	BFJK	ABNQ	YWSR	KJGD
22.	SSCS	DDST	GVFG	KYHK	TTBT
23.	ABBA	KJKK	NNNO	GGGH	SRSS
24.	MRMW	ESHM	EMFM	JTMM	MMVW

Training booklet
Page 6

25.	CDEF	HIJK	MNOP	RTUV	WXYZ
26.	ACAA	AGBA	AJAA	AAKA	AAFA
27.	BCDF	FGHJ	JKLN	OPQT	VWXZ
28.	JFCA	CEHL	LJGC	IKNR	EGJN
29.	ACBD	EGFH	IKJL	MONP	QSTR
30.	AMNB	EMNF	IMNJ	MSTP	SMNT

Scoring Key for Training Booklet

Exception:

1. UXYZ Rule: Skip second letter of each set.

2. KDSK Rule: Put one letter between the repeated letters.

3. AEOU Rule: All the other sets are consonants.

4. FGJK Rule: The middle letter of each set is missing.

5. UDAS Rule: All sets contain the letter "t".

6. ETYF Rule: The two middle letters of each set are consecutive in the alphabet.

7. GIHJ Rule: All other sets follow alphabetical order 1243.
The last two letters of each set are reversed.

8. WCAJ Rule: Each set has a double letter.

9. CNEP Rule: First and second letters of each set are in alphabetical order with one letter skipped and the third and fourth letters of each set are in alphabetical order with one letter skipped.

10. SRRS Rule: The letter that comes first in the alphabet is at the beginning and end of each set.

11. SSST Rule: There are three letters the same in each set but all three letters are not adjacent to one another.

12. BSTX Rule: The two center letters of each set are vowels.

13. BTYF Rule: The two middle letters of each set are consecutive letters in the alphabet.

14. STTS Rule: The letter that comes first in the alphabet is in the middle of each set.

15. XSPN Rule: Letters of each set are in alphabetical (but not consecutive) order.

Exception:

16. STUX Rule: Each of the sets contains the same letter except for one set.

17. HLIN Rule: The first and third letter of each set are consecutive letters in the alphabet. The second and fourth letters of each set are consecutive letters in the alphabet.

18. JKGI Rule: All letters are consecutive letters in the alphabet but the last two letters of each set are reversed. The pattern is 1243.

19. VVGG Rule: The letter that comes first in the alphabet is at the beginning of each set.

20. HGFD Rule: Letters of each set are consecutive letters of the alphabet (even though they may be reversed).

21. RJGC Rule: Each set has two letters that are consecutive letters of the alphabet.

22. DDST Rule: Sets begin and end with the same letter.

23. ABBA Rule: Each set has three of the same letter.

24. ESHM Rule: The same letter is repeated twice in each set.

25. RTUV Rule: Each set contains four consecutive letters of the alphabet.

26. AGBA Rule: Each set has three of the same letter.

27. OPQT Rule: The letter of the alphabet that comes between the third and fourth letter of each set is skipped.

28. LJGC Rule: Start with one letter of the alphabet then skip one letter and write the next letter, then skip two letters, write the next letter, then skip three letters and write the next letter.

$A_BC_DE^FG_HI^J$ *** $C_DE_FG^H_IJK^L$ *** $I_JK_LM^NOPQ^R$ ***

$E_FG_HI^JK_LM^N$

Exception:

29. QSTR Rule: Four consecutive letters of the alphabet with the second and third letters reversed.

30. MSTP Rule: The same two letters are repeated in the center of each set.

APPROVAL SHEET

The dissertation submitted by Donna J. Goetz has been read and approved by the following committee:

Dr. Jeanne M. Foley, Director
Professor, Psychology, Loyola

Dr. James E. Johnson
Associate Professor, Psychology, Loyola

Dr. Emil J. Posavac
Professor, Psychology, Loyola

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Date

Director's Signature