PROBLEM SOLVING COGNITIVE PROCESSES IN
YOUNGER AND OLDER ADULTS

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Patricia A. McGregor, B.S., M.S.
Denton, Texas
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The purpose of the present study was to examine cognitive abilities and problem solving processes of young and older adults. Specifically, three areas of inquiry were investigated: possible age-related differences in problem solving cognitive abilities, possible differences in cognitive processes used during problem solution, and possible differences in determinants of problem solving cognitive processes.

Fifty younger and 50 older adults participated in the study. Personality attributes of subjects were obtained from objective and projective measures. Both ecological and more traditional, nonecological tasks provided information on subjects' cognitive abilities. A "think aloud" procedure was used on selected cognitive tasks to access problem solving cognitive processes.

Multivariate analysis revealed group differences on a number of cognitive ability variables. Younger subjects performed better than older subjects on attention, memory, and fluid abilities tasks while older subjects performed better than their younger counterparts on crystallized
abilities tasks. Performance on ecological tasks was mixed with younger subjects generally performing better. They also exhibited more sophisticated and elaborate steps in solving several cognitive ability tasks.

Multivariate analysis also revealed age differences in several cognitive processes. Younger subjects used strategy, a purposeful manipulation of information, more frequently and also provided more solutions. Older people used a more cautious approach built on developing hypotheses about information and sought more confirmation of thinking. They also engaged in more mind wandering during problem solution.

Results of multiple regression analyses suggested that there is little similarity of specific predictors across tasks or between age groups. For example, factors related to anxiety and self-efficacy were predictive of different variables for the two age groups. Generally, younger subjects may have greater variability in utilizing both cognitive and personality attributes. Results were discussed in terms of contextual factors, different courses of abilities across the lifespan, utilization of abilities, and allocation of resources.
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CHAPTER I

INTRODUCTION

The intellectual functioning of individuals across the lifespan has been an area of interest to psychologists for a number of years. With increased life expectancy, the larger proportion of older citizens, and social issues such as mandatory retirement, additional attention has been placed on the intellectual abilities of older individuals. Older people have fared poorly in some research on intelligence while in other studies, their performance has been comparable to that of younger adults. However, the specific definitions of intelligence used in the research as well as the instruments used to measure intelligent behavior have not been consistent across studies. Therefore, it is often difficult to evaluate an overview of work in the area. The practical relevance of the results of the accumulated inquiry into this area has also been questioned in recent years. Some critics have argued that the majority of previous research has taken place in the sterile environs of the laboratory using tasks that have few similarities to the everyday lives of the subjects. Therefore, the results of such research becomes esoteric rather than pragmatic in terms of application of findings.
The purpose of the current chapter is to review the major findings of traditional research on intelligence with older people, to summarize alternatives to psychometric research, to examine the relatively new concept of practical or everyday intelligence, to present some factors that may affect cognitive performance, and to explore methods for investigating cognitive processes. The goal of the present study is to examine the cognitive processes of older and younger adults on a variety of tasks, some of which will include the traditional psychometric tasks while others will be consistent with more ecologically valid, everyday tasks, in order to ascertain not only differences but also similarities in the processes across groups. Additionally, the contribution of noncognitive variables such as personality, memory, attention, self-rated problem solving abilities, and interpersonal competence abilities to cognitive processes will be examined.

The Nature of Intelligence

What contribution does research make regarding the course of cognitive abilities across the lifespan? Results of research are difficult to synthesize into dominant themes. Part of the difficulty that contributes to a consistent interpretation of findings are the same problems that plague many areas of psychology. First, the definition of intelligence is different across studies. Second, the instruments used to measure intelligence also vary. Third,
research in this area is made more difficult because of different research designs used which contribute to confounding results.

In an attempt to understand the concept under investigation, one of the more common first tasks is to develop a definition. There have been many attempts over the years to define intelligence. The difficulty in defining such an encompassing concept as intelligence has been made evident by some researchers who have stated that attempts to define intelligence are futile. Indeed, Neisser (1979) stated that "the concept of intelligence cannot be explicitly defined" (p. 179) because intelligence is defined as similarity to a prototype consisting of several characteristics correlated to an intelligent person rather than a distinct quality. Goodnow (1984) suggested that intelligence should be viewed as a judgment as opposed to a quality. Thus, she stated that attention should be given instead to the judging or evaluating process.

Experts in the field have long disagreed on the definition of intelligence. In 1921, the editors of The Journal of Educational Psychology asked 17 of the leading researchers of the time to define intelligence. Rybash, Hoyer, and Roodin (1986) summarized some of the responses.

1. The ability to carry on abstract thinking. (Louis M. Terman)
2. The ability to give true or factual responses. (E.L. Thorndike)

3. The ability to learn to adjust oneself to the environment. (S.S. Colvin)

4. The ability to adapt to new situations which reflects the general modifiability of the nervous system. (Rudolf Pintner)

5. The ability to acquire abilities. (Herbert Woodrow)

6. A group of complex mental processes traditionally defined as sensation, perception, association, memory, imagination, discrimination, judgment, and reasoning. (M.E. Haggerty, p. 78)

Albeit a difficult undertaking, theorists continue in their attempts to define and measure intelligence. Of the theories of intelligence briefly reviewed in this work, some emphasized the multiple abilities of intelligence, some focused on the process of knowing and accompanying developmental stages of intellectual development, and others studied the components of intelligence. The definitional differences of these theorists have influenced the methods used to assess intelligence. For example, researchers who focused on multiple abilities primarily used a traditional psychometric approach in measuring intellectual abilities. Researchers involved in the processes and components of intelligence developed alternatives to the psychometric
assessments of intelligence. These different approaches to the assessment of intelligence will serve as a focus for the next review sections.

**The Course of Multiple Abilities Across the Lifespan**

Horn’s work in the area of intelligence which is based on Cattell’s theoretical conceptualization of intelligence has engendered a great deal of research (Horn, 1982; Horn & Cattell, 1966a, 1966b, 1967; Horn & Donaldson, 1976).

Cattell (1963) proposed that Thurston’s general ability factor, $g$, is actually two factors or intelligences: fluid and crystallized. Horn (1982) extended and supplemented Cattell’s work and defined the two abilities in the following way:

- **Gc, Crystallized Intelligence.** This form of intelligence is indicated by a very large number of performances indicating breadth of knowledge and experience, sophistication, comprehension of communications, judgment, understanding conventions, and reasonable thinking. The factor that provides evidence of Gc is defined by primary abilities such as verbal comprehension, concept formation, logical reasoning, and general reasoning . . . . As measured, the factor is a fallible representation of the extent to which an individual has incorporated, through the systematic influences of acculturation, the knowledge and sophistication that constitutes the intelligence of
a culture. Gf, Fluid Intelligence. The broad set of abilities of this intelligence include those of seeing relationships among stimulus patterns, drawing inferences from relationships and comprehending implications. The primary abilities that best represent the factor . . . include induction, figural flexibility, integration, and cooperatively with Gc, logical reasoning and general reasoning . . . . The factor is a fallible representation of such fundamental features of mature human intelligence as reasoning, abstracting, problem solving. In Gf these features are not imparted through the systematic influences of acculturation but instead are obtained through learning that is unique to an individual or is in other ways not organized by culture. (p. 850)

Horn and his colleagues (Horn & Cattell, 1966a, 1967; Horn & Donaldson, 1976) investigated the course of the two intelligences across the lifespan and concluded that there is a probability that Gf capacities decline with age.

On the other hand, Gc capacities tend to improve with age. The Gf decline was explained by "negative transfer and related 'rigidities' produced by accumulated learning and any loss or degeneration of the physiological (principally neurological) substratum supporting intellectual behavior" (Horn & Donaldson, p. 706). They stated that the Gc improvement was due to "increased learning, consolidation of
knowledge in improved concepts, the extended application of problem-solving techniques, and the increased opportunities for facilitation and positive transfer which . . . accompany aging" (p. 706).

Despite this explanation for the variability of the two abilities across the lifespan, there is no clear understanding of how the decrement in Gf ability is specifically expressed on tasks nor how the Gc ability continues to be utilized in a constant or enhanced manner. For example, what differences in verbal comprehension, concept formation, induction, or integration occur across the lifespan that would result in age-related differences on test scores. Granted Horn and Donaldson's (1976) point of greater incidence of adverse physiological change with increased age, some higher order cognitive functions such as general reasoning and logical reasoning are common to both intellectual abilities. How do the two abilities qualitatively differ within individuals and across age groups? These issues have not been adequately addressed.

Schaie's (1979) cumulative work using the Primary Mental Abilities Test (PMA) has also examined the course of multiple intellectual abilities across the lifespan. The PMA consists of the following five subtests: Verbal Meaning, Space, Reasoning, Number, and Word Fluency. Using cross-sectional studies with longitudinal follow-up, Schaie tracked the course of performance on the PMA. Based on the
results of his work, Schaie came to several conclusions regarding the ontogenetic course of intellectual abilities.

First, . . . reliable decrement until very old age (and by that I mean the late 80s) cannot be found for all abilities or for all individuals. Second, . . . for most individuals there is decrement on those abilities which implicate speed of response, and for those abilities whose measurement is particularly sensitive to relatively modest impairment of the peripheral nervous system. Third, decrement is also likely to be found on most abilities for individuals with severe cardiovascular disease at any age, and for individuals living in relatively undifferentiated or socially deprived environments. . . . Fourth, data from independent random samples . . . will tend to overestimate "normal" age decrements for those variables where ontogenetic changes indeed occur, because sampling procedures will tend to include individuals performing at lower levels not because of age, but because of ability-related disease and/or life-style variables. Fifth, . . . variance for ontogenetic change is small relative to that demonstrated for cohort differences. Finally, . . . in healthy well-educated populations ontogenetic change on intellectual ability variables . . . is proportionally
small, such that many individuals perform within the middle range of young adults. (pp. 104-105)

In summarizing the results of his research, Schaie emphasized the importance of individual differences on abilities with some individuals exhibiting early declines on some abilities while others maintained their abilities (p. 105). Thus, while Schaie agreed with the potential adverse effects of physiological changes that Horn and Donaldson had pointed out, he also raised the issue of environmental variables. Furthermore, instead of concluding that psychometric intelligence follows a steady course of decline, he found little decline until the older years and emphasized individual differences in abilities across the lifespan.

In summarizing their research Willis and Baltes (1980) reported conclusions that are remarkably similar to those of Schaie.

1. Chronological age per se accounts for a relatively modest amount of the variance observed in intellectual aging during late adulthood up to the 60s or early 70s. Differences between cohorts, up to ages 60-70, equal or exceed in importance chronological age differences. Chronological age gains in prominence, however, as age reaches the 70s.

2. Interindividual differences (including cohort differences) in intellectual aging are large and
suggest differential (heterogeneous) rather than homogeneous patterns of aging.

3. There appear to be marked differential changes for various intellectual abilities (e.g. Verbal Meaning, Number) with regard not only to age but also to cohort. (p. 263)

Their theoretical explanation (Willis & Baltes, 1980) for such results is comprised of three critical factors. Age-graded influences are biological and environmental influences which are strongly related to chronological age. They stated that they are relatively predictable in that "their occurrence, timing, and duration are fairly similar for all individuals of a given set of aging cohorts" (p. 367). History-graded influences are biological and historical factors related to historical changes and are cohort-related. Non-normative critical life events are primarily unpredictable and individualistic. These three influences explain these researchers' other observations that intellectual development across the lifespan is described by multidimensionality, multidirectionality, interindividual variability, and intraindividual plasticity.

Similar to the psychometric intelligence assessed by the PMA is the idea of multiple intelligences that was developed by Gardner (1983). However, Gardner's intelligences covered a wider range of functioning than the five abilities of the PMA. He proposed the existence of seven intelligences that
included musical intelligence, bodily-kinesthetic intelligence, logical-mathematical intelligence, linguistic intelligence, spatial intelligence, interpersonal intelligence, and intrapersonal intelligence. With the advent of factor analytic techniques, researchers continue to sort out the multiple nature of intelligence with increasing confidence.

Alternatives to Psychometrically Assessed Intelligence

Other researchers have developed alternative approaches to the study of intelligence. These researchers have been interested primarily in the development of knowledge, the processes of intelligence, and the components that contribute to intelligent behavior.

Piaget's research, primarily related to the intellectual development of children, has also been applied to adult intellectual development. Piaget studied the development and adaptation of mental structures as new information or knowledge was encountered and processed by the individual. He proposed four stages of cognitive development with the final stage, formal operational, descriptive of adolescent and adult intelligence.

In their research using a Piagetian classification task, Denney and Denney (1973) found that older subjects performed more poorly than did middle-aged subjects. The older subjects asked fewer constraint-seeking questions, asked more questions before solving problems, and asked more
redundant questions. In gathering data for this study, the
researchers recorded subjects' responses verbatim. In spite
of the performance difference between subjects, Denney and
Denney stated that the causes of such differences were
unknown and could be attributed to such diverse variables as
physiologic condition and salience of the experimental tasks
to the two age groups. There are important implications of
such variables. Physiological changes in older adults may
imply permanent change but there is also the possibility of
learning and applying adaptive strategies to compensate for
such loss. Differential salience of experimental tasks can
be addressed through development of alternative tasks and
methods of presentation.

Reese and Rodeheaver (1985) reviewed the research on
older adults' performance on Piagetian tasks and found mixed
results on tasks of class inclusion and multiple
classification and conservation. As a result of their
review, they suggested a cautiousness in interpreting
findings due to problems involving inferences from cross-
sectional designs, distinguishing competence and
performance, and attaining ecological validity on such tasks
for adults.

In one study that employed the innovative development
of tasks, Sinnott (1975) presented two types of tasks to
groups of younger and older adults. One type of task
consisted of classical Piagetian materials while the other
type of task involved everyday, familiar materials. She found that on formal operational and classification tasks, both groups of subjects performed better using everyday materials with the older subjects exhibiting a greater difference in performance. Unfortunately, however, performance on tasks was scored on only a pass/fail basis so the actual cognitive processes related to task demands for the two types of materials was not known.

In her most recent work, Sinnott (1991) has developed a much more complex and comprehensive scoring system for Piagetian task performance. Her scoring schema was designed to assess the presence of relativistic cognitive processes and included nine criteria (metatheory shift, problem definition, process/product shift, parameter setting, pragmatism, multiple solutions, multiple causality, paradox, and self-referential thought) that are applied to verbatim transcripts of problem solution. Thus, this represents a much more sophisticated scoring system using a nontraditional method for gathering data.

Some researchers have suggested that Piaget's stages of intellectual development do not adequately describe adult cognition and have proposed a fifth stage, postformal operations. Their arguments for such a stage are related to the abilities that enhance adaptively dealing with the kinds of situations that are more characteristic of the adult's environment. Formal thought becomes inadequate when applied
"to the complex physical, practical, or social world" (Cavanaugh, Kramer, Sinnott, Camp, & Markley, 1985). Rybash, Hoyer, and Roodin (1986) distinguished the application of formal and postformal thought to everyday problems in a descriptive manner.

The formal reasoner is predisposed to engage in a logical, rational search for the one philosophically abstract and absolutistically true principle or problem-solving strategy that will help in dealing with a stressful life event. . . . A postformal thinker views a problem-in-living as an "open-system" problem. A problem is regarded as open, in that it is viewed as consisting of a set of potentially infinite, dynamic, and interdependent variables (pp. 138-139).

