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Self-efficacy and performance of younger and older adults in verbal, reasoning, and spatial domains

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Abstract

Intellectual self-efficacy was tested as a mediator of age-related intellectual performance after controlling for perceptual speed differences. Tests of verbal, reasoning, and spatial abilities were administered to 50 younger and 50 older adults, along with measures of perceptual speed and task-specific intellectual self-efficacy. Younger outperformed older adults on spatial, reasoning, and speed measures, whereas no age differences emerged on tests of verbal ability. Younger adults endorsed higher self-efficacy for all domains. For reasoning, speed partially mediated age differences in performance, while intellectual self-efficacy failed to explain additional age-related variance. Age Group X Speed interactions contraindicated planned mediational analyses for younger and older adults in other domains. Within older adults only, speed completely mediated age-performance relationships in spatial and reasoning domains; self-efficacy failed to further attenuate age-related performance in either domain. Issues discussed include age-related patterns of self-efficacy and performance, implications of Age Group X Speed interactions, the intercorrelations between speed and self-efficacy, and methodological difficulties in assessing task-specific self-efficacy for speeded tasks.

I certify that I have read this thesis and find that, in scope and quality, it satisfies the requirements for the degree of Master of Arts.

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SELF-EFFICACY AND PERFORMANCE OF YOUNGER AND OLDER ADULTS IN VERBAL, REASONING, AND SPATIAL DOMAINS

By

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Self-Efficacy and Performance of Younger and Older Adults in Verbal, Reasoning, and Spatial Domains

Age-related decline in intellectual abilities is domain-specific; that is, whether older adults show decreased intellectual performance depends on the type of ability being assessed (Foster & Taylor, 1920; Horn & Cattell, 1967; Kaufman, Reynolds, & McLean, 1989; Sattler, 1982). Specifically, verbal abilities tend to be maintained or even increase as individuals age, while reasoning and spatial abilities tend to decrease with older age (Botwinick, 1977; Cornelius, 1984; Horn & Cattell, 1967; Lachman & Jelalian, 1984). This prevalent finding has been labeled the "classic aging pattern" (Botwinick, 1977). Beyond mere descriptions, however, researchers have begun addressing explanatory mechanisms that underlie age patterns of intellectual decline, maintenance, and growth. What factors might mediate age-related decline on certain types of cognitive tasks? The purpose of the present study was to examine task-specific intellectual self-efficacy as a mediator of age-related patterns of intellectual performance. This study sought to: 1) replicate the differential age differences on verbal, reasoning, and spatial task performance; 2) assess whether older adults are aware of differential intellectual decline; and 3) examine the influence of intellectual self-efficacy on the relationship between age and intellectual performance.

In the sections that follow, a review of the theory of fluid and crystallized intelligence is presented. This theory has provided a framework for many investigations of age differences in intellectual performance. Research on age-related performance in verbal, reasoning, and spatial domains is then reviewed, with a focus on the Seattle Longitudinal Study (for review, see Schaie, 1994). Before intellectual self-efficacy is discussed as a mediator of age-related intellectual performance, the role of perceptual speed is considered, which is especially pertinent because of speed's status in the cognitive aging literature as an explanation for cognitive decline. Research on self-efficacy and performance is then reviewed, with an emphasis on studies of intellectual self-efficacy and performance.

Fluid and Crystallized Intelligence

Horn and Cattell's (1966, 1967) theory of fluid and crystallized intelligence is often used to conceptualize age-related intellectual decline (Cornelius, 1984; Horn & Donaldson, 1976; Nettelbeck & Rabbitt, 1992). Fluid intelligence is indicated by intellectual skills that involve inductive, deductive, and abstract reasoning in order to form concepts and comprehend relationships among novel stimuli. Examples of fluid intelligence tasks are letter and number series, matrices (Horn & Cattell, 1966, 1967; Horn and Hofer, 1992), and paper folding (Salthouse, 1992). Abilities involving fluid intelligence are relatively independent of cultural learning; instead, they rely on comprehension of novel relationships in the immediate situation (Horn & Hofer, 1992). Fluid abilities are considered relatively "vulnerable" because they are adversely affected by central nervous system injuries that accumulate during normal development and aging (e.g., blows to the head, exposure to toxic substances such as lead and carbon monoxide). The age-related decline of fluid abilities predicted by the theory was congruent with existing observations of the 1940's and 1950's that older adults tended to perform more poorly on perceptual, or "culture fair" intelligence tests (Cattell, 1987a). In contrast, crystallized intelligence is measured by tasks that rely on one's accumulated knowledge gained through both cultural and academic education (Horn & Cattell, 1966; Horn & Hofer, 1992). Most tasks that tap crystallized intelligence involve familiar information that has been well-learned by the respondent. Such tasks include vocabulary recognition, verbal and reading comprehension, and famous face recognition (Horn & Cattell, 1966; Kaufman, Ishikuma, & Kaufman, 1994). Crystallized abilities are thought to be neurologically "overdetermined" due to the lifelong exposure and reinforcement involved in learning such skills; thus crystallized abilities are relatively more robust or "maintained" across the lifespan (Horn & Cattell, 1966; Horn & Hofer, 1992).

In 1966, Horn and Cattell conducted a systematic study of age differences in intellectual abilities. Over 50 psychometric measures of various abilities were administered to 297 individuals, ages 14 to 61 years. Comparisons across age groups suggested that fluid skills began to decrease in the twenties, while crystallized abilities improved across the lifespan. These findings supported the patterns of age-related performance predicted by the fluid-crystallized theory.

Substantial research has replicated this pattern of decline on fluid measures and maintenance of crystallized abilities across the lifespan (Horn & Cattell, 1967; Lachman & Jelalian, 1984; Ramsden & Berry, 1996; Schaie, 1989; Storandt, 1977; Wang & Kaufman, 1993). The Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981) has consistently revealed the "classic aging pattern" of intellectual decline: Younger adults tend to outperform older adults on the Performance subtests, but young and old perform at comparable levels on the Verbal subtests (Kaufman et al., 1989; Sattler, 1982; for review, see Salthouse, 1991b).

It should be noted, however, that research examining the maintenance of crystallized skills into very old age (e.g., after age 70) has yielded mixed results. Christensen, Mackinnon, Jorm, Henderson, Scott, and Korten (1994), assessed performance on several cognitive measures in 897 adults, ages 70 and older; age-related decline was obtained on some crystallized measures, including a shortened version of the WAIS-R (Wechsler, 1981) Similarities test and a reading measure. No age differences, however, were found on their shortened version of the WAIS-R Vocabulary test. Schaie and Willis (1993) examined cross-sectional data based on 1,628 participants from the Seattle Longitudinal Study and found that verbal performance patterns in later old age varied among specific measures within that domain. Specifically, age-related decline was observed on the highly speeded Verbal Meaning test of the Primary Mental Abilities before age 60 (PMA; Thurstone & Thurstone, 1949, as cited in Schaie & Willis, 1993), while older adults tended to outperform younger adults until very late old age on two vocabulary tests from the ETS Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, Harman, & Dermen, 1976). The two ETS tests do not emphasize speed to the degree that the PMA Verbal Meaning test does (Schaie & Willis, 1993). Thus, some research suggests that age-related decline occurs on measures of crystallized measures in very old age; however, it is evident that the pattern of such decline has not been consistently demonstrated, and is dependent upon the type of crystallized measure used (e.g., speeded or nonspeeded).

The Spatial Domain

Not all intellectual abilities fit neatly into the crystallized-fluid distinction (Horn & Cattell, 1966, 1967; Kaufman et al., 1994). This was demonstrated by factor analyses of Thurstone's primary mental abilities (Horn, 1965a, as cited in Horn and Cattell, 1967) where, in addition to the fluid and crystallized factors, other factors emerged, including separate visualization and speed factors. The visualization factor was the third factor to emerge in Horn's 1965 analyses (as described in Horn & Cattell, 1967), and comprised tasks involving spatial abilities, including mental rotation or manipulation of spatial information, maintenance of orientation regarding object location, mental imagery, and closure. The fourth factor was designated the speed factor, and included tasks of perceptual speed and copying speed. Some tasks (e.g., WAIS-R Block Design and Picture Arrangement) contain both fluid and visualization elements (Horn & Hofer, 1992; Kaufman et al., 1994). In general, spatial task performance declines across the lifespan and thus has a similar pattern of age effects as that obtained on reasoning tasks (Nettelbeck & Rabbitt, 1992; Salthouse, 1992, 1994; Schaie, 1989).

The Seattle Longitudinal Study

One of the most extensive examinations of intellectual functioning across the lifespan has been the Seattle Longitudinal Study (SLS; Schaie, 1994; Schaie & Willis, 1996). Multiple cognitive measures have been administered to participants every seven years since 1956; new samples have been added during each successive wave (Schaie, 1994). The principal psychometric scale used in the SLS has been the Primary Mental Abilities battery (PMA; Thurstone & Thurstone, 1949, as cited in Schaie & Willis, 1993). The PMA consists of five subtests which measure vocabulary recognition, inductive reasoning, spatial ability, numeric ability, and word fluency. Longitudinal findings of the SLS point to a maintenance of most of these skills through about age 60; the exception is the word fluency task, which showed significant decline by age 53. On average, participants showed decline in all of the skills tapped by the PMA by the late 60's as indicated by longitudinal data. These longitudinal findings do not seem congruent with the age-related patterns of intellectual decline discussed thus far. However, the cross-sectional analyses of SLS data do reveal a more differentiated pattern of decline across age: Reasoning and spatial abilities demonstrated a decline after peaking in early adulthood, while verbal ability showed a decline in early older age (Schaie, 1994).

The discrepant findings of decline versus maintenance in the SLS data reveal how varying research designs can yield different answers to the question of intellectual functioning across the lifespan. Which research method--cross-sectional or longitudinal--provides a clearer picture of the relationship of age and intellectual functioning? The advantages and disadvantages of longitudinal versus cross-sectional designs have generated heated debates (Baltes & Schaie, 1976; Botwinick, 1977; Horn & Donaldson, 1976; Kaufman et al., 1989; Schaie & Willis, 1996). Both have costs and benefits. For example, the SLS has been subject to selective attrition, a problem associated with longitudinal investigations; this effect can serve to positively bias aging samples (Botwinick, 1977; Cattell, 1987b; Horn & Donaldson, 1976; Schaie, 1994). As described by Botwinick (1977) and others, participants in longitudinal studies who remain available for retesting as they age tend to be those who demonstrated higher performance on earlier evaluations when compared to their cohorts who dropped out or are no longer available. For example, some individuals may be unavailable for retesting due to death, poor health, or termination of participation due to lack of interest (Botwinick, 1977); these individuals may have shown decreased performance during initial evaluations in part due to premorbidity factors, or lowered motivation. The eventual unavailability of individuals who tend to score at lower levels initially serves to "enhance" the sample that remains available for retesting. This effect results in an unrepresentative sample of older adults available for longitudinal comparison. Thus the longitudinal design can serve to obscure age-related decline in cognitive performance (Botwinick, 1977).

The biases inherent to both cross-sectional and longitudinal research designs make it difficult to distinguish between age, generational, and sampling effects when examining age-related cognitive performance. Attempts to address such difficulties have been made by employing cohort-sequential analyses, which combine aspects of both cross-sectional and longitudinal designs (Schaie & Hertzog, 1983; see also Botwinick, 1977; Horn & Donaldson, 1976). Schaie and Hertzog (1983) reported cohort-sequential analyses of the SLS data that demonstrated age declines on all PMA measures between the ages of 53 and 67, with reasoning ability showing a decline between ages 32 to 46 as well. Hence sequential analyses suggest somewhat earlier declines on cognitive abilities than did longitudinal analyses.

Thus, cross-sectional and cohort-sequential analyses of the SLS yield a pattern of decline that approaches the "classic aging pattern" with regard to reasoning and spatial abilities reported elsewhere in the literature. It is clear that the PMA data regarding verbal ability (Schaie, 1994; Schaie & Hertzog, 1983) is less consistent with the "classic aging pattern": PMA verbal performance tends to decline in the 60's when examined longitudinally, whereas cross-sectional and cohort-sequential analyses suggest decline by age 60. The decline in verbal ability by age 60 found in cross-sectional analyses of the SLS PMA data does not match the maintenance of verbal ability reported in other cross-sectional investigations (Horn & Cattell, 1967; Kaufman et al., 1989; Ramsden & Berry, 1996). Why might this be so?

Speed as a Mediator in Age-Related Cognitive Decline

The interpretation of age-related patterns of intellectual decline in the SLS must take into account the highly speeded nature of the PMA. To investigate the impact of age-related slowing on SLS PMA performance, Schaie (1989) examined age differences on the PMA while controlling for differences in perceptual speed. Perceptual speed tasks assess the speed at which one is able to carry out simple visual perception processes, including speed of comparing figures and scanning to locate figures or symbols (Ekstrom et al., 1976). Controlling for speed changed the pattern of age-related performance on the PMA measures considerably: The degree of age-related decline was reduced for all abilities, with significant age differences remaining on only reasoning and spatial skills. The most marked change occurred with the reversal of age decline for vocabulary recognition: When perceptual speed was controlled, vocabulary scores increased with age. Similar findings were reported by Hertzog (1989). He examined cross-sectional data from the SLS while controlling for differences in perceptual speed and PMA answer sheet speed. The tasks that assessed PMA answer sheet speed required the respondent to mark as many correct answers onto PMA answer sheets as possible in a given amount of time, using reproduced PMA test booklets in which the correct answers were provided. This task was designed to tap both perceptual and motor speed, while providing a measure of speed specifically related to the answer sheet format used in the PMA. Again, when controlling for speed differences, age-related decline was reduced but not eliminated for measures of reasoning and spatial ability, while verbal score trends were reversed, showing an increase and then leveling off in older age.

Schaie (1989) and Hertzog (1989) demonstrated that speed contributes to the relationship between age and decreased performance on reasoning and spatial tasks--tasks that are usually timed. Indeed, it has been argued and empirically demonstrated that slower speed of processing in older adults adversely affects their performance on reasoning and spatial tasks (Salthouse, 1991a, 1993; Storandt, 1977). For example, Storandt (1977) administered untimed reasoning and spatial tasks from the Wechsler Adult Intelligence Performance Scale (Wechsler, 1955, as cited in Storandt, 1977) to 40 younger and 40 older adults and obtained patterns of age-related performance similar to that of Schaie (1989) and Hertzog (1989): Age differences for reasoning and spatial abilities were reduced but not eliminated.

Salthouse (1991a) examined the relationship between speed and age-related cognitive performance by employing measures of both perceptual speed and working memory in three studies that examined age-related performance on a variety of fluid tasks measuring reasoning and/or spatial abilities. Perceptual speed was assessed using two comparison tasks: Letter Comparison and Figure Comparison. These tests required the respondent to indicate if pairs of letter series or figures were the same or different (Salthouse, 1991a). Age differences in performance were largely mediated by perceptual speed and working memory. Hierarchical regression demonstrated that in accounting for perceptual speed and working memory differences, the contribution of age to cognitive performance was reduced from as much as 30.5% to less than 5% in the three studies. Perceptual speed accounted for a higher percentage of age-related variance in cognitive performance than did working memory. Path analyses demonstrated that age-related differences in working memory were in large part mediated by age differences in perceptual speed (Salthouse, 1991a). These results are consistent with those of Schaie (1989) and

Hertzog (1989). Together, they suggest that age-related decline in perceptual speed can significantly contribute to the age differences seen in reasoning and spatial tasks.

Another investigation by Salthouse (1994) sought to clarify what type of speed--motor or perceptual--mediates age differences in cognitive performance. Speed tasks with minimal cognitive demands (e.g., tasks that involve simple copying, drawing lines, or deciding if two digits are identical) assess motor speed, while tasks that involve more complex operations, such as comparing series of letters or patterns, tap perceptual speed (Salthouse, 1994). In two separate studies, batteries of perceptual speed, motor speed, reasoning, spatial, and memory tasks were administered to adults between the ages of 18 and 87 years (Salthouse, 1994). Regression analyses revealed that perceptual speed was a more significant mediator than motor speed in the relationship between age and cognitive performance. Salthouse concluded that the slowing of cognitive processes, rather than simply motor or sensory slowing, influences age-related cognitive performance.

Should the effects of speed be statistically controlled? As Salthouse (1991b) pointed out, "there is still considerable controversy about whether the slowing is merely a peripheral factor that limits the expression of one's abilities, or is an intrinsic component or determinant of one's level of cognitive ability" (p. 81). Birren (1974) maintained that by statistically controlling for differences in speed, investigators may be removing the effect of an inherent aspect of intellectual ability. In contrast, Hertzog (1989) noted that highly speeded measures of cognitive functioning can serve to exaggerate age differences on the constructs being measured if speed is not an intrinsic aspect of the ability being assessed. For example, the vocabulary subtest of the PMA (Verbal Meaning) is a highly timed measure, though vocabulary skill is not usually conceptualized as having a speed component. As Hertzog (1989) explained, "performance on the Verbal Meaning test is influenced by speed in a way that reduces the construct-validity of the test as a measure of vocabulary knowledge in older people" (p. 648). Thus it seems that if the goal is to measure intellectual capacity versus slowing of thinking processes, age-related decline in speed must be accounted for.

Intellectual Self-Efficacy as a Proposed Mediator in Age-Related Cognitive Decline

The role of self-efficacy as a possible contributing factor to age-related cognitive performance has been examined in numerous contexts (Bouffard-Bouchard, 1990; Cooper & Robinson, 1991; Gardiner, Luszcz, & Bryan, 1997; Lachman, 1983; Lachman & Jelalian, 1984; Ramsden & Berry, 1996). Self-efficacy refers to a set of beliefs about one's own ability to successfully perform a task or action (Bandura, 1977). Bandura discussed the significant role self-efficacy plays in enhancing or impeding performance (Bandura, 1977, 1989). An individual who feels highly efficacious in a given task is likely to show more effort and persistence during task performance compared to an individual who has low confidence regarding her or his abilities in the given domain. Furthermore, individuals who doubt their ability to perform a given task are more likely to be preoccupied by thoughts of self-doubt (Bandura, 1989). These motivational and cognitive effects stemming from self-efficacy can serve to facilitate or degrade performance outcome on the given task (Bandura, 1989). According to self-efficacy theory, self-efficacy and performance affect each other in a reciprocal pattern: Self-efficacy beliefs are largely informed by past performance outcomes, and at the same time affect future performance by their influence over the cognitive and motivational processes discussed above (Bandura, 1977, 1989).

Investigations of self-efficacy across the lifespan have been particularly fruitful in the domain of memory (Berry & West, 1993). For example, Luszcz and Hinton (1995) measured memory self-efficacy and memory performance in younger and older adults. The older adults endorsed lower levels of memory self-efficacy and were outperformed on a recall task by younger adults. Analyses revealed that both domain-specific and task-specific memory self-efficacy, as measured by the Capacity subscale of the Metamemory in

Adulthood questionnaire (MIA; Dixon, Hultsch, & Hertzog, 1988) and the Memory Self-Efficacy Questionnaire (MSEQ; Berry, West, & Dennehey, 1989) respectively, predicted memory performance. In a study examining the mediating effects of effort, Berry (1987) found that memory self-efficacy was a predictor of both memory performance and task effort in older women. These findings support Bandura's model that specifies motivational variables (e.g., effort, persistence) as mediators of the relationship between self-efficacy and performance.

Research investigating domain- and task-specific self-efficacy and academic performance has supported the relationship between self-efficacy level and performance outcome as well (Bouffard-Bouchard, 1990; Cooper & Robinson, 1991). Bouffard-Bouchard (1990) examined the effect of task-specific self-efficacy on performance on a verbal task. After controlling for differences in initial verbal ability, Bouffard-Bouchard experimentally manipulated self-efficacy level by providing bogus feedback for initial task performance. Individuals in the high self-efficacy group attempted a greater number of problems and used problem-solving strategies more efficiently when compared to the low self-efficacy group, despite comparable levels of ability between the two groups. Such results provide support for Bandura's position that higher self-efficacy results in greater task persistence. Multon, Brown, and Lent's (1991) meta-analysis of 39 studies examining self-efficacy, academic performance, and persistence revealed that the relationship between self-efficacy level and performance outcome is significant on a variety of tasks across diverse groups of students. This investigation also found that academic self-efficacy is related to persistence in academic domains.

Lachman and colleagues (Lachman, 1983, Lachman, Baltes, Nesselroade, & Willis, 1982; Lachman & Leff, 1989) examined personality factors and intellectual performance in older adults and found that intellectual self-efficacy is related to intellectual performance. However, this research did not support the position that self-efficacy beliefs and intellectual performance predict each other reciprocally. For example, Lachman and Leff (1989) employed hierarchical multiple regression in a 5-year longitudinal study to examine directional relationships between personality variables and intellectual functioning in older adults. Multiple aspects of intellectual control and efficacy beliefs were assessed, including perceived control and competence beliefs regarding intellectual functioning. Results revealed that on average, performance on the reasoning (fluid) and vocabulary (crystallized) tasks, and endorsements of internal control beliefs remained stable over the 5-year period. External control beliefs regarding "powerful others," however, changed across the 5-year interval, indicating an increased sense of reliance on others for assistance when confronted with cognitive tasks. Initial levels of fluid ability predicted changes in intellectual control beliefs, but control beliefs did not predict change in intellectual performance. Similar findings were reported by Lachman (1983). Causal modeling in a 2-year longitudinal study of older adults suggested that earlier fluid ability levels contributed to later control scores, but a reciprocal relationship between intellectual control beliefs and performance was not obtained.

Conclusions regarding the role of intellectual self-efficacy in age-related intellectual performance are not definitive in these studies for several reasons. As Lachman noted (1983; Lachman & Leff, 1989), the role of intellectual self-efficacy beliefs or control beliefs <u>as predictors of intellectual functioning</u> could not be adequately assessed in either investigation because intellectual functioning itself did not decline. Furthermore, the measure of intellectual self-efficacy used by Lachman limits the generalizability of the self-efficacy findings in these studies because it represents a composite of internal control beliefs and self-efficacy beliefs. Bandura (1977) argued that strong internal locus of control beliefs for a given domain are not necessarily accompanied by high self-efficacy beliefs in that domain, and that the most precise assessment of the relationship between self-efficacy beliefs and performance is yielded by task-specific self-efficacy measures.

Research investigating task-specific intellectual self-efficacy and intellectual performance has yielded mixed results. Lachman and Jelalian (1984) assessed self-efficacy levels of younger and older adults before and after completing reasoning and vocabulary tasks. Consistent with other research and the "classic aging pattern," the older adults outperformed the younger adults on the verbal (crystallized) task, and the younger adults showed higher performance on the reasoning (fluid) measure. Self-efficacy ratings, however, did not differ between younger and older adults before task performance; rather, older adults tended to overestimate and younger adults underestimated their ability to perform the reasoning task, while younger adults overestimated their verbal performance.