Such qualities of a postformal thinker allow more variability in perceiving and solving tasks that are more consistent with daily life events and problems and presents an interesting expansion of Piaget's work. However, whether or not the idea of postformal operations as a distinct stage representing a change in cognitive structure continues to be questioned (Rybash, Hoyer, & Roodin, 1986). This question remains to be answered through additional research. Currently, a clear elucidation of postformal changes and development of tasks that would measure such operations have not been realized.
Schaie (1977-78) also investigated the longitudinal development of intelligence and proposed five stages of adult intellectual development. The first stage, acquisitive, involved skill acquisition and competence, while the second stage, achieving, was a more goal-directed stage of achieving personal and social independence. The focus of the third responsible stage was developing responsibility for others with the attendant need to integrate goals and consider consequences. The fourth stage, executive, involved responsibility for social systems with increased integration of goals. The final reintegrative stage was characterized by the increased influence of individual motivational and attitudinal goals.

Schaie stated that psychometric methods were acceptable for assessing the first two stages; however, he proposed that innovative techniques on a variety of problem-solving tasks using information processing and systems analysis would be necessary to adequately assess the third and fourth stages. Assessment of the final stage would require tasks that were relevant to the experiences and goals of the older adult.

As opposed to examining only the structures involved in the accumulation of knowledge, one of the more prolific recent researchers in the area of intelligence, Robert Sternberg, has developed a triarchic theory of intelligence (1985) which examined the components of intelligence. The
subcomponents of the theory are the componential subtheory, the contextual subtheory and the experiential subtheory. The componential subtheory is concerned with the mechanisms and structure of intelligent behavior. There are several components: those that control information processing as well as monitor and provide feedback on it, those that carry out the results of the information processing, and those that encode new information and compare and combine this data with old information.

The contextual subtheory involves three types of functioning: 1) adaptation to the environment, 2) selection of a more amenable, optimal environment, and 3) modification of the environment to better fit the person. In short, it deals with what is intelligent for an individual in a given context.

The final subtheory, experiential, is a more relativistic view of intelligence. Basically, the "amount" of intelligence devoted a particular task is related to the individual’s experience on that task. This is determined by the novelty of the task (effortful processing) or the automatization of the task (automatic processing).

Sternberg and Berg (1987; Berg & Sternberg, 1985) extended the triarchic theory of intelligence specifically to adult development. They suggested that the question of componential decline is related to the type of assessment tasks and whether it is routine or novel. The contextual
aspect is important in adult development because of the changes in the environment and subsequent adaptations to it. As they pointed out, intellectual variables may differ in importance and salience at different points across the lifespan.

While Sternberg's triarchic theory provides a comprehensive presentation of intelligence and, indeed, incorporates many of the definitions of other theorists, it does not address personality components that may affect intellectual functioning on a long-term basis. Sternberg's theory also does not address affective factors that may influence intellectual functioning on a situational basis.

While not specifically involved in defining intelligence, other researchers have devoted their efforts to the study of the course of cognitive abilities across the lifespan. Denney (1982, 1984) provided one conceptualization of intellectual development across the lifespan. She proposed that there are two separate cognitive potentials, one of which is an untrained or unexercised potential and the other is an optimally trained or optimally exercised potential. Both potentials are exhibited by growth curves to early adulthood followed by a gradual decline. The central idea of the theory is that "the developmental function taken by a particular ability is more a function of the extent to which it is exercised than of the particular type of ability it is" (1984, p. 179). In
keeping with this idea, she suggested that performance on practical, everyday problems would show increase until the early adult years while performance on more traditional, academic problems would indicate a decrease during the adult years. Denney attempted to account for the empirical findings of differential courses of abilities across the lifespan with her model. She suggested that the typical growth pattern on verbal tasks common on intelligence tests is related to the continued exercise of these abilities. The decrement associated with performance tasks is related to the unexercised quality of the abilities as people grow older.

This work shares some similarities with Kliegl and Baltes' (1987) study of reserve capacity and expertise. They proposed that all individuals have the capacity to improve on a baseline performance through selective compensation and optimization of biological reserve. They suggested a dual-process model of intellectual functioning which distinguished the "cognitive processes (‘mechanics of intelligence’) and various aspects of knowledge (‘pragmatics of intelligence’)" (p. 99). Baltes had earlier (Baltes, Dittman-Kohli, & Dixon, 1984) proposed his dual-process model and had defined the mechanics of intelligence as "the basic cognitive operations and cognitive structures associated with such tasks as perceiving relationships, classification, and logical reasoning" (p. 63). The
pragmatics of intelligence, on the other hand, "refers to the function and application of intelligence, . . . emphasizing adaptation as a central feature of intellectual behavior" (p. 63). This aspect of intelligence is more contextual in nature. Baltes and his colleagues (1984) predicted that the pragmatics of intelligence would continue to develop in the later adult years while the mechanics of intelligence would decline in functioning in later adulthood. These researchers acknowledged the similarities between their mechanics and pragmatics of intelligence and Horn's fluid and crystallized intelligences, but noted the differences in development (one primarily factor analytic and the other associated with cognitive psychology and functionalism) of the two theories. Sternberg's triarchic theory of intelligence also shares similarities with Baltes' work.

Rybash, Hoyer, and Roodin (1986; Roodin, Rybash, & Hoyer, 1986; Hoyer, 1987) have developed a theoretical model with some similarities to those of Denney and Baltes. These researchers called their conceptualization of adult cognitive development the Encapsulation Model. According to the model, specific cognitive processes and abilities become "encapsulated" within particular domains during adulthood. As a result, knowledge in these domains becomes more accessible to the individual. The commonly observed decline in fluid abilities across the lifespan is a function of not
properly assessing the encapsulated areas which would indicate maintenance and growth of abilities. They summarized their model (Rybash, Hoyer, & Roodin, 1986) in four statements.

1. Processing, knowing, and thinking are the three dimensions of cognition that must be addressed in any comprehensive theory of adult cognitive development.

2. The processes associated with the acquisition, utilization, and representation of knowledge become encapsulated within particular domains as one grows older.

3. Fluid abilities and control processes appear to decline with age when assessed as general abilities, but they may show less age-related decline when assessed within encapsulated domains.

4. The products of adult cognitive development are the growth of expert knowledge and the emergence of postformal styles of thought. Adult styles of thinking and forms of knowing are the end results of the processes of encapsulation (p. 17).

Ecological Validity

Researchers who have investigated the course of cognitive abilities across the lifespan have accentuated the need for future researchers to be cognizant of the salience of experimental tasks and the ecological validity of such
tasks. This is not, however, a recent recognition by researchers. In 1977, Bronfenbrenner called for a new emphasis in research, ecological validity, that would examine the individual and the environment in which that person lived, functioned and interacted. Hultsch and Hickey (1978) similarly emphasized the importance of "adequate dimensionalization of the organized complexity and its reciprocal interactions" which they termed external validity. Schaie (1978) suggested that measurement that satisfied external validity criteria are more difficult to develop for adults because of the diversity of environmental situations and idiosyncratic adult development. These considerations differ from assessment instruments for children who typically have a common experience of schooling. He emphasized the importance of thoughtful development of tests that measure constructs of intelligence. Also, he stated that tests should be constructed that are "meaningful and relevant to the life experience of the group being studied" (p. 698). Scheidt (1981), however, cautioned against a growing trend in research to mistakenly believe that external validity is satisfied solely at the measurement level (often with only ecological face validity) with less attention paid to the complete research process. Schaie (1978) distinguished between types of validity when he stated,
We are concerned with issues of internal validity when dealing with intelligence as a set of mechanisms which permit us to understand the cognitive process but that external validity issues become paramount when we examine how intelligence relates to our coping in a competent manner with the problems of daily living (i.e., the situations in which intellectual abilities are to be applied and assessed) (pp. 696-697).

**Practical Intelligence**

In recent years, some researchers have turned their attention to another aspect of intelligence that involves applying cognitive abilities to problems or tasks inherent in the course of everyday life. Much of the impetus for this research has been the attempt to address ecological validity issues. Sternberg and Wagner (1986) asserted that studying these abilities or practical intelligence, requires different types of assessment tasks than the more traditional academic intelligence tasks which they described as

... 1) being formulated by other people, 2) often being of little or no intrinsic interest, 3) having all needed information available from the beginning, 4) being disembedded from an individual's ordinary experience, 5) being well-defined, 6) have but one correct answer, and 7) often have but one method of correct solution (p. 52).
In contrast to these characteristics, Frederiksen (1986) pointed out that tasks involving practical intelligence . . . are often ill-structured: they do not provide all the information needed to solve the problem, there are no definite criteria for determining when the problem is solved, they are often complex. . . . [Furthermore], the problems rarely appear in multiple choice form. Responses are not necessarily motivated by a need to get the right answer, and performance can be described in terms of many dimensions other than the number of correct answers (p. 84).

These differences in types of problems lead to different kinds of research questions regarding how people solve problems, the types of problems they encounter, processes used in solving problems, and the importance of the contributing factor of experience or wisdom in solving problems effectively (Abeles & Riley, 1987; Schaie, 1987; Sinnott, 1989). This last factor may be an important distinguishing quality between older and younger adults (Dixon & Baltes, 1986; Smith & Baltes, 1990; Sternberg, 1990).

Going beyond the broad definition of practical intelligence, researchers have investigated the characteristics of individuals who exhibit good practical intelligence. Prototype studies ask subjects to list
characteristics of people who exemplify the quality being studied. In one study (Sternberg, Conway, Ketron, & Bernstein, 1981), laypersons and experts in the field of intelligence were asked to list characteristics of everyday intelligence. Factor analysis of laypersons' responses resulted in four factors: practical problem-solving ability, social competence, character, and interest in learning and culture. Factor analysis of experts' responses yielded three factors: practical problem-solving ability, practical adaptive behavior, and social competence. Using a replication of Sternberg and his colleagues' procedures (Sternberg, Conway, Ketron, & Bernstein, 1981), Fitzgerald and Mollor (1988) found that among laypersons, the primary differentiation is between intelligent and unintelligent behaviors and concluded that lay conceptualizations of intelligence are less complex than Sternberg had implied. Another prototype study (Ford, 1986) found that subjects considered goal setting, decision making, planning, and problem solving important aspects of socially competent people. Heise (1987) proposed that these powerful conceptions are used not only in an evaluative sense but also predict the types of mental activities that people use so that there is congruence between their behaviors and the culturally accepted stereotypes.

Cornelius, Kenny, and Caspi (1989) conducted several experiments to examine further explicit and implicit
theories of intelligence. Sternberg and his colleague (Sternberg, Conway, Ketron, & Bernstein, 1981) defined explicit theories as "constructions of . . . scientists that are based . . . on data collected from people performing tasks presumed to measure intelligent functioning" (p. 37), whereas, implicit theories "are constructions of people (psychologists or laypersons) that reside in the minds of these individuals" (p. 37). In their experiments they found that objectively measured abilities (using Gf and Gc tests) were more highly correlated with conceptions of prototypic academic intelligence than with prototypic everyday intelligence except for a Social Situation test. They also found that educational background was positively correlated with problem-solving and verbal intelligence factors. Education was not correlated with the practical intelligence factor. However, age and self-assessed practical intelligence were positively correlated. These researchers suggested that measures of problem solving and verbal abilities are needed in the assessment of both academic and everyday intelligence. However, they stated that additional measures (social competence and practical intelligence) are needed to adequately evaluate everyday intelligence.

Reese and Rodeheaver (1985) suggested that problem solving and decision making are the necessary interfaces between the individual and everyday situations and that people use a variety of strategies in solving practical
intellectual problems. Scribner (1986) agreed that good practical thinking is characterized by flexibility in problem solving strategies depending on factors contributing to each specific situation. Davis (1966) described two types of problem-solving tasks with concomitant problem-solving strategies. One type, Type 0, involves problems with unknown response outcomes which must be resolved through overt trial-and-error behavior. In problems with known response outcomes, Type C problems, the individual can utilize covert trial-and-error strategies in solving the problem.

Other researchers have investigated more specific characteristics that may be related to practical intelligence. Scandura (1977) suggested three domains that differentiate effective problem solvers from ineffective problem solvers. The first of these domains is content which is perhaps better understood as the person’s capabilities or competencies needed to solve the problem. The second domain is the individual’s cognitive processes involved in attending, identifying subgoals, recalling relevant information from memory, developing steps to achieve the subgoals, carrying out these behaviors, and then evaluating the outcome. In other words, how well does the person apply accumulated knowledge or gain new knowledge given the problem situation, and what rules does the person use in applying this knowledge. Heppner and Krauskopf
have drawn parallels between this second domain and the area of information processing, i.e., encoding information, setting goals, pattern matching, developing plans, and acting on plans. Scandura's third domain is individual differences which pertains to the unique processes and information that an individual brings to a problem situation. Neisser (1976) described three characteristics of practical thinking. The first is cognitive development which "has a complex ontogenetic history, in which maturation, learning, and changing opportunities for experience all play a part" (p. 140). Second is the emotional component. Third, is the multiple, simultaneous motives that the individual has to any situation. Other researchers (Goldner, 1957; Scribner, 1986) have discussed similar aspects of intelligence. These included problem formulation ability, flexibility in developing solutions, awareness of the environment, use of effort saving practices, and situation-specific knowledge.

In summary, everyday intelligence differs from academic intelligence in the ambiguity of the problem itself as well as the solution. Factors that may affect everyday intelligence are practical problem-solving ability, cognitive processes, social competence, personal experience, salience of the tasks, and personality factors. This is a comprehensive set of factors that, in fact, may also be important to academic intelligence. However, these are not
typically studied extensively in research on academic intelligence.

In one example of researching the construct of practical intelligence, Klemp and McClelland (1986) studied competencies of identified outstanding senior managers in different types of organizations. Based on in-depth interviews, they identified common themes that differentiated outstanding from average managers. The competencies relevant to the present study were planning/causal thinking, diagnostic information seeking, conceptualization/synthetic thinking, and self-confidence (seeing oneself as a leader, capable, and stimulated by problems). These authors acknowledged that other competencies such as interpersonal competence may exert an influence but did not elaborate on these areas. Once again, these competencies may not be exclusively related to practical intelligence but may be components of all domains of intelligence.

Some researchers have viewed the interpersonal or social aspects as the sine qua non of practical intelligence (Meacham & Emont, 1989) and have attempted to identify social intelligence as a distinct factor in the global area of intelligence (Ford, 1983). Kramer (1986) emphasized the importance that interpersonal interactions have in the lives of adults, and subsequently, in the interpersonal quality of the problems they encounter. In their review of assessment
of interpersonal problem solving Butler and Meichenbaum (1981) reviewed specific skills that are related to interpersonal cognitive problem solving: problem sensitivity, alternative-solution thinking, means-ends thinking, consequential thinking, and causal thinking. These skills are applied within, and with an awareness of, the social environment.

Platt and Spivack (1972) developed a measure of thinking involved in everyday problem solving, the Means-End Problem Solving Test (MEPS) that consisted of ten interpersonal problem scenarios. The scenarios provide the beginning and end state of the situation and has the test taker provide the middle (the means to arrive at the given end state). The stories are scored on the number of relevant/irrelevant means as well as on the elaboration of subgoals, obstacles, and temporal factors (Butler & Meichenbaum, 1981). Forms of the test have been developed for young children, adolescents, and adults.

In their critique of the interpersonal problem solving literature, Butler and Meichenbaum (1981) paid particular attention to assessment of problem solving skills. Despite the positive aspects of the MEPS in allowing subjects to develop their own resolution to problem situations, Butler and Meichenbaum believed the MEPS was somewhat limited in contributing knowledge because the story outcomes are always positive and are always provided. This restricts
information that could be gained regarding the subjects' outcome expectations and the positive or negative value of that expectation. They also emphasized the need for ecological validity of test situations.

**Development of Instruments to Assess Practical Intelligence**

There have been many efforts to develop instruments that assess some of the components of everyday intelligence. One review (Sinnott & Cook, 1989) of 76 research studies involving measurement of everyday problem solving abilities divided the measurements into the following categories: classification and comparisons, syllogisms and logic problem solving, problem solving judgment and decisions (simulated), and decisions (everyday examples). Some of these efforts at measurement will now be reviewed.

In 1957 Demming and Pressey developed tests "with content and tasks more natural or 'indigenous' to adult life" (p. 144) because of the perceived inadequacy of then current tests to measure adult abilities. They developed items for their tests from several sources: newspapers and popular reading material, records of daily activities, and questions directed to individuals. They found that subjects scored progressively lower on traditional tests of intelligence across the lifespan but the reverse pattern was evidenced on their "indigenous" tests.

Continuing in this tradition, Cornelius and Caspi (1987) constructed a test of everyday problem solving in
adulthood. Their test contained six content domains sampling experience with being an economic consumer, technical information, in home management, interpersonal family conflicts, problems with friends, and coworker conflicts. They then compared scores on the everyday problem solving test, verbal ability tests (Gc), and an abstract problem-solving test (Gf) that were administered to subjects ranging in age from 20 to 78. They found significant correlations on scores on all tests which indicated that all three tests measured aspects of intelligence. In examining age differences, they found that scores on everyday problem solving and verbal ability increased with age while abstract problem solving declined with age. Educational background was positively correlated with verbal ability, moderately correlated with abstract problem solving, and unrelated with everyday problem solving. Thus, they concluded that both verbal ability and everyday problem solving may be fostered by acculturation although gained through different avenues, one through formal education and the other outside of the educational setting. Their results may also be related to factors described in an earlier section of Denney's exercised abilities and Rybash, Hoyer, and Roodin's encapsulated abilities.

Along these lines Denney (1989) suggested that traditional tests measure ability while everyday problem
solving tests measure ability and experience. In her research endeavors, she has examined the performance of adults on everyday problem solving tasks. In her more recent experiments, she developed three sets of test situations that were believed to be appropriate for young adults, middle-aged adults, and older adults. Both young adults and middle-aged adults performed better on problems designed for their respective age groups. Elderly subjects, however, did not perform better on their test problems. Indeed, middle-aged subjects performed better than the elderly on these problems. Denney stated that these results are consistent with her theory of intellectual development across the adult lifespan. Test performance of the elderly was poorer because they had, as a group, met the point on the growth curve where optimally-exercised potential fell below exercised abilities. Results of this research may have been adversely affected by scoring procedures (Reese & Rodeheaver, 1986) since the scoring did not provide for the possibility of diverse, unique patterns of responses across particular areas of practical problem solving. Denney (Camp, Doherty, Moody-Thomas, & Denney, 1989) has since addressed this problem. However, in her recent research, Denney continued to examine only problem solution rather than the processes involved in attaining the solution.

Willis and Schaie (1986) also examined the relationship between traditionally measured abilities and everyday
problem solving abilities using only older adults as subjects. An important, and unexpected, finding was that the everyday problem solving performance had a primary loading on the fluid intelligence factor rather than on the crystallized factor. Denney and her associates (Camp, Doherty, Moody-Thomas, & Denney, 1989) also found fluid intelligence to be a better predictor of practical problem solving abilities. Willis and Schaie (1986) made an important point in light of their conclusions.

Although the content involved in the practical problems studied is crystallized in nature, these problems cannot be solved simply by automatized retrieval of previously acquired knowledge. Rather, the subject must identify the relationships among the variables in the task and must determine an appropriate strategy for solving the problem, these operations represent fluid aspects of the task (p. 261).

Therefore, they concluded, older people may experience difficulty in solving practical problems because of the fluid relational quality that is a part of such problems. In familiar appearing problems, one primary task, then, is to determine the novel relationships associated with it and possible novel solution strategies. Thus, the subject with better situational perception and flexibility in processing may be at an advantage. However, this remains a tentative hypothesis until relevant data are collected and analyzed.
Taking a different approach to investigating practical intelligence, Scheidt and Schaie (1978) developed a taxonomy of situations that are relevant to assessing everyday competence in the elderly. They gathered potential situations from unstructured interviews, structured questionnaires, and diaries of older adults. They classified 80 situations into four dimensions: social-nonsocial, supportive-depriving, common-uncommon (to older people), and high activity-low activity. An example of high activity, common, supportive, social activity might be visitation by a relative. Subjects were then asked to sort the situations three times on the basis of pleasantness, competence and frequency of occurrence. These older subjects rated themselves as being more competent in common and supportive situations and also rated these as more pleasant situations. They also reported a greater frequency of nonsocial and supportive situations. Their work supported the viability of a taxonomic approach to understanding everyday problems that people encounter. They proposed that future research using the taxonomy should investigate the differences in demand characteristics across levels of perceived difficulty as well as how individuals actually respond to the test situations.

Willis and Schaie (1986) examined perceived competence using Scheidt and Schaie's (1978) taxonomy of situations. They found that "significant positive age/cohort differences
in perceived competence for Social, Common, Passive, and Depriving situations" (p. 258). They reported that their findings are consistent with the literature in the field. Social abilities and attendant verbal skills have been seen as especially important to older people; they perform better in familiar versus novel situations and lifelong experiences may prepare older adults for depriving situations. It is important to point out, however, that this study examined only perceived competence in situations rather than actual performance competence.

Differing from such a taxonomic approach in an attempt to understand ability, Sternberg (1984) argued that a strictly contextual emphasis on intelligence lacks a theoretical basis and proposed that such a basis should focus on mental structures and processes. He predicted that the following metacomponents of intelligence are utilized across situations and tasks:

(a) recognizing the existence and nature of a problem, 
(b) deciding on the processes needed to solve the problem, 
(c) deciding upon a strategy into which to combine those processes, 
(d) deciding upon a mental representation upon which the processes and strategy will act, 
(e) allocating processing resources in an efficacious way, 
(f) monitoring one's place in problem solving (what has to be done, what is being done, what needs to be done), 
(g) being sensitive to the existence
and nature of feedback, (h) knowing what to do in response to this feedback, and (i) actually acting upon the feedback (p. 321).

Thus, regardless of the type of situation presented or type of intelligence studied, he would argue that these metacomponents would be present at differing levels of competence. He did not address the question of whether or not the quality of these cognitive processes would vary intraindividually depending upon problem type. For example, if an individual uses the metacomponents effectively on one problem, is there a tendency for that same individual to perform well on a different type of problem? If this were not the case and there were no strong consistency across problems, what factors would influence performance?

Some researchers have begun to explore cognitive processes in a beginning rudimentary fashion appropriate to the current status of the field. For example, in one study (Pollina, Tunick, Toffle, & Puckett, 1990), younger and older subjects did not use different problem solution strategies on an abstract version of a Poisoned Meals problem. However, on an everyday adaptation of the problem, older adults were more inefficient problem solvers in that they took more steps to solve the task. Additionally, in another study (Johnson, 1990) using a thinking aloud technique, older people were found to take more time
processing discrete bits of information in a decision-making task.

Puckett, Reese, Cohen, and Pollina (1991) have provided an excellent summary of possible outcome scenarios regarding cognitive processes of younger and older adult subjects. First, for a given set of everyday and lab tasks, or perhaps for all such tasks, it will be found that either (a) the same strategies are used across task domains or (b) different strategies are used. Crossed with these two possibilities is the set of outcomes, for a given set of tasks, that (a) older adults will do better in the everyday tasks than in the laboratory ones (and perhaps no age differences will be obtained between young and old adults on everyday tasks), or (b) older adults will not perform better in everyday tasks than in laboratory ones (age differences persist) (pp. 3-4).

In a preliminary empirical investigation of their theory of strategies and outcomes, these authors developed two experimental tasks. Both tasks were analogous to the Poisoned Meal task with the more abstract, laboratory task using letters to define groupings of binary choices of individual numbers. The everyday analogue of the task involved a lost keys problem situation. Twelve younger adults and 12 older adults were used as subjects with half of the subjects in each age group presented with one of the
problems situations. Strategies were recorded using a talking aloud procedure and were defined as either primitive (questions about single items) or sophisticated (questions that eliminated pairs of items). In the laboratory task, half of the young subjects used primitive strategies while the other half used sophisticated strategies. On the everyday task, all of the younger subjects employed sophisticated strategies. Older adults were similar on the laboratory task, with half using primitive strategies and half using sophisticated strategies. However, on the everyday task, all older subjects employed primitive strategies. Thus, the researchers concluded that older people do employ different strategies on different types of tasks.

As can be seen by the review of literature in this section, the investigation of practical intelligence is an active area of inquiry at all levels. Definition of terms is still an important factor; development of measurement instruments is ongoing; analysis or relationships between traditional psychometric tests of intelligence and tests of everyday intelligence is providing new information; and theoretical implications continue to be explored. Sinnott (1989) listed eight issues that are important in researching practical intelligence.

- The nature of tasks and scoring systems
- Selection of models and theories
- Choice of macro- or microlevel analysis
- The importance of context
- Fitting strategies specifically to the chosen purpose of the research
- Relations between problem solving and other cognitive processes
- Value of nomothetic and ideographic approaches
- Interpersonal aspects of problem solving (p. 301).

Following the guidelines of this list would result in more theoretical-based research, would focus attention on task selection, would emphasize the unique aspects of practical intelligence (e.g., contextual, social), and would focus on process as well as product with accompanying appropriate methodologies.

Factors Affecting Adult Intellectual Abilities

Many researchers have examined noncognitive factors that impact the development of intellectual abilities across the adult years. This area is too large to be reviewed in detail in this work. However, a brief overview will suffice in addressing the relevance of this body of work. Okun (1980) pointed out the importance in increasing awareness of noncognitive factors and their effect on cognitive performance in the elderly and developing research in this area. Without an awareness of the potential influence of noncognitive factors on intellectual performance, researchers may mistakenly attribute variations in
intellectual functioning solely to cognitive factors. This would result in a serious distortion of intellectual abilities. For example, as pointed out earlier motivation can play an important role in an individual's performance on a task designed to measure intelligence. Lachman (1986) called for an integration of personality characteristics, social environments, and cognitive abilities in order to maximize the functioning of individuals.

Botwinick (1984) discussed research in several areas that may adversely impact the performance of older adults. Sensory impairments occur in the elderly, primarily affecting vision and hearing. Although as Botwinick pointed out, these impairments do not appear to substantially negatively affect daily activities, researchers should not ignore them when developing test materials and tasks especially when such task involve novelty to the subject. Slowness of behavior and increased reaction time in the elderly has also been frequently documented in the elderly (Botwinick, 1984). Research tasks that employ timed measures may thus leave the elderly at a disadvantage due to increased slowness rather than an actual deficit in the variable under study (Hayslip, 1977). Increased cautiousness in responding is also perceived to be associated with aging (Botwinick, 1984); however, research presents mixed results on this variable. Overall, however, the elderly do appear to value accuracy and thus often
commit errors related to omission rather than errors of commission.

Research has indicated a relationship between personality variables and cognitive performance, but as Robertson-Tchabo (1980) pointed out, the reasons for, and possible directionality of, this relationship are unclear. In one study (Hayslip, 1988), the author did examine the relationship between Holtzman Inkblot factors and Gf and Gc. The different pattern of factors associated with the two intellectual abilities suggested some personality related reasons for higher functioning in the two ability areas. The author concluded that the higher functioning individuals may utilize ego defense mechanisms that serve to "insulate the older individual from feelings of self-worthlessness and failure and/or a loss of control over external forces via the development of intellectual skills" (p. 79).

In another study, this same author (Hayslip, 1989) investigated the effect of both induction training and stress inoculation training on performance on Gf tasks. He found that both interventions had positive effects at follow-up compared to a nonintervention control group. Hayslip concluded that practice may be of primary importance in any Gf intervention. He also stated that anxiety-reduction can have beneficial effects.

In the absence of induction training, older persons can generate their own solution strategies with the aid of
minimal practice on credible induction problems. Preexisting skills can be activated—mediated by a reduction in inappropriate arousal-dysfunctional anxiety linked to failure self-statements—leading to higher performance. (p. 124)

The presence of clinical levels of depression could also have deleterious effects on cognitive performance in that depression is frequently accompanied by impaired attention, concentration, and overall levels of energy. Zarit (1980) described depression as the most common psychiatric disorder among older adults. Hayslip, Kennelly, and Maloy (1990) undertook a study to examine the effects of depression on several measures which included Gc, Gf, verbal-auditory short-term memory, and visual-spatial short-term memory using subjects classified as either depressed or nondepressed using the Beck Depression Inventory. In this study, subjects completed a pretest of all measures, engaged in either effortful/fatiguing tasks or noneffortful/nonfatiguing tasks, and then completed a posttest of all intellectual and memory measures. They found that depression and task effortfulness impacted on short-term memory performance; considerably less impact was found on intellectual performance measures.

In order to further separate the relationships between personality factors and cognitive abilities, Lachman and her colleagues (Lachman, Baltes, Nesselroade, & Willis, 1982)
developed a personality inventory that specifically addressed intellectual aging issues. One study (Lachman & Leff, 1989) examined the relationship of Gf and Gc and perceived control of intellectual functioning in the elderly. The authors reported that data from this investigation revealed that "[c]ontrol beliefs were not found to predict changes in intellectual functioning. However, changes in intellectual control beliefs were predicted by fluid intelligence" (p. 726). Thus, they concluded that "intellectual performance influences changes in beliefs, and not the converse" (p. 727). This study examined changes in intellectual ability and control beliefs over a five-year period of time. It is difficult to understand the many nuances that may have contributed to the changes during the intervening time. The authors suggested that one possibility is the increased impact of negative stereotypes regarding older adults' cognitive abilities. However, another possibility could be the perceived changes in ability over the years whether or not such self-evaluations are accurate assessments of performance.

In addressing the issue of causality of change Field, Schaie, and Leino (1988) have stated that given the current state of the field, it is difficult to determine direction of causality (e.g., if personality influences intellectual functioning or if intellectual functioning affects personality). This is an interesting area for additional
research. One component of future investigation might be
the examination of the effect of immediate feedback on
intellectual performance on emotionally laden
self-evaluation of ability. Furthermore, immediate effects
of performance may be processed in a unique manner by
individuals who vary in the more stable characteristics of
personality.

Schooler (1987) addressed the impact that complexity of
environments may have on cognitive performance. Complexity
is related to numbers of stimuli, decisions, contingencies
associated with the environment as well as amount of
structure to the environment. Individuals in optimally
complex environments with associated reinforcement are
hypothesized to develop cognitive capacities with attendant
generalization of processes to other situations and an
suggested that one arena for maintaining a complex
environment during the older years is to continue
involvement in cognitively challenging work situations.
Many factors may affect the choice of level of complexity of
environment, however. These might include health issues,
economic factors, self-image, and personality
characteristics.

One personality construct that is germane to the
present topic of research is self-efficacy. Bandura (1977)
proposed that self-efficacy is crucial to behavioral change and provided the following definitions:

An outcome expectancy is defined as a person’s estimate that a given behavior will lead to certain outcomes.

An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcome (p. 193).

Bandura (1982) stated that level of self-efficacy not only affects type of tasks in which the individual will engage but also performance mastery and persistence in completion of the task. Older adults may be susceptible to decreased self-efficacy (Bandura, 1981) because of negative cultural stereotypes of older people, perceived generalization of physiological effects of aging, and comparisons of current abilities with earlier abilities. Thus, the negative evaluative self-statements (Brockner, 1983; Bandura, 1981) that individuals make adversely affect choice of actions in a downward spiraling manner with accompanying negative affect. Meichenbaum (1977) has emphasized the important effect of internal dialogue on behavior. On the other hand, individuals with positive self-efficacy expectations perceive difficult tasks as challenges, see failure as related to their effort and, thus, under their control, and have an emotional resilience to difficulties (Bandura, 1989). Bandura (1989) stated, "They are active cognitive processors of information and
remain highly efficient in their analytic thinking in complex decision situations" (p. 731).