Other research suggests that older adults may be somewhat aware of patterns of intellectual decline and maintenance (Ramsden & Berry, 1996). In a study of verbal and mathematics self-efficacy and performance in younger and older adults, older adults exhibited both lower mathematics self-efficacy and performance than younger adults. A different pattern emerged for the verbal domain: Older adults displayed higher vocabulary self-efficacy than younger adults, while no age differences emerged in vocabulary performance. These results cannot be generalized to the fluid domain, as mathematics tasks are thought to involve both crystallized and fluid abilities (Horn & Cattell, 1966, 1967). However, such findings provide support for the hypothesis that age-related patterns of intellectual self-efficacy are consistent with, and may even reflect, age differences in intellectual performance. One reason for the discrepancy between Lachman and Jelalian (1984) and Ramsden and Berry (1996) may be the type of task-specific self-efficacy measure used: Ramsden and Berry employed multiple-question, task-specific measures of verbal and mathematics self-efficacy. Lachman and Jelalian assessed pre-task self-efficacy by asking participants this question before the administration of each test: "Out of the 15 questions in this booklet, how many do you think you will get right?" (p. 578). When a single question is used to assess performance expectations, inaccurate and perhaps unreliable assessments can occur (Bandura, 1989; Berry et al., 1989); for example, older adults tend to overestimate their upcoming performance, while younger adults tend to either underestimate or make accurate statements regarding their approaching performance. In the Lachman and Jelalian study, older adults, in fact, overestimated their abilities regarding the reasoning task. This same age group, however, was more accurate in their predictions regarding vocabulary skills. Thus, it is difficult to assess whether the inaccuracy of older adult self-efficacy endorsements regarding the reasoning task was wholly due to an incongruity between beliefs and reasoning performance in older adults, or was in part due to the methods used to obtain such endorsements.

The relationship between age, intellectual self-efficacy, and intellectual performance has not been adequately explored with task-specific measures of self-efficacy. The present study addresses this gap by examining the role of task-specific intellectual self-efficacy in the relationship between age and performance.

The Present Study

The objectives of the present study were 1) to examine age differences in verbal, reasoning, and spatial task performance, while statistically controlling for perceptual speed, and 2) to measure task-specific intellectual self-efficacy for each task to determine the relationship between intellectual self-efficacy and intellectual performance. The purpose of measuring intellectual self-efficacy was two-fold: a) to determine whether older adults are aware of the differential decline typically seen in intellectual performance across the lifespan, and b) to determine the mediating role of intellectual self-efficacy on the relationship between age and intellectual performance.

In light of the research on perceptual speed and cognitive performance in older adults (Hertzog, 1989; Schaie, 1989), it was decided that age differences in perceptual speed would be controlled through statistical means. This decision was in part motivated by the choice of intellectual test battery employed in this study: the highly-speeded Schaie-

Thurstone Adult Mental Abilities Test Form OA (STAMAT Form OA; Schaie, 1985). The STAMAT, which was derived from the PMA, employs the same time limits of its parent scale. In weighing the issues discussed earlier regarding whether perceptual speed should be controlled in investigations of intellectual aging, it was decided to statistically control for perceptual slowing to gain a more accurate appraisal of intellectual performance.

The schematic models presented in Appendix A provide graphic representations of the relationship between age and intellectual performance. The present study sought to elucidate the mediating effects of intellectual self-efficacy on this relationship. Appendix A provides conceptual models of the hypotheses regarding the differential relationships predicted for the variables of age, perceptual speed, domain-specific intellectual self-efficacy, and performance.

The following hypotheses were tested:

Hypothesis 1--Intellectual performance with perceptual speed controlled: Younger adults will demonstrate higher levels of performance on both the reasoning (fluid) and spatial tasks (fluid with visual elements) than older adults. Older adults will perform at levels either equal to or higher than that of younger adults on verbal tasks.

Hypothesis 2--Intellectual self-efficacy beliefs: Younger adults will endorse higher levels of self-efficacy for both reasoning and spatial abilities than older adults. There will be no age differences demonstrated for verbal self-efficacy, or older adults will display higher levels of verbal self-efficacy.

Hypothesis 3--Perceptual Speed as a mediator: Perceptual speed partially mediates the relationship between age and intellectual performance. Based on the empirical literature, speed should contribute to performance in reasoning, spatial and verbal domains; however, it is likely the relationship will be greater for the tasks involving fluid abilities (reasoning and spatial tasks).

Hypothesis 4--Intellectual self-efficacy as a mediator: Task-specific self-efficacy partially mediates the relationship between age and intellectual performance in verbal, reasoning, and spatial domains when differences in perceptual speed are controlled. That is, intellectual self-efficacy explains additional age-related variance in intellectual performance above and beyond that due to perceptual speed.

Method

Participants

The participants were 50 young adults between the ages of 18 and 22 years (M = 19.22, SD = .95), and 50 older adults between the ages of 60 and 87 (M = 70.72, SD = 6.01). The young participants comprised 14 male and 36 female university students. Most of the young participants were enrolled in undergraduate psychology courses at the University of Richmond, and were given class credit for participating. Three of the student participants were paid $10 each rather than given class credit, as their participation occurred after class sessions ended for summer break. The older participants consisted of 16 men and 34 women residing in the city of Richmond and surrounding areas. These older adults were recruited either through newspaper articles discussing the need for older volunteers, or through acquaintances. Each of the older participants received $10 and a memory booklet for his or her participation.

All participants were screened for dementia using Kahn's Mental Status Questionnaire (MSQ; Kahn, Goldfarb, Pollack, & Peck, 1960). The MSQ contains 10 items that assess orientation to person, time, and place. Example items are, "What is the year?" and "Who is the president of the United States?". The recommended cutoff scores are: 0 to 2 incorrect - no or mild brain dysfunction, 3 to 8 - moderate dysfunction, 9 to 10 - severe dysfunction. One young adult was excluded from the study due to responding incorrectly to three MSQ items.

Participants were asked to provide information regarding their race and marital status. According to the responses provided, 94% of the older participants were Caucasian and 2% were African-American, while 92% of the younger participants were Caucasian, 4% were African-American, 2% were Hispanic, and 2% were Native American. Two older adults did not indicate their race. The majority of the older participants were married (68%), while 10% were single, and 20% were either widowed or divorced. This diversity in marital status contrasted with the younger participants, of whom 100% were single. Two older adults did not indicate their marital status.

An Age Group x Sex multivariate analysis of variance (MANOVA) was performed to examine possible age and sex differences in education, self-rated health, self-rated vision, and self-rated hearing. Self-rated health, vision and hearing were obtained by asking subjects to rate their health, corrected vision, and corrected hearing on a 10-point Likert scale ranging from 0 (poor) to 10 (excellent). A significant main effect for age, multi-F (4, 90) = 15.11, $p < .001$, revealed age differences in education, self-rated vision, and self-rated hearing, while a significant main effect for sex, multi-F (4, 90) = 3.32, $p < .05$, indicated sex differences in education. No Age Group x Sex interactions were obtained. The older adults reported more years of education, $F = 18.52$, $p < .001$, with a mean level of 15.04 years (SD = 3.14). Younger adults reported a mean education level of 13.00 years (SD = 1.16). Across age group, men (M = 15.26, SD = 3.58) were more highly educated than women (M = 13.59, SD = 1.93). Eighty-eight percent of the older adults and 96% of the younger adults rated their corrected vision as average or above average, while 82% of the older adults and 100% of the younger adults considered their hearing to be average or above. Overall, older adults rated their visual (M = 6.94, SD = 2.02) and auditory (M = 6.9, SD = 2.30) acuity as significantly poorer than did younger adults (M = 8.82, SD = 1.64 and M = 9.24, SD = .92 for corrected vision and hearing, respectively), $F = 15.48$, $p < .001$ for vision, and $F = 36.57$, $p < .001$ for hearing. The younger and older participants did not differ significantly on their self-rated health status; 98% and 96% of the younger and older participants, respectively, rated their health as average or above average.

The observation of several significant bivariate correlations between the performance variables and self-rated vision and hearing prompted the examination of these self-rated variables as possible covariates contributing to age differences in performance. Due to the lack of age differences in self-rated health, this variable was not pursued as a possible covariate contributing to age-cognition relationships in the present study. Self-rated vision and self-rated hearing served as the covariates in two separate multivariate analyses of covariance (MANCOVAs). The eight intellectual tasks and two perceptual speed tasks under investigation served as the dependent variables, while age group was the independent variable. Self-rated hearing was not related to the ten performance variables at the multivariate level, indicating that this variable did not significantly impact the age patterns of cognitive performance obtained in the present study. Self-rated vision, however, was significantly related to the grouped dependent variables, multi-F $(10, 86) = 1.99$, $p < .05$, prompting inspection of age differences in performance after controlling for this variable. The examination revealed that controlling for self-rated vision did not alter the patterns of age-related performance for any of the ten cognitive variables in question. With the assurance that age differences in self-rated health, vision, and hearing did not significantly contribute to age-related cognitive performance in the present study, the use of these three variables was restricted to the descriptive realm.

Measures

The psychometric battery comprised measures selected to provide multiple indices of the cognitive domains in question. Specifically, the following tests served as measures of verbal, reasoning, and spatial abilities: the Recognition Vocabulary, Figure Rotation, Object Rotation, Letter Series, and Word Series subtests from the STAMAT Form OA; and

Vocabulary from the WAIS-R Verbal Scale (Wechsler, 1981). The STAMAT Form OA is a revised version of the PMA in which nonreusable test booklets are used in which examinees record their responses. Schaie (1985) designed this revised version of the PMA in part to control for answer sheet speed variance between younger and older adults that may unduly influence age-related PMA performance. Further, the STAMAT Form OA circumvents confusion in older adults that can result from the use of separate test booklets and answer sheets (Schaie, 1985). Larger print is used in Form OA to reduce any difficulties older adults may have in reading the test. The Form OA of the STAMAT contains two additional subtests: Object Rotation and Word Series. These two scales were constructed to be comparable to the spatial rotation (Figure Rotation) and inductive reasoning (Letter Series) tests of the PMA, but include items thought to be more meaningful to the examinee, i.e., household objects and familiar words versus figures and letters (Schaie, 1985). All of the STAMAT subtests are timed; subtest directions remind examinees they are not expected to finish all of the items in the time allowed, but ask examinees to work quickly.

Additionally, two perceptual speed measures from Salthouse (1991a) were administered: Letter Comparison and Pattern Comparison. The Salthouse perceptual speed measures were selected for use over the often-used perceptual speed tests from the ETS Kit of Factor-Referenced Cognitive Tests (Ekstrom et al., 1976), based on a discussion with C. Hertzog (personal communication, January 24, 1997) regarding concerns over these measures. Specifically, loss of clarity of the figures making up the ETS perceptual speed items during reproduction of the tests can result in difficulty in discerning the details of the test items, a concern that is especially relevant when administering tests to older adults. Furthermore, ceiling effects have been observed with the ETS perceptual speed tests with some younger participants. In such cases, the employed measures may not be accurately assessing the individual's perceptual speed, as her or his ability may surpass the level of skill represented by the ranges of the tests. The decision to employ the Salthouse perceptual speed measures (1991a) was made in an attempt to circumvent such problems.

The two remaining STAMAT tests (Number Addition and Word Fluency), were administered for exploratory purposes (Schaie, 1985).

The specific tests are described below.

Verbal domain (crystallized intelligence):

1. WAIS-R Vocabulary test - the subject is asked to define a list of 35 vocabulary words of increasing difficulty (e.g., bed, tirade); no time limit is given. For the present investigation, this subtest was administered in written form. Two teams of three research assistants each were employed to score this test. Each subject's test responses were scored individually by three members from one of the two teams; the six scorers were blind regarding the age group from which the test responses came. Scoring standards adhered to the WAIS-R Manual: A completely correct answer received 2 points, a partially correct answer received 1 point, and 0 points were given to an incorrect answer. Following this procedure, the maximum score possible was 70. Final scores were obtained by scorers resolving all intra-team scoring discrepancies through consensus.