In related empirical research (Lachman & Jelalian, 1984), groups of younger and older adults were found to be more accurate in assessing efficacy expectations on types of tasks on which they, in fact, did perform better. Gf task scores were higher for younger adults; Gc tasks scores were better for the older adults. Thus, these subjects did appear capable of accurately assessing performance. It is not clear, however, what characteristics of the experimental tasks contributed to this self-appraisal. Unfortunately, self-statements of an evaluative and emotional nature which would be important aspects of self-efficacy often remain hidden due to research methodologies.

Methodological Considerations in Measuring Cognitive Processes

The vast majority of research on intelligence, whether traditional or practical abilities, employs traditional assessment methods of obtaining numeric data on interval scales of measurement. However, if the following statements (Poon, 1980) are true, different measurement methods may be more appropriate for some research endeavors.

It is now well documented by studies from the experimental and psychometric laboratories, in addition to our observations of everyday functioning, that older persons process information and behave differently from
younger persons. The literature suggests that older persons are different while attending to, perceiving, encoding, and remembering information, processes involved in tasks ranging from simple perceptual decision making to complex problem solving (p. 223).

Several authors have suggested using different data gathering techniques that would allow the researcher to access such processes for study. These authors would examine the cognitive processes as well as the products (Genest & Turk, 1981; Giambra & Arenberg, 1980; Hartley, 1989; Lesgold, 1988). As Hartley (1989) suggested, if the goal is to understand the processes by which problems are solved, then attention must be directed to the strategies that are selected, the contributions of abilities and personal characteristics, and the ways in which those things change or remain stable with age (pp. 313-314).

An advantage to gathering such data is that self-evaluative information is accumulated concurrently (Genest & Turk, 1981). However, use of such techniques (e.g., thinking aloud) (Giambra & Arenberg, 1980) presumes an idiographic approach using small numbers of subjects with the inherent problem of generalizability.

Martin (1984) discussed three procedures for assessing cognitions: process tracing, stimulated recall, and cognitive training. In process tracing, the subject thinks
aloud while performing some experimental task. This procedure is commonly referred to as the "think aloud" technique. Scandura (1977) suggested that this procedure may be useful in studying problem solving specifically. In stimulated recall, audio- or videotapes are made of the subject while he or she is involved in a task. Later, the subject reviews the tape and responds to experimenter instructions (e.g., recalling thoughts that occurred to him or her during a specific point on the tape). The third data gathering method, cognitive training, involves training subjects to become aware of their reactions and signal when they are occurring without disrupting the ongoing activity. For example, the subject might be taught the differences between several types of reactions, increase personal awareness of these reactions in training sessions, and then signal through a code (e.g., one finger tap for one type of reaction, two taps for another) when these reactions occurred. The remainder of this section will provide a more detailed review of the first two data gathering methods.

Genest and Turk (1981) provided an overview of the thinking aloud approach and described several techniques that could be used.

Continuous monologues--subjects verbalize all of their thoughts while simultaneously performing a task.
Random sampling of thoughts--subjects record thoughts that occur within a given time period. The time period
is often signaled either directly by the experimenter or by an electronic beeper.

Event recording—subjects record whenever a previously defined reaction occurs.

Rating scales—subjects rate reactions on scales that have been developed previously.

Reconstructive procedures—this procedure is equivalent to Martin’s (1984) previously mentioned stimulated recall.

Several researchers have used the thinking aloud technique in their work on problem solving or decision making. Goor and Sommerfeld (1975) studied the creative processes involved in problem solving by audio recording subjects’ resolutions of experimental problems. Subjects had been selected based on creativity scores. Tapes were transcribed dividing the responses into three-second intervals with content coded as being in one of seven categories. Analysis was conducted on both frequencies of categories and sequences of categories of high and low creative students. Results indicated that high creative subjects had higher frequencies in generating new information or hypotheses, developing or working on a hypothesis, and self-reference or self-criticism; these subjects had lower frequencies for silence. Results of pattern analysis were less clear.
Schweiger and his colleagues (Schweiger, Anderson, & Locke, 1985) had business students audiotape their decision making processes in a business management simulation. They found that causal analysis (looking for causes of results) was positively correlated to quality of decision while blindly repeating previously successful decisions, errors in thinking or lack of reason, and self-doubt and negative emotions were negatively correlated with decision quality.

While studying group decision making processes, Kaplan and Miller (1987) also used a thinking aloud approach by tape recording the group’s discussion of the decision task. Tetlock (1986) has used a written variation of the thinking aloud technique in assessing cognitive complexity in decision making. Based on his study, he concluded, "What people think (the basic values they hold and the types of problems they are trying to solve) may often constrain how they think (the complexity of their reasoning)" (p. 824).

As part of a large research effort investigating the concept of wisdom, Smith and Baltes (1990) used a thinking aloud technique. They had subjects think aloud as they developed a plan for a fictitious individual faced with difficult decision. They found that subjects were easily able to follow instructions to think aloud and provided complete protocols for analysis.

The work that has most extensively focused on thinking aloud procedures to investigate cognitive processes is that
of Simon and his colleagues (Ericsson & Simon, 1984; Newell & Simon, 1972). In the earlier work, analysis was directed at very structured problems with limited correct choice alternatives and was primarily interested in strategies. Ericsson and Simon's (1984) work provided a more detailed description of the methodology involved in collecting verbal data and, thus, is a useful guide for the thinking aloud technique. Ericsson and Simon noted that, given proper instruction in thinking aloud and application to appropriate tasks, subjects can provide rich verbal protocols. Furthermore, they noted that their research "gave no evidence that verbalization changes the course or structure of the thought processes" (1984, p. 106).

The stimulated recall procedure has also been used in research. Ickes and his associates (Ickes, Robertson, Tooke, & Teng, 1986) believed that their work supported listing thoughts through stimulated recall as a valid procedure because results were positively correlated with behavioral and personality measures. A second study (Asendorpf, 1987) also indicated that stimulated recall can successfully elicit covert processes (cognitions and emotions) that correspond to subjects' performance on more objective measures of personality characteristics. A third study (Peterson, Swing, Braverman, & Buss, 1982) successfully used stimulated recall with grade school
students to assess the cognitive processes that occur during classroom instruction.

A different data gathering technique was used in two studies of assertion which employed a compromise between eliciting free responses of subjects and using a structured response questionnaire by developing a questionnaire based on free responses obtained during pilot studies. In these studies, following exposure to assertive situations, subjects were asked to rate statements on the degree of influence they exerted during the experimental situations.

Caccioppo and Petty (1981) advocated the use of a different method, thought listing, in assessing cognitions. In this technique, subjects are asked to list their thoughts regarding a stimulus or experimental task. They discussed several dimensions that can be used to classify responses: 1) polarity of response, 2) source of information the subject uses in the response, 3) target of the response, 4) irrationality of the response, 5) saliency of response, 6) emotionality of the response, and 7) reality of response. Scoring can be done by independent raters, by the subjects themselves, or both groups. They stated that results of this third scoring method have been strongly correlated in past studies. These authors suggested that thought listing is a valuable technique in assessing sequences of cognitions.
One experiment (Caccioppo, Glass, & Merluzzi, 1979) indicated that thought listing is indeed a viable technique for gathering cognitive data. This study used two groups of subjects, high heterosocially anxious males and low heterosocially anxious males. Subjects, on an individual basis, were told they would be required to participate in a dyadic interaction with an unknown female student. Following a brief contrived delay after this information was given, subjects were asked to list all their thoughts about the upcoming interaction (which, in fact, did not occur). After listing their thoughts, subjects were then asked to rate each thought as favorable toward themselves, unfavorable toward themselves, or neutral. Independent raters also scored the responses. Using frequency counts of the categories of self-statements, they found that high heterosocially anxious men had more negative self-statements than low heterosocially anxious men.

In summary, researchers have found thinking aloud, stimulated recall, and thought listing are viable techniques for gathering data on covert processes. However, there are also precautions (Genest & Turk, 1981) that accompany these techniques. First, subjects may not report all of their thoughts. Second, it may be difficult for subjects to verbalize everything they experience internally because of the limitations of language. Third, these techniques often require the time-consuming task of transcribing subject
reports. Fourth, there may be a mass of data for the researcher to organize and classify. However, in order to adequately gather information on cognitive processes, these appear to be the most effective procedures.

Need for the Study

As the literature reviewed thus far indicates, excellent work has been conducted in developing theories of intellectual development across the lifespan. The recent interest in practical intelligence is concerned with competence and abilities applied to situations that people typically encounter in their lives rather than performance on traditional laboratory tasks. The field of intellectual research, both theoretical and empirical, is expanding rapidly onto new ground. As the previously cited literature suggested, new research methods may be required in this new endeavor. Horn (1979) pointed out that, "knowledge about intellectual processes . . . has not been well integrated into theories of intelligence" (p. 197). Landauer (1989) stated that "[W]e need much more in the way of qualitative naturalistic descriptions of the kinds of problem solving, memory use, learning, retrieval, calculation, and so forth, that go on in everyday life" (p. 121). Further, we need to know if the cognitive processes utilized are similar across different types of problems (i.e., interpersonal problems) (Hartley, 1989). Finally, are the processes similar across
adults of different ages. The proposed research will address these issues.

Although previous research has addressed these issues to some extent, performance is typically studied rather than process. Performance data do not reveal the strategies involved in problem resolution. Without this information, it is impossible to determine the effects of on-going self-evaluation during the task, the appropriateness of strategy irregardless of performance outcome, and the possible ineffective application of strategy. An additional dimension that has not been studied extensively in the past is academic and everyday intelligence. As Puckett, Reese, Cohen, and Pollina (1991) outlined, until the cognitive processes themselves are studied, researchers are uncertain of the contribution of strategy and outcome to studies comparing younger and older adults' intellectual abilities. Finally, personality variables are another dimension that are often not included in research on intellectual abilities. However, personality styles and characteristics can have powerful long- and short-term effects on performance and processing of information. These are the factors that the present study will examine in an effort to better understand intelligence and cognitive processes across the lifespan.

An additional need for the proposed study is to enhance training programs designed to develop and remediate
cognitive skills that may be adversely affected by increasing age. Researchers (Hayslip, 1988, 1989; Hayslip & Maloy, 1989; Labouvie-Vief & Gonda, 1976; Willis, 1987, 1989) have experimented with training strategies with some positive results. It would appear that training endeavors would be more powerful if increased specificity of cognitive process deficits and strengths were available. Furthermore, training would be more meaningful if attempts were made to enhance competence on everyday tasks.

Research Questions

Because the present study proposes a unique examination of cognitive processes across a variety of tasks, utilization of several noncognitive measures, and a thinking aloud method of data gathering which have not previously been combined in research, exploratory questions rather than confirmatory hypotheses have been developed which will be the focus of this investigation. The present study will address the following questions:

1) Are there differences in the problem solving cognitive ability of younger and older adults?
2) Are there differences in cognitive processes used during problem solution?
3) Are the determinants of problem solving cognitive processes different for younger and older adults?
CHAPTER II

METHOD

Subjects

In order to evaluate potential differences in cognitive processes across the lifespan, two groups of subjects were used in the present study: younger adults and older adults. Fifty younger adult subjects between the ages of 18 and 27 (M = 22) were recruited from introductory psychology classes at a large, urban university. They were awarded extra credit for completion of tasks. This group was comprised of 25 males and 25 females. Fifty older adults (age range 64-81, M = 73) who lived independently in the community were recruited from a variety of sources to participate in the study. There were 14 males and 36 females in the older group. Older subjects were paid $15.00 for their participation.

Subjects completed a brief questionnaire eliciting demographic information. Mean number of years of school completed for the younger subjects was 13 years. For older subjects mean educational level was 15 years. Mean rating of health on a four-point scale (1 = excellent; 4 = poor) was 1.6 for the younger group and 1.9 for the older group.
When asked to rate their health relative to others of the same age on a similar four-point scale, younger subjects' average was 1.9 while older subjects' average was 1.7.

**Instruments**

Three types of instruments were administered (Table 1). One group consisted of personality measures. The second group consisted of quantitatively-scored nonecological tasks which were more representative of traditional psychometric instruments. The third group included quantitatively-scored ecological tasks. This group included tasks which were more representative of everyday problems but which were also scored based on the product or final solution to the problem. Tasks from both the ecological and nonecological instruments were selected to examine cognitive processes utilized during actual solution of the problems using a thinking aloud technique. These processes became the qualitative variables which represented dimensions of cognitive processing and which will be presented in a later section.

**Personality Tests.** A battery of personality tests was included which included both objective as well as projective measures. The Holtzman Inkblot Technique (HIT) (Holtzman, 1968) is a projective personality measure that utilizes standardized administration procedures. The HIT consists of 45 cards with one response elicited for each card. The one response per card aspect facilitates research of reliability
and validity indices (Hayslip, 1982). Data from the HIT are scored along 22 variables such as Reaction Time, Location, Movement, Color, and Anxiety. Several researchers (Hayslip, 1988; Holtzman, 1968) have employed factor analytic techniques on the HIT variables. Holtzman's work yielded six factors while Hayslip's research resulted in the following five primary factors: Anxiety over Ideational Sufficiency, Hypochondriasis, Feelings about Bodily Integrity, Use of Cognitive Resources to Deal with Reality, and Organizational Ability/Intellectual Functioning. Scores from these five factors will be used in the present study.

The state portion of the State-Trait Anxiety Inventory (Form X) (Spielberger, Gorsuch, & Lushene, 1970) is a 20-item self-report inventory that assesses state or situational anxiety. Subjects are asked to rate items along a four-point scale in terms of self-descriptiveness. Internal consistency reliabilities for the state portion are in the .80s and .90s. Test-retest reliabilities are relatively low (in the .30s) as would be expected from a measure so heavily influenced by situational factors (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

The NEO Five-Factor Inventory (NEO-FFI) (Costa & McCrae, 1989) is a 60-item personality inventory answered on a five-point scale that provides scores on five dimensions of Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness. The Neuroticism scale
broadly measures emotional stability and susceptibility to anxiety and psychological distress. The Extraversion scale contrasts liking to be with other people, assertiveness, and preference for excitement with a more reserved, independent style of interpersonal interaction. The Openness to Experience scale includes features of an active imagination, curiosity about self and environment, and a willingness to examine novel ideas. The Agreeableness scale measures the orientation toward others with one end of the continuum representing an individual who is altruistic and sympathetic to others while the other end of the continuum is characterized by an egocentric, uncooperative individual. The final scale, Conscientiousness, is related to the qualities of persistence, high moral scruples, and reliability. Internal consistency reliabilities for the five factors range from .76 to .93. Retest reliabilities have ranged from .68 to .83. McCrae and Costa (1991) noted that the NEO may be especially salient for work with older adults since they were used in developing and validating the instrument.

The Relational Competence Scale (RCS) (Carpenter, 1990) is a 100-item measure of two broad domains involving competence in interpersonal skills: Initiation and Enhancement. Initiation, which is composed of the scores from five subscales (assertiveness, dominance, instrumental competence, shyness, and social anxiety) is related to
initiating relationships as well as actively utilizing such relationships when needed. Enhancement measures abilities that serve to maintain and enhance relationships and is composed of the intimacy, trust, interpersonal sensitivity, empathic concern, and perspective taking subscales. Internal consistency coefficients for the subscales range from .77 to .90. The internal consistency coefficients for the Initiation and Enhancement domains are .95 and .93 respectively. Test-retest reliabilities for the scales range from .61 to .84. Although scores are obtained on each of the ten subscales as well as the two broader domains, only domains scores were utilized in the present study.

The Problem Solving Inventory (Heppner, 1986) is a self-rating instrument designed to assess problem solving behaviors and attitudes. Thirty-five items are presented in a 6-point Likert format. Individuals who score low on the PSI respond to items in a way indicative of effective problem solvers, whereas those who score high respond in a manner associated with ineffective problem solving. Factor analysis of the PSI revealed three factors: problem solving confidence, approach-avoidance style, and personal control. Although scores are obtained on the three factors as well as a total problem solving score, only total score was used in the present study. Reliability estimates of internal consistency (.90) and test-retest stability (.89) have been conducted. The PSI appears to be related to an internal
locus of control and is not correlated with intelligence or social desirability (Heppner & Petersen, 1982).

The Need for Cognition is an 18-item test that measures the "tendency to engage in and enjoy effortful cognitive endeavors" (Cacioppo, Petty, & Kao, 1984). It was presented in a five-point Likert format. The developers cited an internal reliability coefficient of .90.

A brief 15-item measure of test anxiety was included that was modeled after Sarason’s (1978) Test Anxiety Scale (TAS) in order to assess the effect of anxiety experienced in relation to the potential stress of an evaluative situation. Items from the TAS which are primarily specific to academic examinations were modified to make them appropriate for a more generic evaluative situations. For example, the original TAS item which read "Thinking about the grade I may get in a course interferes with my studying and my performance on tests" was modified to read "Thoughts of doing poorly interfere with my performance on tests."

The 15 items were presented in the same 5-point Likert type format as was the TAS.

Quantitatively-scored Nonecological Tasks. Ten tasks comprised the nonecological measures. As noted previously, these tasks represent more traditional laboratory tests that measure performance with a single, final score.

Short-term memory was assessed using the Digit Span subtest from the Wechsler Adult Intelligence Scale - Revised
(Wechsler, 1981) as well as the Logical Memory Subtest of the Wechsler Memory Scale (Wechsler, 1945) with immediate recall. The score on the Digit Span task is the number of correct trials prior to failure on both trials of an item for both forward and backward presentation. The Logical Memory Subtest is scored as the number of correctly recalled units of paragraph presentation for immediate recall.

Attention was measured using a letter cancellation task developed by Diller and his colleagues (Diller, Ben-Yishay, Gerstman, Goodkin, Gordon & Weinberg, 1974) and which Lezak (1983) described as a pure test of the ability to sustain attention. On this task, subjects were presented with 105 alphabetic characters with instructions to cross out all C's and E's as quickly as they could. Scores are obtained for both errors and time for completion. In prior research, median error scores for control subjects was 1 with 100 seconds as the median time for completion (Lezak, 1983).

Subjects were tested on traditional measures of Gc (vocabulary and abstruse analogies) and Gf (letter series and matrices) as well as a task that utilizes both abilities (common analogies) using selected portions of the Gf-Gc Sampler (Horn, 1975). The Gf-Gc Sampler is composed of several subtests designed to provide "quick, yet accurate assessment of both crystallized and fluid functioning" (Hayslip & Sterns, 1979, p. 406). For example, the vocabulary subtest has 15 items while the matrices subtest
has 14 items. Subjects work on the test by themselves at their own pace with scores consisting of the number of items correctly answered on each subtest.

In order to assess subjects’ abilities on a task where pre-experimental associations are beneficial to solution (Davis, 1966; Hayslip & Sterns, 1979), 16 five-letter anagrams were presented. The items were evenly selected from four lists of anagrams representing common/uncommon words and easier/more difficult letter placement. Prior to solving the test items, subjects were presented with sample items with accompanying solutions. Subjects were allowed to work at their own pace and were instructed not to write notes as they worked on solutions. The score was the number of correct solutions.

Arenberg’s (1968) Poisoned Foods task is a novel task (Davis, 1966; Hayslip & Sterns, 1979) which involves presentation of nine foods with subjects told that one of the foods contains poison. Foods are then grouped into meals of three foods each with the subject deciding whether the person eating the meal lived or died. Feedback on the correctness of response is given immediately. The task is to identify the specific poisoned food as more information is gained through each meal presentation. Scores were obtained for trials to solution as well as for correctness/incorrectness of final solution.
Two Water Jar problems from the Stanford-Binet Intelligence Scale (Terman & Merrill, 1973) were also given to subjects. The subject is instructed to "measure" the water rather than guess at a solution. A correct score is given if the subject can demonstrate appropriate steps followed in the solution of the problem. One of the problems is provided below.

A mother sent her boy to the river to bring back exactly 2 pints of water. She gave him a 5-pint can and a 3-pint can. Show me how the boy can measure out exactly 2 pints of water using nothing but these two cans and not guessing at the amount. You should begin by filling the 5-pint can first. Remember, you have a 5-pint can and a 3-pint can and you must bring back exactly 2 pints. (p. 107)

A Twenty Questions Task (Denney & Denney, 1981) was developed that presents a seven by six array of 42 pictures of common objects. Subjects were instructed to discover the single picture that the examiner has previously selected by asking questions that could be answered affirmatively or negatively. Subjects were further instructed to try to discover the picture asking as few questions as possible. Scores on Twenty Questions reflect the number of constraint seeking questions (i.e., questions that eliminate more than one item at a time), the number of hypothesis seeking questions (i.e., questions that eliminate only one item at a
time), and redundant questions. Correctness/incorrectness of a subject’s solution was also scored.

Two Piagetian formal operations problems were presented. One problem involved a more traditional presentation of a combinatorial problem while the second one was given within a more familiar framework (Sinnott, 1975). The more traditional problem read as follows:

Six letters of the twenty-six letters of the alphabet appear below. Imagine that you are making pairs of letters, writing down all the possible ways of putting two different letters together. How many pairs will you have when you make all possible pairs of the six letters? (Sinnott, 1991, p. 172)

The more familiar version of the problem involved pairing six children for a camping trip when each child wanted to camp with every other child. Although Sinnott (1991) has developed an elaborate scoring system designed to indicate the presence or absence of relativistic processes, for purposes of the present research, responses were scored as either correct or incorrect.

Quantitatively-scored Ecological Tasks. Four types of ecological tasks were presented to subjects in order to present them with problems that are more representative of everyday problems. Three of these tasks included presentation of scenarios while the fourth task was presented in a standardized multiple choice test format.
The ETS Basic Reading Skills test (Educational Testing Service, 1977) has 65 items related to daily living tasks that are believed to provide a simulation for how individuals might resolve a situation in their lives. Although individual items may not have been specifically encountered in the person's life, similar information and attendant skills are believed to be common in everyday situations. Skill areas include understanding labels, reading maps, understanding charts/schedules, paragraph comprehension, filling out forms, understanding ads, understanding technical documents, and news text comprehension. For the present study, 23 items representing all eight skill areas were selected for presentation to subjects. Scores were the number of items answered correctly.

The Means-End Problem Solving Procedure (MEPS) (Platt & Spivak, 1988) is a measure of interpersonal cognitive problem solving skills. The procedure consists of problematic interpersonal scenarios that provide the beginning and have a successful outcome. The subject's task is to provide the "middle" or means to the successful outcome. Scores are obtained on relevant means, irrelevant means given the context of the scenario, no means, number of different categories of means, enumeration of means, obstacles to means, and number of enumeration of obstacles. An example of one story is provided below.
Mr. C. had just moved in that day and didn’t know anyone. Mr. C. wanted to have friends in the neighborhood. The story ends with Mr. C. having many good friends and feeling at home in the neighborhood. You begin the story with Mr. C. in his room immediately after arriving in the neighborhood. (p. 17)

Stories were made gender-appropriate by substituting male/female nouns and pronouns for presentation to men and women. Five scenarios were selected for the current research from Platt and Spivak’s original ten stories.

Denney and her colleagues (Denney, 1989; Denney, 1990; Denney & Palmer, 1981; Denney & Pearce, 1989; Denney, Pearce, & Palmer, 1982) have developed a number of scenarios that represent everyday problematic situations that people may encounter. An example of a problem is presented below.

Let’s say that one evening you go to the refrigerator to get something cold to drink. When you open the refrigerator, you notice that it is not cold inside, but rather, is warm. What would you do? (Denney, 1990, p. 339)

Subjects were presented with four of these types of problems and were asked to orally present their solution to the situation. Denney and Pearce (1989) have developed a scoring system based on the number of safe and effective solutions provided for each problem. These solutions are summed across problems.
A final single everyday problem scenario was included for presentation to subjects. This problem was developed by Kramer and Woodruff (1986) in their research on postformal thought. This problem was included because it gives a more elaborate presentation of a situation that involves several domains (e.g., intrapersonal values, interpersonal relationships, cultural mores, and financial concerns). As such, it invites the subjects to include relativistic and dialectic considerations to their solutions. Although Kramer (1984) has developed a scoring schema to measure the presence of relativistic and dialectical thought, in the present study subject responses were coded using verbal protocol categories that were developed for this research and which will be presented in a later section.

**Pilot Study**

Following selection of measures, ordering of presentation of tasks, and developing instructions, a pilot study was conducted using two older adults and two younger adults. Because no difficulties were perceived by the examiner or presented by the subjects, no changes were made in the tasks or procedures.

**Standardization of Administration**

Because the examiner was assisted in data collection by two upperclass undergraduate psychology majors, care was taken in standardizing administration procedures. Tasks were administered in a sequentially consistent manner.
Typed, verbatim instructions for presenting tasks were provided to the assistants and were carefully reviewed and rehearsed during several practice sessions. Additionally, the examiner reviewed audiotape recordings of initial testing sessions conducted by the assistants.

**Procedure**

Subjects were tested individually in two sessions which were typically scheduled one week apart. Younger adults were tested in offices on the university campus. Older adults were tested in various locations, primarily in their homes or in a private office at a senior citizens' center. During the first session, the demographic questionnaire, letter cancellation, Digit Span, Logical Memory subtest, and Holtzman were administered. Time for completion of these tasks typically ranged from one to one-and-one-half hours. At the conclusion of the first session, instructions for the paper and pencil personality battery were reviewed with the subject and left for self-completion prior to the second meeting.

During the second testing session, the remaining tasks were administered (Gf-Gc Sampler, anagrams, Sinnott's two combinatorial problems, Water Jar problems, Poisoned Foods, Twenty Questions, selected ETS items, Denney's everyday problems, Kramer and Woodruff's scenario, and the five MEPS stories). Completion of these tasks typically involved one-and-one-half to two hours.
Specific tasks were selected for utilization of a thinking aloud technique in order to access problem solving cognitive processes. Subjects used thinking aloud on the following tasks: anagrams, Sinnott's two problems, Water Jar problems, Poisoned Foods, Twenty Questions, Denney's problems, Kramer and Woodruff's problem, and three MEPS scenarios. All instances of thinking aloud were audio tape recorded. Prior to the first thinking aloud task, subjects were instructed in the manner suggested by Ericsson and Simon (1984).

In this experiment we are interested in what you say to yourself as you perform some tasks that we give you. In order to do this we will ask you to TALK ALOUD as you work on the problems. What I mean by talk aloud is that I want you to say out loud everything that you say to yourself silently. Just act as if you are alone in the room speaking to yourself. If you are silent for any length of time I will remind you to keep talking aloud. Do you understand what I want you to do? (p. 376)

These instructions were followed by several practice problems. Tape recordings were transcribed by one individual.

Initial coding categories for this verbal protocol data were developed following Ericsson and Simon's (1984) suggestion to use a theoretical framework for developing
coding categories that is consistent with actual protocol data. A general problem solving framework was used which included typical steps involved in problem solution (realizing that a problem exists, understanding the nature of the problem, developing a plan for solution of the problem, carrying out the plan, evaluating the effectiveness of the solution, and integrating the experience into personal knowledge) (Hayes, 1981; Horan, 1987; Mayer, 1983).

Twenty-three scoring categories were initially developed. Utilizing them in scoring one protocol by two independent raters resulted in refinement to 15 categories (Table 2). These categories were used by the same two raters in scoring four additional protocols. Interrater reliabilities ranged from .75 to 1.00. Following this procedure, all verbal protocols (which were de-identified) were scored by the examiner. The 15 categories became the qualitatively-scored variables used in statistical analyses which represented the dimensions of cognitive processing.

Statistical Procedures

Age differences in performance on both quantitatively and qualitatively scored variables were investigated via a one-way (age: young vs. old) MANOVA. Post hoc univariate ANOVAs were conducted as warranted. Age differences in relationships between predictor and criterion tasks were investigated using a stepwise multiple regression (backward entry), utilizing sex, education, and health as predictors.
in combination with quantitatively-scored nonecological and personality variables. In a separate series of stepwise multiple regressions, age differences were examined with quantitatively-scored nonecological tasks as the criterion variables and sex, education, and health, personality test scores, and qualitatively-scored variables as predictors.
CHAPTER III

RESULTS

Results of MANOVA Exploring Age Differences

The first two exploratory questions were related to the issue of possible differences between younger and older adults.

1. Are there differences in cognitive abilities between the two groups?

These abilities were defined by all of the quantitatively-scored variables.

2. Are there differences between the two groups in cognitive processes used during problem solving efforts?

These processes were defined by the qualitatively-scored verbal protocol categories. To investigate these questions a one-way MANOVA was employed. A significant multivariate effect was found (Pillai’s trace = .83), $F(40, 59) = 7.10$, $p < .000$. Follow-up univariate $F$ tests revealed significant differences on a number of the variables.

Quantitative Variables. There were significant differences on 18 of the 25 quantitative variables (Table 3). Younger adults’ performance was better on Letter Cancellation (errors), Letter Cancellation (time to
completion), both Logical Memory stories, Digit Span Forward and Backward, Letter Series, Matrices, and Common Analogies. On the Twenty Questions task, they asked more constraint seeking questions that are more categorical in quality. On everyday tasks, younger adults correctly answered more of the selected ETS items, provided a greater number of means to Means-End Problem Solving stories, and included more categories of means in these stories. In contrast, older adults performed significantly better on Vocabulary and Abstruse Analogies, asked more hypothesis seeking questions (eliminating only one item at a time) on Twenty Questions, provided more irrelevant means to MEPS stories, and gave more no responses to MEPS stories.

Qualitative Variables. Results of post hoc univariate analysis revealed significant group differences on seven of the 15 cognitive processing variables (Table 4). Younger adults used more pauses and long pauses, employed strategy more frequently, and offered solutions to problems more often than their older counterparts. The older subjects engaged in more mind wandering, used more statements of hypothesis, and sought more confirmation of thinking than did the younger subjects.

Results of Chi-square Analyses

Because several problems were scored as being either correctly or incorrectly solved, a chi-square procedure was employed to investigate the relationship of correctness of
solution to age. Table 5 summarizes the results of the six chi-square analyses. There were no significant differences between age and solution on three tasks: Water Jar Problem 1, $\chi^2(1, N = 100) = .71$, $p > .40$, Water Jar Problem 2, $\chi^2(1, N = 100) = 2.22$, $p > .14$, and Twenty Questions, $\chi^2(1, N = 100)$, $p > .12$. Pearson chi-square was used on the two Water Jar Problems while Fisher's exact test, two-tailed, was used for the Twenty Questions due to cells with small expected frequencies.

There was a significant relationship between age and solution on three tasks. These problems included Sinnott Problem 1, $\chi^2(1, N = 100) = 10.87$, $p < .001$, Sinnott Problem 2, $\chi^2(1, N = 100) = 11.79$, $p < .0006$, and Poisoned Foods, $\chi^2(1, N = 100) = 7.11$, $p < .008$. Frequency counts indicated that younger adults were more likely than older subjects to solve these three problems correctly.