2. STAMAT Form OA Recognition Vocabulary - this is a multiple-choice vocabulary test in which the subject selects the best synonym of the target word, out of four choices. The target words increase in difficulty (e.g., moist, insolent). The subject is given 4 minutes to complete 50 items. As directed by the STAMAT Manual, the subject's score was the total number correct. Thus the maximum score possible was 50.

Reasoning domain (fluid intelligence):

1. STAMAT Form OA Letter Series - this is a multiple choice test in which the subject is asked to identify which of five letters comes next in a given series of letters. The subject is given 6 minutes to complete 30 items. Following the STAMAT manual, the score was total number correct. Thus the maximum possible score was 30.

2. STAMAT Form OA Word Series - this is a multiple choice test in which the subject is asked to identify which of five words comes next in a given series of words. The subject is given 6 minutes to complete 30 items. Again, the score was total number correct, resulting in a maximum score of 30.

Spatial domain (fluid intelligence with visual elements):

1. STAMAT Form OA Figure Rotation - the subject is asked to identify which of six drawings of rotated abstract figures are the same as a target figure; there are two or three correct responses for each target figure. The subject is given 5 minutes to complete 20 problems. As indicated by the STAMAT Manual, the score was total correct minus total incorrect, with a maximum possible score of 54.

2. STAMAT Form OA Object Rotation - the subject is asked to identify which of six drawings of rotated everyday objects are the same as the target object; there are two or three correct responses for each target object. The subject is given 5 minutes to complete 20 items. Again, the maximum score was total correct minus total incorrect, with a maximum possible score of 54.

Perceptual speed:

1. Letter Comparison - the subject is presented with a list of 21 pairs of letter series, made up of three, six, or nine letters, and asked to indicate if the two letter series in each pair are the same or different by marking an "S" or "D" in the blank line provided between the two letter series. The test consists of two trials of 21 pairs with 30 seconds given for each trial. The subjects were asked to work down the column of letter pairs as quickly as possible, without skipping any. The scores obtained from this test included the number correct, number incorrect, and number omitted for both trials. The final Letter Comparison performance scores were obtained by averaging the number correct across the two trials. Thus the maximum score possible was 21.

2. Pattern Comparison - the subject is provided with two columns of 15 pairs of line patterns made up of three, six, or nine lines, and asked to indicate if the two patterns in each pair are the same or different by marking an "S" or "D" in the blank line provided between the two patterns. The test consists of two trials, each trial involving two columns of 15 pairs, with a 30 second time-limit for each trial. Subjects were asked to start at the top of the left-hand column and to work down the columns as quickly as possible without skipping any. The scores obtained from this test included the number correct, number incorrect, and number omitted for both trials. The final Pattern Comparison scores were obtained by averaging the number correct across the two trials, resulting in a maximum score of 30.

Exploratory measures:

1. STAMAT Form OA Number Addition - the subject is asked to indicate whether the provided answers to simple addition problems (the sum of four two-digit numbers) are correct or incorrect. The subject is given 6 minutes to complete 70 problems. As indicated by the STAMAT manual, the score was total number correct minus total number incorrect. Thus the maximum score was 70.

2. STAMAT Form OA Word Fluency - the subject is asked to write down as many words as possible that begin with the letter "s" within 5 minutes. The score was total number correct, as indicated by the STAMAT manual.

Reliability coefficients were computed for the five original STAMAT scales (Recognition Vocabulary, Figure Rotation, Letter Series, Number Addition, and Word Fluency) over seven-year periods (1956 to 1977) for 1,063 individuals, ages 22 to 84 (Schaie, 1985). Test-retest reliability coefficients for the five subscales ranged from .72 to .86. Analyses of the two newer scales, Object Rotation and Word Series, over three years yielded test-retest coefficients of .80 and .86, respectively. The STAMAT measures five distinct primary mental abilities, as supported by the relatively low intercorrelations between the five original subscales. In the correlations reviewed by Schaie in the STAMAT manual, no subscale was shown to share more than 50% of its variance with another subscale.

Reliability coefficients for the WAIS-R Vocabulary subtest were .94 to .96 when computed as split-half correlations (corrected by the Spearman-Brown formula) from scores obtained from subjects, ages 16 to 74 (Wechsler, 1981). Test-retest reliability coefficients for this subtest were .93 at ages 25 to 34, and .91 at ages 45 to 54.

Salthouse (1993) reported reliability estimates for the Letter Comparison and Pattern Comparison tests using the Spearman-Brown formula for a sample of 100 college students, and a second sample of 305 adults, ages 19 to 84 years. The reliability coefficients for Letter Comparison were .83 for both samples, while Pattern Comparison reliability was .85 for the college sample, and .90 for the adult sample.

Task-specific self-efficacy was assessed using the Intellectual Self-Efficacy Questionnaire (ISEQ; see Appendix B). This scale, designed specifically for the present study, is based on the Memory Self-Efficacy Questionnaire, which has satisfactory psychometric properties (MSEQ; Berry, et al., 1989). The ISEQ consists of eight subscales that correspond to eight of the psychometric cognitive tests that were administered to subjects: Recognition Vocabulary, Figure Rotation, Object Rotation, Letter Series, Word Series, Number Addition, and Word Fluency from the STAMAT Form OA; and the WAIS-R Vocabulary test. Each subscale presents a series of statements that describes levels of performance relating to the corresponding intellectual measure. The first statement in the series describes the easiest level of performance, with subsequent statements describing increasingly difficult task levels. For example, the first statement from the Figure Rotation subscale reads, "If I were given a set of 20 target figures to work on for five minutes, I could identify which figures were like the target figure but rotated in different directions for 1 to 3 of the figures." The next statement of this scale asks about identifying the figures for 4 to 6 of the target figures--and so forth up through all 20 target figures. For each statement, subjects are asked to indicate if they think they could perform the task described at each level by circling no or yes. If they circle yes, they are asked to rate their certainty by circling a confidence rating on a provided scale that ranges from 10% to 100%, in 10 unit increments. Each ISEQ subscale provides detailed examples describing the tasks. Following the scoring procedure used in the MSEQ, task-specific self-efficacy level (SEL) was obtained by summing the yes responses within each subscale, while task-specific self-efficacy strength (SEST) was calculated by averaging confidence ratings within each subscale. In addition to calculating task-specific self-efficacy, domain-specific SEL and SEST were computed when SEL and SEST scores for the two subscales of a particular domain were shown to highly correlate ($r \geq .70$).

Self-rated speed was assessed with three items; each item inquired about the subject's speed in performing tasks of increasing complexity. Subjects were asked to rate their speed for each item on a 7-point Likert scale in which 1 = very slow, 4 = average, and 7 = very fast. For example, the second item read, "How would you rate your speed in completing slightly more complex tasks, like scanning a group of shapes to determine which ones are the same?" These three questions made up the battery item entitled "Questionnaire" (see Appendix C).

The Post-test Questionnaire consisted of 20 items on 7-point Likert scales (see Appendix D). Subjects were asked to rate both their familiarity with (1 = not at all familiar, 4 = somewhat familiar, 7 = very familiar) and performance on (1 = very poor, 4 = average, 7 = very good) each of the six cognitive tasks corresponding to the primary domains in question (i.e., STAMAT Recognition Vocabulary, WAIS-R Vocabulary, STAMAT Figure Rotation, STAMAT Object Rotation, STAMAT Letter Series, and STAMAT Word Series). Subjects were also asked to individually rate the difficulty of these six tasks (1 = very easy, 4 = moderately easy/difficult, 7 = very difficult). The two remaining items of the Post-test

Questionnaire asked subjects to rate their motivation for doing well on the tests they just completed (1 = not at all motivated, 4 = somewhat motivated, 7 = very motivated), and how much fatigue they experienced in completing the tests (1 = no fatigue, 4 = some fatigue, 7 = extreme fatigue).

As detailed in the Participants section, subjects were also asked to provide background information and rate their health, corrected vision, and corrected hearing.

Procedure

Participants were tested in small groups of approximately 1 to 12 in a classroom setting at the University of Richmond. The test sessions were age-group specific, i.e., younger and older adults were not tested together. Participation involved a one-time session lasting approximately 2 to 2.5 hours.

After reviewing and signing the Informed Consent, participants completed the background information sheet and MSQ, in that order. The Questionnaire, ISEQ, STAMAT, and perceptual speed tasks were then administered. The order of administration was counterbalanced such that half the participants received the Questionnaire first, followed respectively by the ISEQ, the STAMAT and perceptual speed measures, and the remainder received the perceptual speed tasks first, followed by the ISEQ, the STAMAT, and then the Questionnaire. Note that the ISEQ preceded the STAMAT in both conditions. The WAIS-R Vocabulary test and Post-test Questionnaire, in that order, were always the last two items administered. The STAMAT subtests and perceptual speed tasks were timed with a stopwatch.

Prior to ISEQ administration, the experimenter reviewed several ISEQ subscales with the group; a minimum of one verbal, one spatial, and one reasoning subscale was explained in detail. Such procedures were followed to ensure that participants fully understood what they were being asked. The participants were then asked to complete the ISEQ, with a reminder to ask clarification questions as needed.

The STAMAT subtests were administered in the order in which they appear in the STAMAT Form OA booklet: Recognition Vocabulary, Figure Rotation, Object Rotation, Letter Series, Word Series, Number Addition, and Word Fluency. As directed in the STAMAT Manual, the general instructions were read to the participants before test administration. Before each test was administered, the experimenter read the instructions for each while the participants followed along in their test booklets. The STAMAT booklet presents several detailed example problems for each subtest. The experimenter asked the participants to work out the examples, and provided assistance as needed. The experimenter pointed out that assistance would not be given during the timed portions of the STAMAT.

The two perceptual speed tasks were administered in invariant order with the Pattern Comparison test preceding the Letter Comparison test. Test instructions were read to the participants before each test. The experimenter asked participants if they understood what they were being asked to do before proceeding with test administration, encouraging questions as appropriate.

After completion of the psychometric measures, all subjects were debriefed regarding the nature of the study, and given an opportunity to ask questions.

Refer to Appendix E for a complete listing of the questionnaires and psychometric measures in the order in which they were administered.

Results

Order Effects

Before considering the primary analyses, the potential effects of the order of task and questionnaire presentation were examined. The order of administration was counterbalanced such that half the participants received the Questionnaire first, followed respectively by the ISEQ, the STAMAT and perceptual speed measures (Condition 1), while the remainder received the perceptual speed tasks first, followed by the ISEQ, the

STAMAT, and then the Questionnaire (Condition 2). The presentation of the WAIS-R Vocabulary test and Post-test Questionnaire did not vary; these items were always administered last, respectively. Four separate 2 X 2 (Age Group X Condition) multivariate analyses of variance (MANOVAs) were conducted to assess possible order effects. The first MANOVA addressed the impact of condition on cognitive performance; thus the eight intellectual tasks and two perceptual speed tasks served as the dependent variables. Nonsignificant multivariate Fs for condition and Age Group X Condition indicated that the order of administration had no significant impact on either intellectual task or speed task performance. Two separate MANOVAs were performed to assess order effects on self-efficacy level (SEL) and self-efficacy strength (SEST) variables. Again, the main effect of condition, as well as the interaction of Age Group X Condition, were nonsignificant at the multivariate level, indicating that order did not significantly affect self-efficacy ratings. The last MANOVA examined the effects of order on Questionnaire responses. The three items of the Questionnaire described paper-and-pencil tasks of increasing complexity, and asked subjects to rate their speed in performing such tasks on a 7-point Likert scale, in which 1 = very slow, 4 = average, and 7 = very fast (see Appendix C); these three items served as the dependent variables in the analysis. The main effect for condition was nonsignificant at the multivariate level. The Age Group X Condition term, however, was significant, multi-F $(3, 94) = 3.76$, $p < .05$. Inspection of the univariate Fs revealed that only the second Questionnaire item (Item 2) was affected by order of administration, $F(3, 94) = 11.30$, $p < .01$. Item 2 read "How would you rate your speed in completing slightly more complex tasks, like scanning a group of shapes to determine which ones are the same?". T-test analyses indicated that, when rating their speed before the ISEQ, the STAMAT, and the perceptual speed measures (Condition 1), younger and older adults did not differ in their Item 2 responses; however, when rating their speed after the ISEQ, the STAMAT, and the perceptual speed measures (Condition 2), younger adults endorsed significantly higher speed levels than older adults on this item, $t(48) = 5.79$, $p < .001$ ($M = 5.16$, $SD = 0.75$ for young; $M = 3.40$, $SD = 1.32$ for old). The example task described in Item 2 is quite similar to the Pattern Comparison test, one of the perceptual speed measures actually performed by the subjects of this study. Thus it is speculated that the Condition 2 age differences found on this item reflect the process of participants looking to their recent performance on the Pattern Comparison task as a source of information when responding to Item 2; the participants of Condition 1 had no such recent experiences with this speeded task by which to gauge their responses. Indeed, the Condition 2 age differences found on Item 2 correspond to the pattern of age differences found on Pattern Comparison: Younger adults significantly outperformed older adults on this task, $F(10, 87) = 93.29$, $p < .001$ ($M = 18.51$, $SD = 3.78$ for young; $M = 11.69$, $SD = 3.18$ for old). This order effect impacting Questionnaire Item 2 responses was considered during all subsequent analyses involving this item.

Age Differences in Cognitive Performance

A one-way multivariate analysis of variance (MANOVA) was performed to assess age differences in intellectual performance before adjusting for speed differences. The independent variable was age group (young and old), and the dependent variables were the eight intellectual measures and two perceptual speed measures. The main effect for age group was significant at the multivariate level, $F(10, 87) = 35.98$, $p < .001$. Table 1 displays the descriptive statistics and the p values which denote the significance of the univariate Fs for the cognitive measures by age group before accounting for perceptual speed. As shown in Table 1, age differences were obtained in the expected direction on the measures of spatial and reasoning abilities, and perceptual speed. Specifically, younger adults outperformed older adults on Figure Rotation, Object Rotation, Letter Series, Word Series, and both measures of perceptual speed. As predicted, no age differences were detected on the untimed WAIS-R Vocabulary test; however, this same finding for the Recognition Vocabulary test was not expected, considering its highly speeded nature.

To allow for examination of age differences in cognitive performance at the domain levels (spatial, reasoning, verbal, perceptual speed), composite variables were computed when the two measures assessing a given domain were found to correlate highly ($r \geq .70$). Composites were calculated by first transforming raw performance scores to z scores, and then averaging the z scores across measures corresponding to the domain in question. Thus composite domain scores were created using the following variables: Figure Rotation and Object Rotation ($r = .82$) were combined to form the spatial performance score; Letter Series and Word Series ($r = .92$) were combined to create the reasoning performance score; and Pattern Comparison and Letter Comparison ($r = .80$) were combined to form the perceptual speed composite. A verbal performance composite was not created, as the correlation between Recognition Vocabulary and WAIS-R Vocabulary ($r = .52$) was not high enough to warrant this. Thus the two vocabulary measures were treated as separate variables for all analyses. The lower correlation found between the vocabulary performance variables is not surprising when one considers the distinct aspects of the two verbal measures (i.e., a highly-timed recognition task versus an untimed open-ended response task), compared to the highly similar formats of the Figure and Object Rotation tests, and the Letter and Word Series tests, respectively.

In order to examine age-related patterns of performance for the domains or constructs of interest, a MANOVA was performed in which age group served as the independent variable, and spatial performance, reasoning performance, and perceptual speed served as the dependent variables; the two verbal measures were included as dependent variables as well. This analysis, significant at the multivariate level, $F(5, 94) = 47.63$, $p < .001$, revealed patterns of age-related performance identical to those yielded by examination of age differences at the task level; that is, no age differences were detected for either verbal measure, while younger adults displayed higher levels of performance for spatial ability, F (5, 94) = 95.72, $p < .001$, reasoning ability, F (5, 94) = 168.09, $p < .001$, and perceptual speed, F (5, 94) = 123.26, $p < .001$. Figure 1 provides a visual summary of these age-related patterns of performance obtained before accounting for perceptual speed. Performance means of the younger and older adults are plotted for the two verbal measures, the spatial domain, and the reasoning domain; all means are in z score form to allow for comparison of age-performance patterns across domain.

As speed was hypothesized to mediate the relationship between age and cognitive performance, a multivariate analysis of covariance (MANCOVA) was planned to assess age differences in performance while controlling for perceptual speed. These analyses were intended to test Hypothesis 1, which predicted that, when perceptual speed differences were controlled, younger adults would outperform older adults on both the spatial and reasoning tasks, while older adults would perform at equal or higher levels than younger adults on the two verbal tasks. A critical assumption of the MANCOVA procedure, however, is that the linear relationships, or regression slopes, between the covariate and the dependent variable be homogeneous for all levels of the independent variable; if this assumption of homogeneity of regression is not met, MANCOVA is not a suitable analysis (Stevens, 1990; Tabachnick & Fidell, 1996). Thus in the case of the present analyses, the slope between the proposed covariate--speed--and intellectual performance must be the same for younger and older adults for MANCOVA to be appropriate. Hierarchical multiple regression analyses were employed to test this assumption. Four analyses were conducted in which spatial performance, reasoning performance, Recognition Vocabulary, and WAIS-R Vocabulary served as separate criterion variables. The predictor variables, age group and perceptual speed, were entered first, followed by the interaction term, Age Group X Perceptual Speed. The interaction term was found to be significantly related to spatial performance, Recognition Vocabulary, and WAIS-R Vocabulary, all Fs $\geq$ 4.48, all ps < .05. No interaction was detected for reasoning performance. The significant Age Group X Perceptual Speed interactions indicated that the regression slopes between speed and cognitive performance for the spatial composite and the two vocabulary measures were different for younger and older adults; consequently, the proposed use of MANCOVA to examine age differences in spatial and vocabulary performance while controlling for speed was inappropriate. Thus Hypothesis 1, as stated, could not be tested for three out of the four cognitive variables of interest. As a result, addressing the question of age differences in spatial and vocabulary performance was limited to the examination of age-related performance before controlling for speed. As noted earlier and displayed in Figure 1, such examination yielded age differences on these variables in the predicted direction; that is, younger adults outperformed older adults in the spatial domain, while no age differences were detected for either vocabulary measure.

As noted above, an Age Group X Perceptual Speed interaction was not detected for reasoning performance. Thus the homogeneity of regression assumption was met for this variable and a one-way analysis of covariance (ANCOVA) was employed to examine age differences in reasoning performance while statistically "equalizing" younger and older adults on perceptual speed. Such analyses served to test the portion of Hypothesis 1 concerning the reasoning domain. Age group served as the independent variable, and the reasoning composite was the dependent variable; perceptual speed served as the covariate. In support of Hypothesis 1, age differences favoring younger adults persisted for reasoning performance after controlling for perceptual speed, $F(1, 97) = 31.09$, $p < .001$.

In addition to providing guidance about the appropriateness of MANCOVA, the Age Group X Speed interactions found for the spatial and verbal variables, discussed above, are interesting on their own, as they imply that speed affected the spatial and verbal performance of younger and older adults in different ways. In an attempt to discern the nature of these Age Group X Speed interactions, three multiple regression analyses were conducted separately for the younger and older samples, with speed predicting spatial, Recognition Vocabulary, and WAIS-R Vocabulary performance. These analyses essentially tested for the effects of individual differences in speed on intellectual performance, within age groups. Comparison of the younger and older regression equations for spatial performance, Recognition Vocabulary, and WAIS-R Vocabulary revealed a clear pattern: Speed was a significant predictor of performance for all three of these performance variables for older adults, including the untimed WAIS-R Vocabulary task, all $Fs \geq 6.24$, all $p < .05$, while speed failed to predict any of the three performance variables in younger adults. The differential relationships between speed and performance on the spatial and vocabulary tasks for younger and older adults were also evident by examining the corresponding bivariate correlations for the two age groups presented in Table 2; perceptual speed was significantly related to all four performance variables within the older adults, but only to reasoning performance within the younger adults. It is tempting to draw conclusions based on these regression and correlation analyses; indeed, it appears that older adult spatial and verbal performance is affected by, or at least varies with, speed while younger adult performance in these domains is not. As discussed by Salthouse (1991b), however, care must be taken when interpreting such interactions in terms of differential effects of process variables, e.g., speed, across age. Because such cautions are relevant to the interpretation of the present interactions, they are considered further in the Discussion section.

Age Differences in Intellectual Self-Efficacy

Task-specific intellectual self-efficacy level (SEL) and strength (SEST) were examined for age differences by employing two MANOVAs. The first MANOVA assessed the eight SEL subscales that correspond to the eight intellectual tasks of this study (listed in Table 3) as dependent variables, with age group (young and old) as the independent variable. A significant main effect, F (8, 86) = 2.58, $p < .01$, pointed to age differences on seven of the eight SEL subscales at the univariate level. As displayed in the left side of Table 3, younger adults endorsed significantly higher levels of self-efficacy for all intellectual tasks except Recognition Vocabulary, for which no age differences were detected. Age-related patterns of SEST were examined with a second MANOVA; again, the independent variable was age group, and the dependent variables were the eight SEST subscales corresponding to the specific intellectual tasks later administered. This analysis demonstrated age differences favoring the younger adults for all eight of the SEST subscales, multi-F (8, 82) = 5.41, $p < .001$; younger adults endorsed higher SEST for all of the intellectual tasks described by the ISEQ, including Recognition Vocabulary (see the right side of Table 3).

According to Bandura (1977), the most precise information regarding an individual's efficacy expectations for a given task comes from an examination of self-efficacy endorsements at that same level, i.e., the task-specific level. Thus, based on Bandura's methodology, all self-efficacy judgments assessed by the ISEQ correspond to the specific intellectual tasks later administered. The primary purposes of measuring self-efficacy in the present study, however, were to both assess older adults' awareness of the differential decline typically seen in intellectual performance across the lifespan, and to examine self-efficacy's mediating effects, if any, on the relationship between age and intellectual performance. Motivated by the domain-specific findings of the "classic aging pattern" (Botwinick, 1977) described earlier, these research questions are not fully addressed by the strictly "microanalysis" approach of examining self-efficacy-performance relationships advocated by Bandura. Thus age-related patterns of SEL and SEST at the domain or construct level were also of interest. To allow for such examination, composites were created when the two SEL or SEST subscales assessing a given domain were found to correlate highly ($r \geq .70$). Because the self-efficacy judgments comprising these composite scores are task-specific endorsements, it is believed that the benefits of task-specificity described by Bandura were not lost due to this combining of ISEQ subscales.