**Factor Analyses**

The final exploratory question addressed the possibility that determinants of cognitive processes were different for younger and older adults. Because of the large number of predictor variables, the number of subjects, and to aid in interpreting results, preliminary factor analyses were conducted prior to further statistical analysis of this research question. Three separate analyses were conducted including personality variables, nonecological quantitative variables, and the qualitative
verbal protocol scoring variables. Age was included as a variable on all three analyses. In all three analyses, a principal axis factoring procedure using varimax rotation to a terminal solution was employed. Factors with eigenvalues greater than one were retained. For purposes of defining individual factors, variables with factor loadings equal to or greater than .40 were primarily noted.

Factor Analysis of Personality Variables. On this analysis, six factors were extracted accounting for 72% of the total shared variance among the variables. Table 6 summarizes the factor structure of the personality variables.

Factor 1 defined by Neuroticism, Test Anxiety, Problem Solving Inventory, Initiation (negatively), and State Anxiety is principally defined as Anxiety and Insecurity. Factor 2 is defined by Enhancement, Agreeableness, Extroversion, and State Anxiety (negatively) and is best labeled as Social Adeptness. Factor 3 is defined by the HIT factors of Anxiety over Ideational Sufficiency, Feelings about Bodily Integrity, Hypochondriasis, and Organizational Ability/Intellectual Functioning. This factor might best be viewed as Vulnerability Regarding Personal Well-being. The fourth factor is defined by Age (negatively), HIT Factor 4 (Use of Cognitive Resources to Deal with Reality), Extroversion, and Initiation (with a secondary loading on this factor) and can be seen as a youthful, Pragmatic Use of
Resources. Two variables, Openness (negatively) and Need for Cognition (a high score indicates a low need for cognition) load on Factor 5 which is best summarized by Constricted Thinking. The final factor, Factor 6, is defined by Conscientiousness and the Problem Solving Inventory (negatively, secondary loading) and is labeled Self-assurance.

Factor Analysis of Nonecological Quantitative Variables. Table 7 summarizes the five factors which were extracted on this analysis and which accounted for 65% of the total shared variance among the variables. Factor 1 is principally defined by Letter Series, Common Analogies, Matrices, Letter Cancellation Errors (negatively), and Age (negatively). It is best labeled a Fluid Abilities factor. Factor 2 is defined by Digit Span Forward and Digit Span Backward and is related to Short Term Memory. Variables defining Factor 3 are Vocabulary, Abstruse Analogies, and Age. This factor is best labeled as a Crystallized Abilities factor. The fourth factor is defined by Twenty Questions (redundant questions) and Twenty Questions (hypothesis seeking questions) suggesting that this factor is related to Specific Hypothesis Testing. Factor 5 is defined by Twenty Questions (constraint seeking questions) and Twenty Questions (redundant questions) (secondary loading) and is labeled Schema Hypothesis Testing.
Factor Analysis of Qualitative Variables. Four of the verbal protocol scoring variables were not included because they were either derived from other variables (Total Number of Questions) or provided limited additional information (Pause, Long Pause, Very Long Pause). Four factors (Table 8) were extracted which accounted for 55% of the total shared variance among the variables.

The first factor is defined by Confirmatory Statements, Statements of Hypothesis, Age, and Self-critical Statements. This factor might best be labeled Clarification related to greater age. Factor 2 is defined by Spontaneous Solution (negatively) and Age. This factor is labeled Spontaneity of Thought which is related to a cautious or impulsive risk taking approach utilized by older and younger adults respectively. The third factor is principally defined by Strategy with a secondary loading of Statements of Relativism. These variables suggest that this factor is related to more Global Cognitive Processes. Right/Wrong Statements and Procedural Questions load on Factor 4 which is viewed as Restricted Thinking.

Regression Analyses

The factors derived from the previously discussed factor analyses were used in exploring the final research question which asked:

3. Are the determinants of problem solving cognitive processes different for younger and older adults?
This question was analyzed using stepwise backward entry multiple regression analyses. Three demographic variables (sex, education and health) as well as the six personality factors and five nonecological quantitative factors were the independent variables. Dependent variables included the four factors derived from the qualitative verbal protocol scoring categories.

In order to further explore possible differences in predictors of performance for the two age groups, additional multiple regressions were executed. Dependent variables were grouped into two categories, quantitatively-scored ecological variables and quantitatively-scored nonecological variables, for discussion. The first category of dependent variables (quantitatively-scored ecological variables) included ETS score, Denney score, MEPS total score, and MEPS irrelevant/no means score. The second category of dependent variables (quantitatively-scored nonecological variables) included Fluid abilities, Short Term Memory, Crystallized abilities, Specific Hypothesis Testing, and Schema Hypothesis Testing.

**Qualitative Dependent Variables - Younger Subjects.**

Results of regressions on the four qualitative variables are summarized in Table 9. For the younger sample, results of the regression analysis on the dependent variable Verbal Factor 1, Clarification, revealed that nonecological quantitative factor 4 (Specific Hypothesis Testing) alone
predicted performance. The second dependent variable, Spontaneity of Thought, was best predicted by Vulnerability regarding Personal Well-being and Short Term Memory. Schema Hypothesis Testing alone predicted Global Thinking which was the third qualitative variable. The final dependent variable in this series of regressions, Restricted Thinking, was predicted by Fluid abilities.

**Qualitative Dependent Variables - Older Subjects.** For older subjects, Specific Hypothesis Testing, Social Adeptness, Crystallized abilities, and Schema Hypothesis Testing predicted utilization of Clarification processes (Table 9). Spontaneity of Thought was best predicted by the two variables Crystallized abilities and Specific Hypothesis Testing. The third regression for this group revealed that Crystallized abilities as well as the personality factor Social Adeptness were significantly predictive of the processes identified by Restricted Thinking. The final qualitative variable, Restricted Thinking, was best predicted by Crystallized abilities and Sex in the older group of subjects.

**Quantitatively-scored Ecological Dependent Variables - Younger Subjects.** On the first ecological variable, ETS score, (Table 10) Fluid abilities, Pragmatic Use of Resources, Specific Hypothesis Testing, Self-assurance, and Anxiety and Insecurity predicted performance for younger subjects. The second ecological variable, Denney score, was
best predicted by Education and Specific Hypothesis Testing. The total score from the MEPS was the third ecological dependent variable and was predicted by Vulnerability regarding Personal Well-being, Constricted Thinking, Education, and Self-assurance. The final ecological quantitative variable was the MEPS irrelevant/no means score and was predicted solely by Pragmatic Use of Resources for the younger sample.

Quantitatively-scored Ecological Dependent Variables - Older Subjects. The first ecological quantitative dependent variables (Table 10) used in regression with the older subjects, ETS, was best predicted by several variables including Fluid abilities, Crystallized abilities, Schema Hypothesis Testing, Sex, Short Term Memory, Social Adeptness, and Health. Denney scores for the older subjects were predicted by Schema Hypothesis Testing, Health, Fluid Abilities, Social Adeptness, Anxiety and Insecurity, and Short Term Memory. There were no significant predictors for performance on the final two ecological variables, MEPS total score and MEPS irrelevant/no means score, for the older subjects.

Quantitatively-scored Nonecological Dependent Variables - Younger Subject. For the younger group the first nonecological quantitative dependent variable (Table 11), Fluid abilities, was best predicted by ETS, Self-assurance, Constricted Thinking, Pragmatic Use of Resources, Global
Thinking, MEPS total score, Denney score, Vulnerability Regarding Personal Well-being, and Education. Regression analysis revealed that Global Thinking, Anxiety and Insecurity, Clarification, Constricted Thinking, Pragmatic Use of Resources, and Health predicted performance on the Short Term Memory variable for younger subjects. Seven variables predicted performance on Crystallized abilities: Sex, ETS, Global Thinking, Vulnerability Regarding Personal Well-being, MEPS Irrelevant, Restricted Thinking, and Denney score. The fourth nonecological quantitative variable, Specific Hypothesis Testing, was predicted by Clarification, ETS, Health, and Denney score. The final regression for younger subjects on Schema Hypothesis Testing indicated performance was best predicted by Global Thinking, Sex, Self-assurance, Clarification, Pragmatic Use of Resources, Education, and Denney score.

Quantitatively-scored Nonecological Dependent Variables - Older Subjects. In the final series of regressions on nonecological quantitative variables (Table 11), ETS, Spontaneity of Thought, Sex, and Health significantly predicted Fluid abilities. Short Term Memory was best predicted by Education, Denney score, Self-assurance, and Pragmatic Use of Resources. Four variables, Spontaneity of Thought, Global Thinking, ETS, and Clarification, predicted performance on the Crystallized abilities variable. The Specific Hypothesis Testing variable was best predicted by
Clarification and Global Thinking in the older subject group. Predictors for the fifth nonecological quantitative dependent variable, Schema Hypothesis Testing, included Denney score, Clarification, Pragmatic Use of Resources, Health, and Global Thinking.
One goal of the present study was to further examine possible age differences in cognitive abilities. To this end, diverse tasks utilizing cognitive abilities were administered to younger and older subjects. Tasks varied on several dimensions: novel/familiar, ecological/nonecological, and quantitatively scored/qualitatively scored. Some aspects of the present study were unique to the research area. First, extensive personality measures were included. Second, verbal protocols were obtained through a thinking aloud technique in order to access the underlying cognitive processes that are used during problem solution. These verbal protocols were used to attain the second goal of the current research, to develop measures of problem solving cognitive processes. The third and final goal of this research was to examine possible age-related determinants of problem-solving processes. The present study was primarily exploratory rather than confirmatory in character. Three exploratory questions were posed to direct the research endeavor.

Discussion of Quantitatively-scored Variables

The first question explored the possibility of differences between the two age groups on cognitive
abilities that generally contribute to problem solving (Kausler, 1991). Results from a MANOVA and subsequent post hoc ANOVAs revealed age differences on 18 of the 25 quantitatively scored variables. Overall, younger subjects performed better than their older counterparts. They obtained higher scores on a timed attentional task, memory tasks, fluid ability tasks, and a paper and pencil everyday test (ETS). They also engaged in more sophisticated questioning strategies (constraint seeking) and provided more elaborated means to MEPS stories. Older adults scored better on crystallized ability tasks, engaged in more primitive types of questions (hypothesis seeking), and had greater difficulty responding appropriately to MEPS stories given the parameters of the task. Results of chi-squares indicated that younger subjects were more likely to correctly solve both Sinnott combinatorial problems and the Poisoned Food task.

Present results are generally consistent with previous research. Older subjects have traditionally performed more poorly on timed tasks such as Letter Cancellation. Due to the timed nature of the task (Hayslip, 1977), it is not possible to detect whether or not older subjects' attentional abilities are actually diminished in comparison to younger adults. Prior research indicates that attentional ability decreases across the lifespan; although as Salthouse (1991) noted, most of the research has been
conducted using divided attention tasks. Kausler (1991) cited specific earlier research in which older subjects performed more poorly than younger subjects on a letter cancellation task. He noted that the generally poorer performance of older subjects on selective attention tasks may be related to search-related processes. Horn and Hofer (1992) suggested that attentional ability is an important part of the foundation for the reasoning related to Gf. Plude and Doussard-Roosevelt (1990) succinctly described such differences in explanation as specific components of information processing (e.g., identification and comparison) and generalized mechanisms (e.g., generalized slowing and reduced attentional capacity). However, regardless of explanatory hypotheses, results of research are relatively consistent in noting the age-related vulnerability of attentional abilities.

In the extensive research on fluid and crystallized abilities, younger subjects have done better on fluid tests while older people have shown decrements in these abilities (Horn & Cattell, 1966a, 1967, Horn & Donaldson, 1976). Horn and Hofer (1992) suggested that older people have a deficit in general reasoning ability which is a primary component of fluid intelligence. As they further suggested, fluid intelligence is important because relevant tasks "do not so much require one to bring forth knowledge as they require problem solving in the immediate testing situation" (p. 60).
In other words, fluid intelligence becomes important in novel problem situations. Crystallized ability (acculturated knowledge) has always shown more stability, if not increase, across the lifespan. This also was replicated in the present study with younger subjects attaining superior performance on Gf tasks and older subjects performing better on Gc tasks.

Older subjects' poorer performance on memory tasks (measured here by digit span and a paragraph memory task) is also not surprising and is consistent with previous research (Kausler, 1991; Salthouse, 1991; Stine & Wingfield, 1990). Researchers have proposed different reasons for such decline. Horn and Hofer (1992) postulated that short-term memory loss in older people is related to the loss of the reasoning abilities associated with Gf. They based this premise on analyses that "indicate that Gf reasoning predicts much of the variance in measures of encoding novel information, which is the core of short-term memory" (p. 85). Similarly, Salthouse (1992a) pointed out that many researchers view memory deficits in older people as retrieval deficits while they, indeed, may also reflect encoding deficits. He further noted that "age-related reductions in processing speed contribute to impairments in working memory" (1992b, p. 918).

The poorer performance of older subjects on the selected items from the ETS test also appears to be
compatible with previous research (Willis, Jay, Diehl, & Marsiske, 1992). Such a result should not be surprising given research (Hayslip & Maloy, 1991) that finds ETS loaded more heavily on a Gf factor. Willis (1992) noted similar findings when she stated, "Both fluid and crystallized abilities have been found to account for everyday task performance, although a somewhat greater portion of the variance was accounted for by fluid abilities" (p. 89). Although it is tempting to hypothesize that declines in ETS scores may be reflective of a general age-related decline in Gf abilities, Willis (1992) cautioned against such thinking. She stated that "causal relationships among variables cannot be determined by examination of concurrent relationships" (p. 89). Based on longitudinal studies, she found that Gf and Gc both significantly predicted later everyday problem solving performance.

Again, the findings that younger adults used more constraint seeking questions than their older counterparts and, conversely, that older people used more hypothesis seeking questions than younger subjects on the Twenty Questions task are consistent with prior research (Denney, 1980; Denney, D.R. & Denney, N.W., 1973; Denney, N. W. & Denney, D.R, 1982; Denney & Palmer, 1981; Denney, Pearce, & Palmer, 1982). Denney’s research (1980) did indicate that older people have the capacity to engage in more sophisticated questioning strategies if the solution is
drawn from a more infinite array of possibilities or if the stimuli are more defined by obvious categories. Thus, while older adults may use less efficient questioning strategies than younger adults overall, they do have the capacity to modify their strategy to a more efficient one given the nature of the task. Puckett et al. (1991) have also found contextual differences (laboratory vs. everyday tasks) between younger and older adults on questioning strategies with older subjects performing more poorly on the everyday task. The reason for this more contextual task-demand aspect for older subjects is unclear.

It is interesting that there were no age differences in the numbers of redundant questions asked during administration of Twenty Questions given previous research (Denney & Denney, 1973) which indicated that older women asked more redundant questions than middle-aged women. Although older subjects performed more poorly on direct measures of memory, they did not ask more redundant questions which would have suggested forgetfulness during a seemingly nonmemory task. It is possible that when older subjects are directly assessed on memory tests, they exhibit more pronounced deficits related to anxiety, self-efficacy, cultural expectations, or other self-defeating types of processes (Hertzog, Dixon, & Hultsch, 1990). Given these potential sources of interference, it is also possible that on direct measures of memory, older subjects become more
sensitive and adversely affected by immediate feedback (either overt or covert) on performance from the experimenter for each trial with cumulative deleterious effects.

It is also important to note that despite a less efficient questioning strategy used by older adults, they were equally likely to correctly solve the task. Although different means were employed by the two groups on this problem, the end was similar. This emphasizes the importance of differentiating between qualitative (process) and quantitative (outcome) measures on the same task.

Results of MEPS scores are more difficult to interpret because of the lack of lifespan research using this task. In the present study, younger subjects provided more means and categories of means than older adults while older subjects provided irrelevant means and no means. However, there were no significant differences between the two groups in enumeration of means, number of obstacles, and enumeration of obstacles scores. Thus, group differences were related to scores that were more specific to task instructions of providing a mean to story outcome.