Composites were calculated by computing z scores for the SEL and SEST measures, and then averaging the z scores of the two SEL and SEST scales corresponding to a given domain. Specifically, composites were created for the following self-efficacy variables: Spatial SEL was calculated by averaging Figure Rotation and Object Rotation SEL ($r = .88$); spatial SEST was calculated by averaging Figure Rotation and Object Rotation SEST ($r = .87$); reasoning SEL was obtained by averaging Letter Series and Word Series SEL ($r = .77$); and reasoning SEST was computed by averaging Letter Series and Word Series SEST ($r = .87$). Composite SEL and SEST scores were not computed for the vocabulary domain, as the correlations between STAMAT Recognition Vocabulary and WAIS-R Vocabulary SEL ($r = .56$) and SEST ($r = .69$) were below criterion. Thus the four verbal self-efficacy scores were treated as separate variables for all analyses. Again, it is likely that the lower correlations found between the vocabulary self-efficacy variables reflect the distinct formats of the two verbal measures. It should be noted that these patterns of correlations dictating the formation of composite self-efficacy variables were the same as those yielded by correlations of the performance variables. Thus the self-efficacy composites correspond to the performance composites described earlier.

To test Hypothesis 2, a MANOVA examining SEL and SEST at the domain level was performed. Hypothesis 2 predicted that differential age patterns would be obtained on self-efficacy measures based on the domain being assessed. Specifically, it was hypothesized that younger adults would endorse higher spatial and reasoning self-efficacy than would older adults, while older adults would demonstrate levels of verbal self-efficacy equal to or higher than that of younger adults. Age group served as the independent variable, and the following self-efficacy variables served as dependent variables in this analysis: spatial SEL, spatial SEST, reasoning SEL, reasoning SEST, Recognition

Vocabulary SEL, Recognition Vocabulary SEST, WAIS-R Vocabulary SEL, and WAIS-R Vocabulary SEST. As expected, the analysis was significant at the multivariate level, $\underline{F}$ (8, 82) = 4.92, $\underline{p} < .001$. The univariate $\underline{F}$s yielded age patterns of self-efficacy endorsements parallel to those found at the task level; that is, age differences favoring younger adults were found for virtually all of the SEL and SEST variables, all $\underline{F}$s > 5.10, all $\underline{p}$s < .05; the exception was Recognition SEL, on which no age differences were found. Figure 2 visually displays the age-SEST relationships for the spatial and reasoning domains, and the two verbal tasks, Recognition Vocabulary, and WAIS-R Vocabulary. As SEST scores are obtained by averaging confidence ratings (from 10% to 100%) within each ISEQ subscale, percentages are used to indicate mean self-efficacy ratings on the $\underline{Y}$ axis; percentages were chosen as the unit of measurement over $\underline{z}$ scores to enhance the conceptual information conveyed by this figure. The higher SEST scores obtained by the younger adults for the spatial, reasoning, and verbal (represented by the two verbal tasks separately) domains are evident by the negative slopes for all variables across age group. A figure depicting age differences in SEL was not included, as SEST was the self-efficacy variable used for all subsequent analyses. As conveyed in Figure 2, the differential age patterns of self-efficacy, predicted by Hypothesis 2, were not demonstrated by this analysis.

Predictors of Intellectual Performance Examined Through Multiple Regression

Overview. A series of hierarchical multiple regression analyses were planned with the following aims in mind: 1) to determine the mediating effects of intellectual self-efficacy on the relationship between age and cognitive performance after the effects of speed are partialled out, and 2) to examine the unique relationship of age group, speed, and intellectual self-efficacy with cognitive performance in the three domains of interest. To address these questions, four separate multiple regression analyses were planned in which each of the following performance variables were to serve as the criterion variables: spatial performance, reasoning performance, Recognition Vocabulary, and WAIS-R Vocabulary.

Each analysis was to consist of three steps, with age group entered in the first step, perceptual speed entered in the second, and the corresponding SEST score entered last. It was decided that for all regression analyses, SEST scores would be used as measures of self-efficacy for each domain or cognitive task in question over SEL, as SEST scores convey the amount of confidence in efficacy judgments the subject endorsed for each task; this measure was considered the richer source of self-efficacy information of the two for the given analyses. The first goal of the analyses involved assessing both perceptual speed and intellectual self-efficacy as mediators of age-cognition relationships. As Salthouse (1992a) described, the influence of a hypothesized mediator can be assessed by determining the degree to which age-related variance is attenuated (and thus explained) as a result of controlling for the potential mediator. The second aim of the analyses, which sought to elucidate the unique contribution of age group, speed, and intellectual self-efficacy to cognitive performance, involved determining if and how each of these variables significantly predicted additional, unique variance after the other two predictors were partialled out of the regression equations.

A crucial aspect of the mediational analyses described above, however, is examining age-related variance in cognitive performance after partialling out the effects of the hypothesized mediators, i.e., speed and intellectual self-efficacy. Thus the same Age Group X Speed interactions that precluded the use of MANCOVA to partial out the effects of speed posed serious problems for the analyses intended to test whether speed mediated the relationship between age group and cognitive performance. Recall that significant Age Group X Speed interactions were obtained for spatial performance, Recognition Vocabulary, and WAIS-R Vocabulary, but not reasoning performance. As a result of these findings, Hypothesis 3, which predicted that perceptual speed partially mediates the relationship between age and intellectual performance, could not be tested for three out of the four cognitive variables in question.

Intellectual self-efficacy was also hypothesized to mediate the age-cognition relationship. As with speed, any significant Age Group X SEST interactions would preclude partialling out task-specific intellectual self-efficacy, as planned. In a series of hierarchical regression analyses using the interaction term, no significant Age Group X SEST interactions were detected for the four cognitive variables of interest. Thus, intellectual self-efficacy predicted performance similarly in younger and older adults. Hypothesis 4 predicted, however, that task-specific intellectual self-efficacy partially mediates the relationship between age and intellectual performance when differences in perceptual speed are controlled. That is, it was hypothesized that self-efficacy would account for additional age-related variance in cognitive performance above and beyond that due to speed. Note that Hypothesis 4 concerns the influence of intellectual self-efficacy on age-cognition relations after the effects of speed are removed. Thus again, the obtained Age Group X Speed interactions proved problematic for the intended analyses. Consequently, Hypothesis 4 could not be tested as stated for three out of the four cognitive variables under examination.

It was determined that Hypotheses 3 and 4 would be tested for reasoning performance alone, the cognitive variable for which no Age Group X Speed interactions were obtained. However, curiosity regarding the mediating influence of speed and task-specific self-efficacy on age-related spatial and vocabulary performance remained. Thus it was decided to test these effects within the older adults only. Though such analyses would not allow for the younger-older adult comparisons that were planned, the age range of the older sample (ages 60 to 87 years) was seen as adequate to assess possible contributors to age-cognition relationships within the older adults. Any interactions between the continuous older age variable and either hypothesized mediator, however, would preclude mediational analyses within the older adults due to the homogeneity of regression assumption. Accordingly, a series of hierarchical regression analyses was performed to determine whether such interactions were present. These analyses failed to detect any Age X Speed or Age X SEST interactions for the four performance variables within the older adults. With this assurance, regression analyses were conducted to ascertain the mediating roles of speed and intellectual self-efficacy in age-cognition relationships for spatial, Recognition Vocabulary, and WAIS-R Vocabulary performance. Reasoning performance was included as a criterion variable in these analyses as well, to allow for comparison of the mediational influences on age-cognition relationships across both age groups, and within the older adults. The results of these mediational analyses are presented in the subsections that follow. The mediating roles of speed and intellectual self-efficacy were not examined within the younger age group alone due to the restricted age range of the younger sample (ages 18 to 22 years).

The Age Group X Speed interactions described above did not pose problems for the second goal of the regression analyses, which was to determine if and how age group, speed, and intellectual self-efficacy uniquely and significantly contributed to intellectual performance in both younger and older adults. Again, these results are indicated by the final regression equations for the three domains of interest, and are presented below.

Perceptual speed and intellectual self-efficacy as mediators of the age-reasoning performance relationship in younger and older adults. As described above, ANCOVA demonstrated that age differences favoring younger adults remained in reasoning performance after controlling for perceptual speed. It cannot be concluded from the ANCOVA results, however, that speed differences in younger and older adults did not somehow impact, or partially mediate, the relationship between age group and reasoning performance. Hypothesis 3 predicted that speed indeed would partially mediate the relationship between age and intellectual performance. The remaining age differences found in reasoning performance after adjusting for speed, however, suggest that other factors were contributing to the age-related patterns of performance found in this domain.

Was task-specific self-efficacy partially mediating this relationship between age and intellectual performance after the effects of speed were removed, as predicted by Hypothesis 4?

Hierarchical regression was employed to test the portions of Hypotheses 3 and 4 that concerned the reasoning domain. As noted earlier, the influence of a hypothesized mediator can be evaluated by examining the amount by which age-related variance is attenuated as a result of controlling for the potential mediator. For example, if partialling out variable x reduced age-related variance of reasoning ability by 60%, it would be concluded that variable x is most likely an important mediator of the relationship between age and reasoning ability (Salthouse, 1992). Salthouse provided "tentative guidelines" (p. 26) regarding how significant a mediator's influence is, e.g., whether the influence is "small," "interesting," "important," and so forth. These guidelines were considered when examining the effects of the hypothesized mediators (i.e., speed and self-efficacy) in the present analyses.

Thus, as initially planned, reasoning performance served as the criterion variable, and the three predictor variables, age group, perceptual speed, and reasoning SEST, were entered in separate steps, respectively. These separate steps allowed for examination of initial, or "unpartialled" performance variance associated with age, and the change in this age-related variance after each of the two proposed mediators was partialled out. The unique age-related variance remaining after the other variables were accounted for was determined by the squared semipartial correlations (sr^2) for age group at Steps 2 and 3. Table 4 displays the summary findings of the multiple regression analysis. R^2 reflects the total amount of variance in reasoning performance accounted for by the variables in the equation at that step. sr^2 indicates the squared semipartial correlation between the predictor variable of that row and the criterion variable, after all the variables of that step have been entered; thus the sr^2 of the "new" variable of each step reflects the increment in R^2

associated with that added variable. The last two columns of Table 4 display the Fs and corresponding p levels, which assess either the significance of the increment in R^2, or the significance of the total set of predictor variables. The R^2s, Fs, and ps are provided for both the "new" variables of each step, and the total set of predictors. Of particular interest was the reduction of age-related variance, reflected by the sr^2, when the effects of speed and SEST were removed.

In examining Table 4, it is clear that controlling for perceptual speed served to considerably reduce age-related variance in reasoning performance: The R^2 associated with age group alone was reduced from .65 to an sr^2 of .09 when speed-associated variance was removed. Thus partialling out perceptual speed reduced age-related variance by 86%. The influence of speed as a mediator on the age-reasoning performance relationship, as reflected by the magnitude of this reduction, is considered "definitely major," according to Salthouse's (1992a) guidelines. Hence, in support of the portion of Hypothesis 3 concerning the reasoning domain, it was concluded that perceptual speed partially, and quite substantially, mediated the relationship between age and reasoning performance in the present study.

To evaluate intellectual self-efficacy as a mediator of the relationship between age group and reasoning performance after accounting for speed, reasoning SEST was entered into the regression analysis after both age group and perceptual speed. As depicted by the unchanged sr^2 of age group for Steps 2 and 3, partialling out SEST did not result in any further attenuation of age-related variance after the effects of speed were controlled (see Table 4). Thus no support was found for the reasoning portion of Hypothesis 4, which predicted that self-efficacy would partially mediate the relationship between age group and reasoning performance after the effects of perceptual speed were controlled.