Unsolicited aspects of responses (elaboration and obstacles) that would presumably require additional cognitive effort did not reveal group differences. Perhaps the constrained nature of the story outcomes somehow did not challenge or invite older subjects to utilize more sophisticated
strategies. In connection with this proposition, it should be noted that on the more open-ended Denney problems which will be discussed later, there were no significant group differences. Additionally, it should be noted that although older subjects provided more "no" responses to MEPS stories, this was primarily specific to one five story with an individual "getting even" for a perceived personal insult. It was observed during the administration of this particular story, that older people frequently stated that they "did not believe in getting even" and chose not to respond or responded with this qualifier. It is possible that the group difference in this score is related to cohort differences in social/moral philosophies between older and younger generations. Blanchard-Fields and Camp (1990) found age-related differences in problem solving styles when subjects were presented with more highly emotionally-laden problems. They found that older subjects were more likely to use a "cut and dry" approach or a more passive avoidance strategy when presented with such problems. They hypothesized that this age difference could be attributable to production deficits or flexibility in responding in older adults and noted the need for a more clear delineation in future research.

The chi-square results of Sinnott's two combinatorial problems (which revealed group differences) are also difficult to interpret. Although these problems have been
included in Sinnott’s research, they were always included with other formal operations tasks. In one cross-sectional study (1975), she also found that younger subjects performed better on formal operation tasks than did older subjects. In the present research, younger subjects were also more likely to solve these problems successfully. Blackburn and Papalia (1992) noted that combinatorial formal operation problems are particularly more difficult for older adults. While classical Piagetian stage theory would suggest that both age groups should be capable of solving formal operations tasks (Bidell & Fischer, 1992), this has not been proven using these types of problems. It is difficult, given the scope of the present research, to integrate the current findings with Piagetian theory because of continuing major evolutions in the theory (Blackburn & Papalia, 1992; Sinnott, 1975). Perhaps, the psychometric theory involving Gf and Gc can, again, explain current results. On relatively novel tasks such as these, Gf reasoning abilities may be more involved. Alternatively, Hoyer and his colleagues (Hoyer, 1987; Rybash, Hoyer, & Roodin, 1986) have suggested that the cognitive abilities of older adults experience a qualitative shift in several ways. First, cognitive processing and knowledge for older people becomes encapsulated into specific domains. This is an adaptive process given both their everyday needs and declines in overall cognitive abilities, Gf. Second, postformal styles
of thinking (e.g., relativistic, open-ended) are utilized within these encapsulated domains which results in more creative and expert problem solutions for older adults. Therefore, they would argue that older adults would perform more poorly on Sinnott’s problems because they do not tap the intact processes and knowledge that have become more domain-specific. This is one area that may be worthy of future investigation.

Results of the chi-square indicating younger subjects were more likely to correctly solve the Poisoned Foods task is similar to results involving Sinnott’s problems. Again, this was a task that was relatively novel to subjects; therefore, Gf abilities may have contributed to solution. It is interesting to note that there was no significant difference in the number of trials to solution between the two groups. Based on these two findings, it appears that although younger and older subjects were accumulating information over similar numbers of trials, younger subjects were better able to derive appropriate deductions. Although Poisoned Foods has been used in previous research, it is difficult to directly compare current results due to different administration procedures as well as differences in scoring. However, two other studies (Arenberg, 1968; Hayslip & Sterns, 1979) found that younger subjects performed better on the task than did older subjects. Hayslip and Sterns stated, "Fluid ability accounted for more
variance, relative to Gc, in problems [Poisoned Foods] that were more abstract [and] placed less importance on past experience" (p. 410).

Two tasks, Anagrams and Denney problems, did not show age differences based on post hoc univariate ANOVA's. Differences in Anagram scores are consistent with previous research (Hayslip & Sterns, 1979) which revealed a stronger correlation between Anagrams and Gc than with Gf. In a recent study, Salthouse (1993) found that processing speed and word knowledge were equally important in predicting performance in verbal tasks (including anagrams) for both younger and older subjects. He proposed that age deficits are ameliorated by the increase of one of these factors (speed or knowledge) relative to a decrease in the other. Therefore, the absence of age differences on anagram problems may be related to increased word knowledge in older samples of subjects.

The lack of group differences on Denney problems are in conflict with her research using such everyday scenarios (Denney, 1989). Several factors may have contributed to this difference. First, different combinations of scenarios may have some effect on results. Additionally, the use of audiotaping may have added to the perceived importance of responses. However, the most probable explanation is that the presentation of fewer problems in the present study artificially restricted the range of scores.
Chi-square analyses of the two Water Jar problems indicated there was no significant difference in likelihood of correct solution across age groups. Kausler (1991) reported that younger subjects usually outperform their older counterparts on water jar problems. Reasons for this discrepancy are unknown although such problems vary in the form of presentation which may affect performance. However, the similarity of performance in the present research may be related to the problems being more familiar to subjects due to personal experience with common measuring devices such as pints and may also be more representative of Gc abilities. This hypothesis may be worthy of further exploration.

In summary, results indicate that there are more differences than similarities on performance on the diverse cognitive abilities tasks administered in the present study. Generally, these findings are consistent with research in the field. Kausler (1991) summarized the existing body of research by stating, "It seems unlikely these deficits reflect only performance differences and not age differences in competence" (p. 656). He further proposed that "[deficiencies] in working memory, a slower processing rate, and encoding and retention difficulties appear to effect problem solving and reasoning" (p. 657). Many of the differences also appear to fit into the Gf-Gc theory and the different courses of these two abilities across the
lifespan. Thus, it may be that some type of interaction between abilities and underlying processes adversely affects older subjects' problem solving competence.

Discussion of Qualitative Verbal Processing Variables

The second research question was related to possible age group differences on cognitive processes used during problem solution. Statistical analyses revealed differences on seven of the 15 verbal protocol scoring categories that were developed for this study. Although younger subjects engaged in pauses and long pauses more often, it is difficult to interpret this information since there is no knowledge of intraindividual processes that occurred during these periods of silence. Pause categories may, therefore, provide little information relevant to inquiries into cognitive processes and are not included in the present discussion.

Younger subjects engaged in more instances of Strategy (a purposeful combinatorial use of evidence) and Solution (providing a specific solution to a problem). Taken together, it appears that younger subjects overall engaged in a more active approach to the problems, developing strategies and then acting on them more frequently than did older subjects. In other words, younger adults engaged in more instances of purposefully manipulating and ordering information and subsequently coming to more conclusions. Conversely due to the finding that older subjects made more
Statements of Hypotheses, it appears that this group was perhaps more reticent in solving problems. They seemed to more carefully examine the parameters of the information through "if-then" types of statements and then be more cautious about stating a solution. The cautiousness that, in the past, has been seen as characteristic of older adults (Botwinick, 1984) has more recently been questioned (Kausler, 1991; Salthouse, 1991). However, the present study, via verbal protocols, also suggests that different cognitive processes precede the final solution and, indeed, may provide a more comprehensive picture of the overall approach to processing information.

Analysis also revealed other areas of age differences. Older subjects engaged in more Mind Wandering than did the younger subjects. This may be related to the earlier discussion on apparent attentional decline in older adults. It is also possible that such mind wandering or distractibility may have been related to more emotionally-laden factors such as anxiety or stress. Because of the final techniques used in the statistical analysis, this relationship was not explored directly.

The final variable that indicated group differences, Confirmatory Statements, again may be related to a more reticent, cautious approach utilized by older subjects. Older adults may examine the steps in their problem solving process in an evaluative way in order to provide self-
feedback, as well as rhetorical feedback from others. In this way, they may try to detect possible errors in thinking throughout the process. Thus, this may serve as a compensatory strategy for older persons who may perceive themselves as likely to make errors. Dixon (1992) reported a similar compensatory conclusion from his research on problem solving. He found that older adults engaged more in a process similar to the current Confirmatory Statements, particularly when they were placed in problem solving groups that included up to three strangers. On one of his tasks, the increased use of this process by older subjects correlated positively with correct responses. Thus, he concluded that older subjects may increase collaboration with others in order to compensate for or maximize their individual abilities. It is also conceivable that this confirmatory process may be cohort related and underscore the importance to an older generation of checking and rechecking their work.

There were several verbal protocol scoring variables with no group differences that are important to discuss briefly. Older subjects did not engage in more Self-critical statements than younger subjects. It appears that their personal attitudes regarding self-worth and efficacy may not have differed significantly from the younger subjects. However, this finding may be a result of selective sampling since the older subjects, who were
volunteers, may have positive self-perceptions of worth and esteem. Additionally, although older subjects had amassed more experience due simply to their longevity, they did not refer to this personal bank of experience through the use of Self-reference Statements. Thus, they did not appear to overtly draw from personal experience in solving problems. The similar numbers of statements related to Right/Wrong and Relativism perspectives suggest that both groups exhibited similar aspects of formal and postformal processes. The limited number of tasks that invited such thinking may have resulted in a restricted range of scores along these dimensions. This may have precluded finding a group difference similar to Kramer and Woodruff (1986) where older subjects engaged in more relativistic thinking.

In summary, the results involving the qualitatively-scored variables indicate that younger adults used a more active manipulation of data and offered more solutions. Older subjects used a more reticent approach with more confirmation of efforts. Off-task thinking also occurred more frequently for older subjects. Thus, the second goal of the present research was realized through the development of scoring dimensions of problem-solving cognitive processes via verbal protocols and application to analysis of age group differences. Core problem-solving strategies appear to be different for the two groups, and one source of off-task interference was greater for the older subjects.
However, there is great need for additional research in the area of problem-solving strategies which Salthouse (1991) has cogently addressed. He pointed out that the distinction between a strategy and ability must be kept clear. A strategy "is an optional method of performing the cognitive task" (p. 197). Further, he noted, "the method must be within the capability of the individual or it cannot be considered a strategy for him or her even though it may be a strategy for other individuals" (p. 197). Finally, he concluded that given usage of different strategies, their effects on mediating age differences should be investigated.

In the present research, it appeared that both age groups had the capability to perform both Strategy and Statements of Hypothesis satisfying Salthouse's first point regarding the general study of strategy. His second point regarding investigation of possible mediating effects on performance, then, would seem to be a logical extension of the current work.

**Discussion of Predictive Variables**

The final exploratory question related to the possible age differences in determinants of cognitive processes. In general, there is minimal overlap of predictor variables for the two groups; thus, determinants are different. However, results of the multiple regressions conducted during the present study are difficult to summarize and condense into clear patterns due to the number of variables involved in
the analysis. Predictor by predictor comparisons of differences and similarities are also difficult to succinctly discuss due to the diversity of predictors remaining when the backward elimination criterion was reached in the regression analyses. Therefore, a more global approach will be taken in discussing the findings.

An overview of the regressions on the four qualitative verbal processing variables (Clarification, Spontaneity of Thought, Global Thinking, and Restricted Thinking) reveals remarkably fewer predictors for each dependent variable when compared to the numbers of predictors for both quantitatively-scored ecological and nonecological dependent variables. For example, the uses of Clarification, Global Thinking, and Restricted Thinking were each predicted by only variable (quantitatively-scored nonecological variables of Specific Hypothesis Testing, Schema Hypothesis Testing, and Fluid Abilities, respectively). Thus, these four dimensions of cognitive processing may represent more clearly defined qualities in terms of subjects' allocation of resources.

There is also an interesting pattern of determinants on these same four qualitative variables for the older group of subjects. On all four of these regressions, crystallized abilities was one of the predictors and reached the .01 level of significance on three of the regressions. Thus, older subjects' cognitive processing, as defined in the
present research, was in some way reflective of their crystallized abilities. Conversely, it is interesting to note that for younger subjects performance on Gf tasks was predictive on only one of the processing variables, Restricted Thinking.

Since these cognitive processing variables (Clarification, Spontaneity of Thought, Global Thinking, and Restricted Thinking) were a unique aspect of the present research, their predictive utility was also important to evaluate. They were included as predictors only on regressions on the five nonecological variables (Fluid Abilities, Short Term Memory, Crystallized Abilities, Specific Hypothesis Testing, and Schema Hypothesis Testing). Upon examination of the relationships, there are notable connections between variables which generally appear to make intuitive sense. For example, for both age groups Global Processing was a significant predictor of Schema Hypothesis Testing, and, for older subjects, it was negatively predictive of Specific Hypothesis Testing. Clarification was a significant predictor of Specific Hypothesis Testing for both age groups. Differences in utilization of these processes may also aid in understanding age-related performance outcomes. For example, for younger subjects Global Thinking was negatively related to Crystallized Abilities while it was positively related to Crystallized Abilities for older subjects. Thus, increased utilization
of Global Thinking, a purposeful examination and recombination of information within a relativistic framework, was facilitative for performance on tests of acculturated knowledge for older subjects while it appeared to interfere with the efforts of younger subjects on the same tests.

Further global differences in predictors become interesting when they are grouped into the three major domains of sociodemographic, personality, cognitive variables. There do not appear to be noticeable differences across these domains in terms of their ability to predict performance on the four verbal processing dependent variables just discussed. Additionally, there are no age-related differences when the sociodemographic variables (sex, education, and health) are summed across ecological or nonecological tasks. However, there are differences across personality and cognitive domains on regressions on both quantitatively-scored ecological tasks and quantitatively-scored nonecological factors. It will be recalled that ecological tasks consisted of ETS score, Denney practical problems total score, MEPS total score, and MEPS irrelevant/no means score. Summing within these predictor domains and across the four dependent variables, younger subjects' performance was predicted by more personality variables than older subjects' (seven variables compared to three variables, respectively). Conversely, older subjects'
performance was predicted by more cognitive variables than was younger subjects’ (seven variables compared to three respectively).

Similar results were found when variables were summed across the three domains (sociodemographic, personality, and cognitive) for the five quantitatively-scored nonecological factors (Fluid Abilities, Short Term Memory, Crystallized Abilities, Specific Hypothesis Testing, and Schema Hypothesis Testing). Younger subjects’ performance was predicted by more personality variables than was older subjects’ (10 variables compared to three variables respectively). Similarly, younger subjects’ performance was predicted by more cognitive variables than older subjects’ (17 variables compared to 11 variables, respectively).

Several tentative hypotheses emerge related to the predictive power of the three domains for both ecological and nonecological variables. First, the finding that sociodemographic variables were not more numerous for older subjects merits some discussion. If the variables of education and health are considered risk factors for older subjects, it is initially surprising that they were not more predictive of performance variables for them. It is possible that these results are specific to the present samples of subjects. For example, mean education for older subjects was two years more than for younger subjects. Kausler (1991) discussed the "importance of balancing age
groups in educational levels" (p. 9). Although specific studies suggest that health influences cognitive performance (Hultsch, Hammer, & Small, 1993), Salthouse (1991) and Kausler (1991) both stated that in general health factors have minimal influence on age differences in cognitive functioning.

Further, in examining the personality and cognitive domains of variables, there appears to be a contextual aspect in relationship to use of resources. On everyday tasks, younger subjects primarily drew upon personality variables while older subjects utilized cognitive resources. This may indicate that the older adults were employing resources that were not optimally effective since they generally performed more poorly on these tasks. As Cornelius (1990) noted, in developing everyday problem scenarios, researchers typically include situations that represent everyday "hassles" rather than major life "crises" (p. 442); older people may be less willing to invest their resources in resolving the "hassles" in life. Additionally, because everyday problems may be more emotionally-laden, older adults may engage in the acontextual or passive-avoidant solutions noted by Blanchard-Fields and Camp (1990). It is possible, then, that older subjects tend to invest less of their personality resources in problem solving which contributes to adverse effects on performance. Reasons for this are unclear but may be related to the
importance of problem solving tasks to older adults compared to younger adults, underscoring issues of ecological validity.