Age group, perceptual speed, and intellectual self-efficacy as predictors of intellectual performance in younger and older adults. In addition to addressing the mediational analyses described above, regression analyses also provided valuable information regarding the predictive merit of age group, speed, and intellectual self-efficacy (as measured by SEST) for intellectual performance in the spatial, reasoning, and verbal domains. Hierarchical regression analyses, in which the four performance variables of interest served as criterion variables, were conducted. For each analysis, age group, speed, and SEST were used as predictors in three separate steps, respectively. To ascertain the inter-relationships of the three predictors, additional regression analyses were conducted in which speed and each of the SEST variables served as criterion variables in turn, and age group and either speed or SEST (depending on the criterion) served as predictor variables. To visually summarize the final unique relationships of the predictor variables with the criterion and each other, path diagrams are provided (Figures 3 through 6) for each of the four performance variables. The partial regression or beta coefficients, taken from the final step of each regression, are listed on the paths connecting the two corresponding variables, and the bivariate correlations are displayed in parentheses. The R^2 of the last step of each of the regression analyses in which a performance variable served as the criterion is displayed in the corner of each figure, indicating the total percent of variance accounted for in each performance variable.

As indicated by the R^2s of the four paths, the combined predictive power of age group, speed, and SEST varied greatly for the cognitive variables of interest. The predictors explained over half of the performance variance in the two domains of fluid abilities (54% and 74% for spatial and reasoning, respectively), while they accounted for less than a fifth of the variance in vocabulary performance (16% and 14% for Recognition Vocabulary and WAIS-R Vocabulary, respectively).

Closer examination of the paths and their betas reveals some interesting patterns between the predictors and performance variables. Age group, for example, proved to be the most powerful predictor of cognitive performance for spatial, reasoning, and, surprisingly, Recognition Vocabulary performance, after controlling for speed and SEST, as displayed in the four diagrams. For the spatial and reasoning domains, however, controlling for speed and SEST did serve to considerably reduce the performance variance associated with age group, as can be seen by comparing the zero-order correlations and partial betas between age group and performance for these two variables (-.70 to -.46 for spatial and -.81 to -.47 for reasoning performance). These results suggest age differences in speed and/or SEST contributed to the relationship found between age group and performance in these two variables. Indeed, as discussed above, mediational analyses indicated that perceptual speed substantially mediated the relationship between age group and performance in the reasoning domain. Recall that SEST failed to further mediate this age group-performance relationship; thus the "explanation" of age-related reasoning performance variance depicted in Figure 4 is primarily due to accounting for speed, rather than partialling both speed and SEST together. Such conclusions regarding the possible mediating effects of speed and SEST on age-related performance variance cannot be discussed for spatial domain, however; again, the Age Group X Speed interaction obtained for spatial performance described earlier precludes the partialling of speed for the purposes of mediational analyses. Unfortunately, the same Age Group X Speed interaction for Recognition Vocabulary prevents drawing conclusions regarding speed and SEST's mediating effects on the age group-performance relationship that is suggested by the considerable increase in age-related performance variance in Recognition Vocabulary (from .06 to .40) that resulted when these two variables were partialled, as displayed in Figure 5. It is interesting to note that the change in the relationship between age group and performance, from nonsignificant to significant and positive, $t\,(93) = 2.74$, $p < .01$, which indicates that older age was associated with higher Recognition Vocabulary performance, is congruent with the direction of the "classic aging pattern," in which verbal abilities tend to be maintained or even increase as individuals age. The same pattern did not emerge for

WAIS-R Vocabulary: Though it appears that partialling out speed and SEST served to increase age-related variance slightly (from -.09 to .14), the age-performance relationship remained nonsignificant.

Speed, which was related to three out of the four performance variables at the bivariate level, was a significant predictor for just reasoning performance after age group and SEST were partialled out. These results suggest that the significant bivariate relationships between speed and performance obtained for the other two variables, spatial and WAIS-R Vocabulary performance, were wholly due to the influence of age group and SEST. Indeed, upon examination of the path diagrams, one observes strong age group-speed, and, unexpectedly, speed-SEST relationships for all four performance variables; thus it is possible that speed's relationship to spatial and WAIS-R Vocabulary performance at the bivariate level was due to speed's shared variance with age group and SEST. These two performance variables, however, are two of the three criterion variables for which Age Group X Speed interactions were observed. Though it is interesting to speculate how these interactions may be related to the lack of a direct relationship between speed and cognitive performance, they also hinder drawing conclusions regarding the mediational role age group (and SEST, because age group was always partialled before SEST) may have played in the speed-performance relationships for the spatial domain and WAIS-R Vocabulary. For reasoning, however, no such interaction was obtained to prevent concluding that age group and/or SEST partially mediated, or contributed to, the relationship between speed and performance; this is evidenced by the reduction in the speed-performance relationship after age group and SEST were partialled (from .80 to .37; see Figure 4). Despite this attenuation, speed remained a significant predictor of reasoning performance, $\underline{t}$ (94) = 4.28, $p < .001$, as noted earlier.

The only predictor that was significantly related to all four cognitive performance variables, both at the bivariate and "partialled" levels, was SEST. For WAIS-R

Vocabulary, SEST was the only predictor that was significant when the other two predictors were partialled; thus it can be concluded that WAIS-R Vocabulary SEST was a significant and unique predictor of WAIS-R Vocabulary, accounting for 14% of variance in this criterion. Examination of the SEST-performance paths of Figures 3 through 6 shows that partialling speed and age group from performance had differential effects on the relationship between self-efficacy and performance in the various cognitive domains: For spatial and reasoning performance, accounting for age group and speed served to considerably reduce, or partially explain, the relationship between SEST and performance (.52 to .18 for spatial, and .52 to .13 for reasoning performance); for the two vocabulary measures, however, partialling the two predictors had virtually no effect on the strength of the SEST-performance relationship (.31 to .32 for Recognition Vocabulary, and .35 to .33 for WAIS-R Vocabulary). Such a pattern indicates that self-efficacy's relationship to performance was more direct in the verbal domain than in either the spatial and reasoning domains; that is, SEST shared more unique variance with performance, independent of age group and speed, in the verbal domain than in the other two cognitive domains.

The unexpectedly strong relationship between speed and SEST, mentioned earlier, is evident upon examining the speed-SEST paths of the four diagrams. Speed and SEST were positively related, both at the bivariate level and after the partialling of age group, for three out of four of the cognitive variables; the exception was WAIS-R Vocabulary, for which speed and SEST's relationship, present at the bivariate level, was eliminated after controlling for age-group variance. These findings indicate that, although age group may have contributed to these speed-SEST relations, speed and SEST were uniquely related in the spatial and reasoning domains, and in Recognition Vocabulary. As is evident upon comparing the partial betas of the speed-to-SEST and the SEST-to-speed paths of Figures 3 through 5, speed was a more significant predictor of SEST than vice versa. That is, after accounting for age-related variance, speed explained more variance in self-efficacy than self-efficacy explained in speed. These intriguing speed-SEST relationships and the implications of such for the relationships obtained between age group and self-efficacy are examined in more detail later in the presentation of results, as well as the Discussion section.

In summary, age group, speed, and intellectual self-efficacy predicted intellectual performance differentially for the four cognitive variables of interest. Age group was the most significant predictor for spatial, reasoning, and Recognition Vocabulary, after partialling out speed and SEST, while SEST was the only significant predictor of WAIS-R Vocabulary performance, after controlling for the influence of age group and speed.

Perceptual speed and intellectual self-efficacy as mediators of age-cognition relationships in older adults. As noted earlier, the questions regarding the mediating role of speed and self-efficacy on age-related spatial and vocabulary performance, which could not be examined for the entire sample due to the Age group X Speed interactions obtained, prompted further mediational analyses within the older age group only. Thus four separate regression analyses were performed with each of the following variables serving as the criterion: spatial performance, reasoning performance, Recognition Vocabulary, and WAIS-R Vocabulary. Each analysis comprised three steps in which age (a continuous variable within the older adult sample ranging from 60 to 87 years), perceptual speed, and SEST were entered, respectively. Table 5, the format of which is identical to Table 4, displays the results of these regression analyses. Table 6 provides the bivariate correlations of the variables used for each of the analyses. The unpartialled age-related variance for each performance variable is indicated by the R^2 of age at Step 1. By examining this column of Table 5 for the four criterion variables, it can be seen that the pattern of cognitive performance within the older adults matches the performance patterns between the younger and older samples; that is, significant age-performance relationships were obtained for both spatial and reasoning performance, while no age differences (as indicated by the lack of age-related variance) were detected on either Recognition Vocabulary or WAIS-R Vocabulary. This pattern is also evident upon examining the zero-order correlations between age and performance displayed in Table 6; the negative direction of the bivariate correlations for both age and reasoning and age and spatial performance indicate that older age was associated with decreased performance in these two domains.

Again, speed and self-efficacy were evaluated as possible mediators by examining the change (or lack thereof) in age-related variance after each was partialled out, as reflected by the sr^2 for age at Steps 2 and 3. A perusal of Table 5 reveals that age-related variance in both spatial and reasoning performance was considerably reduced when perceptual speed was entered into the equation: The R^2 associated with age alone was reduced from .09 to an sr^2 of .01 for spatial performance, and from .16 to an sr^2 of .04 for reasoning performance when speed-associated variance was removed from the respective equations. Thus partialling out perceptual speed reduced age-related variance by 88% and 75% for spatial and reasoning performance, respectively, leaving the variance associated with age nonsignificant for both performance variables. According to Salthouse's 1992(a) guidelines, speed's mediating influence on age-cognition relationships for both spatial and reasoning performance was "definitely major," as indicated by the magnitudes of these reductions. Due to the nonsignificance of age-related variance once speed was controlled, however, it was concluded that speed's influence as a mediator was not only major, but total; speed completely mediated the relationship between age and both spatial and reasoning performance within the older adults of the present study.

What about the possible mediating effects of speed on the age-performance relationships for the two vocabulary measures? Table 5 reflects the lack of age-related variance detected for either vocabulary measure when age was the only variable in the equation (note the initial R^2 of .02 for Recognition Vocabulary and .00 for WAIS-R Vocabulary). Can the influence of a hypothesized mediator of age-cognition relationships be assessed when there is no initial age-related variance present in the cognitive variable of interest? Though not specifically addressed in Salthouse's 1992(a) discussion, it seems that any change in age-related variance brought about by controlling for another variable is informative regarding the impact of that variable on the age-cognition relationship, regardless of whether 1) significant age-related variance is initially present, or 2) that the change is a reduction or an increase. For instance, if speed influences age-related performance on a task in which no age differences are detected, the lack of age-related variance may be due to speed differences favoring younger adults. This seems especially feasible for a highly-timed task, such as Recognition Vocabulary; because vocabulary performance trends across age generally do not match performance patterns found on speed measures, controlling for speed might actually serve to increase age-related variance in vocabulary scores. In such cases, assessment of possible mediators contributing to age-related performance, such as speed, illuminates valuable information regarding the relationship between age and the cognitive variable--information that was "masked" by the influence of the mediating variable. Thus speed, and SEST as well, were not dismissed as possible mediators of age-vocabulary performance relationships because no age-related variance was initially present. The purpose of mediational analyses, however, is to explain age-related variance. Thus it seems that for such analyses to be called for, significant variance related to age must be present either before or after the proposed mediators are entered into the equation. As Table 5 indicates, age-related variance dropped to .00 for Recognition Vocabulary after speed and SEST were entered. For WAIS-R Vocabulary, variance in performance related to age rose slightly (sr^2 = .04) after the effects of speed were controlled, and then dropped to an sr^2 of .02 after SEST was entered; at no point, however, was age-related performance variance significant. So, variance in performance related to age did not become significant, even after controlling for the possible influencing variables, speed and SEST. Consequently, speed and SEST were not assessed as mediators of the age-vocabulary performance relationship in the present investigation.