On the nonecological variables, younger subjects utilized more personality and cognitive resources than the older subjects. These differences may indicate that younger subjects’ performance, which was generally superior, involved more attributes and, consequently, perhaps a wider range of resources than did older subjects’ performance. This may be representative of a conservation of resources by older subjects. Salthouse (1991) posited three reasons for a seeming conservation of resources by older adults which are applicable to the present findings. First, he noted that the quantity of processing resources might actually decline with age; second, the quantity of resources might not decline but, rather, older persons may experience an increased demand on resources which would affect performance. Finally, "the quantity of resources does not decline, but instead there is an age-related impairment in the selectivity or efficiency with which resources are allocated to processing components" (p. 307). It is possible that this selectivity is related to older individuals’ self-efficacy (Bandura, 1981) regarding abilities involved in novel or more complex tasks which would be particularly relevant to the present nonecological tasks. Thus, in light of the current research, the actual
quantity of resources may appear to decline (Salthouse's first and second explanations), and the performance of older subjects may be further compromised by impairment in allocating resources. Therefore, it is possible that older people may suffer a seemingly double handicap if they misallocate their resources in a given context. Their performance on the present ecological problems (continuing to use cognitive resources despite generally poorer performance) may represent the effects of such deficits.

In summary older subjects' primary ability strength, Gc, was related to cognitive process variables (such as Clarification, Spontaneity of Thought, Global Thinking, and Restricted Thinking) which may indicate optimal use of their cognitive abilities. Overall, there were fewer predictors for qualitatively-scored variables for both age groups than for the quantitatively-scored variables. This may be related to them being more clearly-defined qualities in terms of subjects' allocation of resources. Cognitive abilities were more predictive of older subjects' performance on quantitatively-scored ecological variables (ETS, Denney, MEPS total score, MEPS irrelevant/no means score), while personality variables were more predictive of younger subjects' performance on the same tasks. On nonecological quantitatively-scored variables (Fluid abilities, Short Term Memory, Crystallized abilities, Specific Hypothesis Testing, and Schema Hypothesis Testing),
there were more personality variable and cognitive variable predictors for younger subjects than for older subjects suggesting that greater variability in utilizing attributes may exist for younger adults during problem solution. It was noted that older adults’ performance may be adversely affected not only by fewer resources but also by impaired allocation of resources. One major conclusion that comes from the results of the multiple regressions, however, is the seemingly contextual quality of the predictors. There is virtually no similarity of predictors either by age group or by task. Thus, the two age groups appear to differentially employ abilities based on the specific task in which they are engaged.

Although the discussion of predictor variables has thus far been relatively global, it is also important to examine specific predictor-criterion relationships, particularly between the personality and quantitatively-scored nonecological variables. In their review of literature in the field, Gold and Arbuckle (1990) discussed relationships between personality factors and cognitive functioning. They noted that "over the adult age range greater emotionality or neuroticism is associated with poorer outcome on measures of cognitive functioning" (p. 357). However, Gc abilities appear to be less vulnerable to such a relationship, and, indeed, enhancing Gc might serve as a defense against feelings of anxiety and vulnerability regarding intellectual
abilities (Hayslip, 1988). In the present study, the two personality factors of Anxiety and Insecurity and Vulnerability regarding Personal Well-being appear to be more closely related to the neurotic and anxious qualities described by Gold and Arbuckle and Hayslip. Examination of these two variables revealed that Anxiety and Insecurity was related to poorer performance on ETS and Short Term Memory tasks for younger subjects and to the Denney score for older subjects. Vulnerability regarding Personal Well-being was predictive of a poorer MEPS total score and better performance on Gf and Gc tasks for younger subjects only. Thus, there is partial agreement with previous research using these two variables derived from factor analyses.

Other researchers have suggested that enhanced self-efficacy facilitates cognitive functioning (Bandura, 1982, 1989; Bouffard-Bouchard, 1989). In the present study Pragmatic Use of Resources appears to have qualities related to self-efficacy. This variable was positively related to performance on Short Term Memory tasks for older subjects. For younger subjects it was positively related to MEPS irrelevant/no means score, Gf, and Schema Hypothesis Testing while it was negatively related to performance on the ETS and Short Term Memory tasks. Thus, for younger subjects, results are more confusing. In general it appears that for the younger adults, this variable was facilitative for the more "global" reasoning abilities, Gf and organizing data
into schemata. It is possible, therefore, that self-efficacy becomes more important as a predictor when stronger demands are placed on cognitive resources. During such times, self-efficacy may positively effect secondary factors such as motivation and perseverance. Further personality-cognitive performance relationships are difficult to assess due to the paucity of existing literature.

**Limitations of the Present Research**

The internal validity of the present research may be compromised because subjects were not randomly selected. They instead volunteered for the research and were subsequently rewarded for their participation. Another potential threat to internal validity is that the older group was composed of unequal numbers of males and females. Finally, the length of the testing battery may have resulted in fatigue which could have adversely impacted on performance. Attempts were made to control this by dividing the tasks into two sessions and presenting the more cognitively demanding tasks at the beginning of each session.

External validity may have been affected by the sample size as well as the previously mentioned sampling procedures. The younger group of subjects was comprised of university students and may represent a more homogeneous group. External validity may have been threatened by the sex ratio of the older group. Because a cross-sectional
design was used, generalizations regarding age differences are tentative. The cohorts that are represented in such research may have unique characteristics (e.g., educational opportunities, nutritional history) that confound findings. For example, as noted earlier, older subjects in the present study were notably more reluctant to respond to a specific MEPS story which may represent a moral philosophy unique to that generation rather than actual performance abilities.

Contributions of the Present Research

One of the goals of the present study was to develop and implement a method for accessing underlying cognitive processes that are employed during problem solution. This goal was realized through the development of the 15 dimensions of cognitive processes and application to the coding of verbal protocols. Although this is a time-consuming task, it does provide useful information on how groups of subjects solve problems and possible interferences to such endeavors. The general theoretical orientation of the present study might best be viewed as a combination of information processing and psychometric theories where differences in processes are investigated across ability domains.

The present research also attempted to examine the determinants of processes related to problem solving. The questions raised by this aspects of the present study
regarding allocation or conservation of resources are areas remaining for future investigations.

**Suggestions for Future Research**

The results from the present exploratory research suggest that future investigations attend to the importance of contextual aspects of problems. Different contexts may not only greatly influence performance but also the predictors of such performance. Similarly, differences in presentation of tasks (e.g., novel vs. familiar or explicit vs. implicit instructions regarding effort) may affect performance outcomes. Thus, researchers should be cognizant of the effects of different types of problems and different administration procedures.

Additionally, thinking aloud does appear to be a viable, albeit time-consuming, method for accessing cognitive processes. Important information could be obtained from research using this method in numerous ways. These might include problem solving under extreme conditions (e.g., stress induction) or in situ tasks. They might also be used in monitoring pre- and post-training gains in programs designed to accentuate older adults' problem solving skills.

It might be useful to employ these techniques with groups who represent a more extensive spectrum of the lifespan. In this way, it might be possible to examine the developmental course of utilization of processes.
Finally, two areas of further inquiry that extend the present study have already been noted. The first is to explore whether or not use of a specific problem solving strategy, assessed via verbal protocols, has a mediating effect on performance. The second area of further study is to examine whether or not predictors are similar for both age groups based on level of performance. Thus, for example, high-performing older adults would be compared to high-performing younger adults in terms of both strategies employed as well as predictors of performance.
INFORMED CONSENT

I, ____________________________, agree to participate in a study of the ways people solve problems. The purpose of this study is to examine the ways different people solve many different kinds of problems. We hope that information from this study can be used in the future to help people become better problem solvers.

I understand that I will be asked to participate in two separate sessions. In each session I will meet individually with an interviewer. In the first session I will be asked to complete several questionnaires and activities relating to my knowledge, attitudes, and behaviors. I will also be given a set of questionnaires to complete on my own before the second session. In the second session, I will be asked to solve a variety of different problems. I understand that I will receive $15.00/7 extra credit points for completion of all research tasks.

I understand that my responses will be confidential. All analyses of the data will be conducted on group data, with no reference made to my personal responses.

I understand that there is minimal personal risk or discomfort involved in this research and that I am free to withdraw my consent and discontinue participation in this study at any time without penalty. However, I realize that should I withdraw, I will not receive the $15.00/7 extra credit points for participation.

If I have any questions or problems that arise in connection with my participation in this study, I should contact Pat McGregor at 565-2671.

_________________________________________  Date
Signature of Subject

_________________________________________  Date
Project Director

THIS PROJECT HAS BEEN REVIEWED BY THE UNIVERSITY OF NORTH TEXAS COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS (PHONE: 565-3940).
Table 1

Instruments Used in the Study

<table>
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<th>Personality Instruments</th>
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<tr>
<td>Holtzman Inkblot Problem Solving Inventory</td>
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<td>State Anxiety (From STAI) Need for Cognition</td>
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<td>NEO-FFI Test Anxiety</td>
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<td>Relational Competence</td>
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<td>Quantitatively-scored Nonecological Tasks</td>
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<td>Digit Span (Forward/Backward) Common Analogies (Gf/Gc)</td>
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<td>Logical Memory (from WMS) Anagrams</td>
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<td>Vocabulary (Gc) Poisoned Foods</td>
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<td>Abstruse Analogies (Gc) Water Jar 1 and 2</td>
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<tr>
<td>Letter Series (Gf) Twenty Questions</td>
</tr>
<tr>
<td>Matrices (Gf)</td>
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<tr>
<td>Quantitatively-scored Ecological Tasks</td>
</tr>
<tr>
<td>ETS (selected items) Denney Problems 1-4</td>
</tr>
<tr>
<td>MEPS 1-5 Kramer &amp; Woodruff Postformal (not scored except verbal protocol categories)</td>
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</tbody>
</table>
Table 2

Scoring Categories for Verbal Protocols

1. Number of Questions
2. Pause (2-5 seconds, approximately)
3. Long Pause (6-10 seconds, approximately)
4. Very Long Pause (11+ seconds, approximately)
5. Mind Wandering—extraneous to the problem
6. Restate Problem—declarative statements
7. Self-critical Statement—Example, "That should come to me."
8. Self-reference Statement—perspective taking. Example, "She's scared of finding a new job; I know I was scared when I changed jobs."
9. Strategy—purposeful; using evidence in combinatorial, conclusive way. Examples: "I'm trying to relate it to the six numbers." "I'm trying to put a vowel in between letters."
10. Statement of Hypothesis—"if then" type of statement. Examples: "If I fill up the three and empty it into the eight, that wouldn't do any good." "If it has two 'c's', it must start with a 'c'.”
11. Spontaneous Solution—scored for every solution offered irregardless of correctness.
12. Confirmatory Statement—regarding quality of S's thinking. Examples: "No, that's not a word." "No, I can't do that."
13. Procedural Question—questions regarding testing procedures. Examples: "You mean just start with the first one?" "Do I have to write it?"
14. Relativism Statement—awareness of context, relativism. Examples: "They need not go into a rage because there might be a very good reason for a child being two hours late from a date." "There are naturally several solutions to this problem."
15. Right/Wrong Statement—single (right/wrong) solution, acontextual. Examples: "Since they can't meet expenses, she needs to get a job." "She should get the job; you should always be willing to try new things."
Table 3
Means and Standard Deviations for Younger and Older Adults on Cognitive Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Younger (N = 50)</th>
<th>Older (N = 50)</th>
<th>F^a</th>
</tr>
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<td>SD</td>
<td>M</td>
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<td>Ltr Canc Err</td>
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<td>6.94</td>
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<td>MEPS No Response</td>
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^aUnivariate analysis, df = 1, 98
*p < .05; **p < .01
Table 4

Means and Standard Deviations for Younger and Older on Verbal Protocol Categories

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<tr>
<th>Task</th>
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<th>Older (N = 50)</th>
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<sup>a</sup>Univariate analysis (df = 1, 98)

*<sup>p</sup> < .05; **<sup>p</sup> < .01
Table 5

Sample Composition by Age and Correctness of Problem Solution

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Table 6

Factor Structure Personality Variables

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<th>Factor3c</th>
<th>Factor4d</th>
<th>Factor5e</th>
<th>Factor6f</th>
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</tbody>
</table>

aFactor1 = Anxiety and Insecurity, eigenvalue = 3.88, 22.8 percent of common variance.
bFactor2 = Social Adeptness, eigenvalue = 2.60, 15.3 percent of common variance.
cFactor3 = Personal Well-being, eigenvalue = 2.05, 12.1 percent of common variance.
dFactor4 = Pragmatic Use of Resources, eigenvalue = 1.51, 8.9 percent of common variance.
eFactor5 = Constricted Thinking, eigenvalue = 1.14, 6.7 percent of common variance.
fFactor6 = Self-assurance, eigenvalue = 1.07, 6.3 percent of common variance.
Table 7

**Factor Structure Nonecological Tasks**

<table>
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<tr>
<th>Variable</th>
<th>Factor1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Factor2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Factor3&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Factor4&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Factor5&lt;sup&gt;e&lt;/sup&gt;</th>
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<td>.64</td>
<td>.92</td>
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</tbody>
</table>

<sup>a</sup>Factor1 = Fluid Abilities, eigenvalue = 3.68, 24.6 percent of common variance.

<sup>b</sup>Factor2 = Short Term Memory, eigenvalue = 1.78, 11.9 percent of common variance.

<sup>c</sup>Factor3 = Crystalized Abilities, eigenvalue = 1.53, 10.2 percent of common variance.

<sup>d</sup>Factor4 = Specific Hypothesis Testing, eigenvalue = 1.44, 9.6 percent of common variance.

<sup>e</sup>Factor5 = Schema Hypothesis Testing, eigenvalue = 1.32, 8.8 percent of common variance.
Table 8

Factor Structure Verbal Protocol Variables

<table>
<thead>
<tr>
<th>Variable</th>
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<th>Factor4</th>
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\( \text{a} \) Factor1 = Clarification, eigenvalue = 2.33, 19.4 percent of common variance.

\( \text{b} \) Factor2 = Spontaneity of Thought, eigenvalue = 1.74, 14.5 percent of common variance.

\( \text{c} \) Factor3 = Global Cognitive Processes, eigenvalue = 1.36, 11.3 percent of common variance.

\( \text{d} \) Factor4 = Restricted Thinking, eigenvalue = 1.16, 9.7 percent of common variance.
Table 9
Regression Analysis of Qualitative Dependent Variables

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Note. YS = Younger subjects ($N = 50$), OS = Older Subjects ($N = 50$).

^aStepwise regression method.
^bF value for B.
^cUnstandardized regression coefficient (B).
^dStandardized regression coefficient (b).
^eAdjusted $R^2$.

*p < .05; **p < .01.
Table 10

Regression Analysis of Quantitatively-scored Ecological Dependent Variables

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**MEPS Irrelevant/No Means**

*Note. YS - Younger subjects (N = 50), OS = Older Subjects (N = 50).*

*aStepwise regression method.*

*bF value for B.*

*cUnstandardized regression coefficient (B).*

*dStandardized regression coefficient (b).*

*eAdjusted R^2.*

*p < .05; **p < .01.
Table 11
Regression Analysis of Quantitatively-scored Nonecological Dependent Variables

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Note. YS - Younger subjects ($N = 50$), OS = Older Subjects ($N = 50$).

$^a$Stepwise regression method.

$^b$F value for $B$.

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*p < .05; **p < .01.
REFERENCES


Basseches, M. (1984b). Dialectical thinking as a metasystemic form of cognitive organization. In M.L. Commons, F.A. Richards, & C. Armon (Eds.), Beyond formal operations: Late adolescent and adult cognitive development (pp. 216-238). New York: Praeger.


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