As displayed in Table 5 partialling out SEST did not result in any further reduction of age-related variance for spatial or reasoning performance (note the unchanging sr^2s for age at Steps 2 and 3); this is not surprising when one observes that age and SEST were not related at the bivariate level for any of the four SEST variables (see Table 6). As noted above, the role of SEST as a mediator was not assessed within the vocabulary domain, due to the lack of age-related variance in the two vocabulary measures.

In summary, regression analyses indicated that speed completely mediated the relationship between age and both spatial and reasoning performance within the older adults of the present study. Intellectual self-efficacy failed to further mediate the relationship between age and performance in either the spatial or reasoning domain. As described earlier, neither speed nor self-efficacy was assessed as a mediator of the age-vocabulary relationship due to the lack of vocabulary performance variance within the older adults of the present study.

Speed-self-efficacy relationships in younger and older adults. As displayed in Table 3 and discussed earlier, significant age differences favoring younger adults were obtained for virtually all of the SEL and SEST variables; the one exception was Recognition Vocabulary SEL, for which no age differences were detected. Though the question regarding the effect of speed on the relationship between age group and self-efficacy was not originally posed, such interest emerged when it was noted that the bivariate correlations between perceptual speed and all individual SEL and SEST variables were significant (all rs > .22, all ps < .05). Speed was related to the four primary SEST variables, namely spatial SEST, reasoning SEST, Recognition Vocabulary SEST, and WAIS-R Vocabulary SEST, at the .01 level. The significant relationships between speed and the SEST variables of interest, both before and after partialling out age group, are also evident upon inspection of the speed-SEST and SEST-speed paths of Figures 3 through 6, with the exception of the direct paths between speed and SEST for WAIS-R Vocabulary, as noted earlier. Were age differences in speed somehow contributing to the age patterns found on the self-efficacy measures? To investigate the possible influence of speed on the age group-SEST relationships, mediational analyses through hierarchical regression were planned, in which the four SEST variables were to serve as separate criterion variables, and age group and speed were to be entered as predictors in two separate steps, respectively. As noted earlier, however, the homogeneity of regression assumption must be met for mediational analyses to be appropriate. In this case, the assumption required that the relationship between speed and the SEST variables were the same for both younger and older adults. Again, significant Age Group X Speed interactions for SEST were obtained for three out of four SEST variables, precluding hierarchical regression analyses to address the question of mediation. WAIS-R Vocabulary SEST was the one SEST variable for which no Age Group X Speed interaction was obtained. As displayed in Figure 6, it appears that speed completely mediated the relationship between age group and WAIS-R Vocabulary SEST, as can be observed by comparing the bivariate correlation coefficient and the partial beta of the age group-SEST path (from -.25, significant at the .01 level, to -.05, nonsignificant). Figure 6 also reveals, however, that once age-related variance was controlled for SEST, speed was not a significant predictor of SEST. Thus it appears that age group mediated, or contributed to, the relationship between speed and SEST as well. The hierarchical regression analysis, in which WAIS-R Vocabulary SEST served as the criterion, supported this effect: Partialling out speed resulted in a 100% reduction in the age-related variance of WAIS-R Vocabulary SEST. Interestingly, though speed and age group combined explained 31% of the variance in WAIS-R Vocabulary SEST, neither alone were significant predictors, as displayed in Figure 6. Such findings indicate that neither age group or speed was uniquely related to SEST--the SEST variance each of these predictors accounted for was also accounted for by the other. Thus, though it appears that speed completely mediated the relationship between age group and WAIS-R Vocabulary SEST, caution must be taken with such an interpretation, due to these findings. These results, along with the Age Group X Speed interactions for the other SEST variables, prevent drawing conclusions regarding the mediational role speed may have played in the age group-SEST relationships obtained in the present study.

Despite what they prevent in terms of mediational analyses, the Age Group X Speed interactions obtained for spatial, reasoning, and Recognition Vocabulary SEST are quite interesting to consider on their own, as they imply that speed and SEST were related differentially for younger and older adults. Indeed, this pattern emerges when one examines the bivariate relationships between speed and the SEST variables for younger and older adults separately; these correlations are provided in Table 7. It can be seen that speed was significantly related to all four SEST variables within the older adults, while the only SEST variable related to speed within the younger adults was reasoning SEST. Thus the observed bivariate relationships between speed and spatial SEST, Recognition Vocabulary SEST, and WAIS-R SEST obtained for the entire sample and discussed earlier are wholly due to the speed-SEST relationships within the older adults. The implications of these Speed X SEST interactions are further considered in the Discussion section.

<u>Other Self-Evaluation Variables</u>

In addition to the self-efficacy endorsements obtained before task performance, participants were asked to respond to other self-evaluative items via the Questionnaire and Post-test Questionnaire, as described in <u>Materials</u> of the Method section.

The Questionnaire consisted of three items that asked subjects to rate their speed in performing tasks of increasing complexity on a 7-point Likert scale, in which 1 = very slow, 4 = average, and 7 = very fast (see Appendix C). Administration of the Questionnaire was counterbalanced such that half the participants completed the

Questionnaire first, while the remainder received the perceptual speed tasks first, followed respectively by the ISEQ, the STAMAT, and the Questionnaire. The purposes of collecting self-rated speed were 1) to ascertain the relationship between self-rated speed and actual speed performance for the total sample, and for younger and older adults separately, and 2) to examine possible age differences in self-perceived speed. Correlational analyses were conducted to examine the relationships between self-rated speed and actual perceptual speed performance. Recall that half the subjects completed the Questionnaire items before the perceptual speed measures (Condition 1), while the other half rated their speed after completing the speed tasks (Condition 2). As displayed in Table 8, distinct patterns between the two conditions emerged when correlational analyses were employed for each condition group separately; thus the two condition groups were not collapsed for Questionnaire analyses, as originally planned. The correlations for the entire sample, displayed in the first two columns of Table 8, indicate a high degree of relationship between all three Questionnaire items and speed performance; further, comparison of Conditions 1 and 2 for the first two items reflect that an even higher degree of relationship was obtained for subjects who rated their speed after having completed the two perceptual speed tasks. These patterns, however, do not hold when the relationships are examined within each age group separately. As reflected in Table 8, there is actually a slight trend indicating that both younger and older adults' self-rated speed was more highly related to speed performance when responding to Questionnaire items <u>before</u> completing the speed exercises. These patterns are not consistent with the findings discussed earlier regarding condition effects and self-rated speed. Recall that differential age differences on Questionnaire Item 2 responses for the two conditions revealed by order effect analyses suggested that Condition 2 participants may have looked to their recent experiences with the speed tasks to gauge their Questionnaire responses. The only correlational finding that supports such speculation was obtained for the older adult Item 1 responses: As displayed in the last two columns of Table 8, responses on this item were related to speed performance for Condition 2, but not for Condition 1. These equivocal findings regarding the relationship between self-rated speed and speed performance may be related to the relatively small number of subjects in each of the "subgroups" of age group by condition (approximately 25), and/or possibly reflect the ambiguity present in the actual items designed to tap self-rated speed.

To investigate age differences in self-rated speed, a 2 X 2 (Age Group X Condition) MANOVA was conducted in which the three items of the Questionnaire served as dependent variables. The significant age group term, multi-F (3, 94) = 10.83, $p < .001$, allowed for inspection of the univariate Fs, which revealed age differences, favoring younger adults, for all three Questionnaire items. As discussed earlier, the Age Group X Condition term was also significant; univariate tests indicated that only Item 2 responses of the Questionnaire was affected by order of administration. Further analyses indicated that younger and older adults did not differ in their Item 2 responses when rating their speed prior to completing the perceptual speed measures, while younger adults endorsed significantly higher speed levels than older adults on this item when rating their speed after completing the actual speed tasks. The order effect analyses and findings were discussed in full earlier in the Results section.

The Post-test Questionnaire (see Appendix D) comprised 20 items on 7-point Likert scales, for which subjects were asked to rate their familiarity with (1 = not at all familiar, 4 = somewhat familiar, 7 = very familiar), the difficulty of (1 = very easy, 4 = moderately easy/difficult, 7 = very difficult), and performance on (1 = very poor, 4 = average, 7 = very good) each of the six cognitive tasks used to assess intellectual performance in the spatial, reasoning, and verbal domains. Subjects were also asked to indicate their motivation for doing well on the tests they just completed (1 = not at all motivated, 4 = somewhat motivated, 7 = very motivated), and how much fatigue they experienced in completing the tests (1 = no fatigue, 4 = some fatigue, 7 = extreme fatigue). As with the Questionnaire, the Post-test Questionnaire was administered with the goals of examining how such "subjective experience" variables (e.g., prior experience with task format, perceived difficulty level of and success on individual tasks, motivation), may have related to actual task performance, and to investigate age differences on these variables.

Table 9 provides the bivariate correlation coefficients between performance and the corresponding familiarity, difficulty, and self-rated performance variables for each cognitive task for the total sample, and for younger and older adults separately. For the total sample analyses, familiarity, perceived difficulty, and self-rated performance were significantly related to their corresponding performance variables in the expected direction for all cognitive tasks, with the exception of WAIS-R Vocabulary familiarity, as displayed in the first column of Table 9. Examination of these relationships for younger and older adults separately, however, reveals some interesting age trends, as is observed upon inspection of the last two columns of Table 9. For example, it appears that, overall, task familiarity was more related to performance among the older age group. Another point of interest concerns the older adults and the two reasoning tasks, Letter Series and Word Series: The relationships of perceived difficulty and self-rated performance with actual performance for these two cognitive measures were the weakest of the perceived difficulty-actual performance and self-rated performance-actual performance relationships for older adults (albeit they were still significant, with the exception of Letter Series difficulty). The relatively weaker relationships for the Series tasks for older adults suggest that this age group was perhaps less able recognize the task demands and to monitor their own performance on the two reasoning measures than on the spatial and verbal tasks. Finally, it is interesting to note the high degree of relationship between self-rated performance and actual performance for all cognitive tasks, among younger and older adults alike.

Age differences on the familiarity, perceived difficulty, and self-rated performance variables were assessed via three MANOVAs. For each of the analyses, age group served as the independent variable. The first MANOVA concerned task familiarity; thus the dependent variables were the six familiarity variables corresponding to the cognitive tasks of interest. The significant multivariate F for age group, multi-F (6, 90) = 5.27, $p < .001$, prompted examination of the univariate Fs. These tests yielded significant age differences for all of the familiarity variables, with the exception of WAIS-R Vocabulary. Inspection of the means by age group revealed that these differences favored younger adults; that is, the younger adults rated all tasks, except WAIS-R Vocabulary, as more familiar. At first glance, the comparable familiarity ratings between age groups for WAIS-R Vocabulary seems congruent with the lack of age-related performance differences obtained on this task; it may be recalled, however, that WAIS-R Vocabulary was the only cognitive task for which familiarity ratings and performance were not related for either younger or older adults. The six difficulty rating variables served as the dependent variables for the second MANOVA; this analysis was not significant for age group at the multivariate level, multi-F (6, 91) = 1.88, $p = .09$, indicating that younger and older adults rated the six cognitive tasks at comparable levels on the difficulty scale. A third MANOVA was employed to assess possible age differences on the six self-rated performance variables, which served as the dependent variables in the analysis. Significant at the multivariate level, multi-F (6, 92) = 8.80, $p < .001$, the MANOVA pointed to age differences, favoring younger adults, on five out of six self-rated performance variables. It is interesting to juxtapose these results and the findings concerning age differences both on the self-efficacy ratings for and performance on the same six cognitive measures: Identical age patterns are observed for the spatial and reasoning tasks, for which younger adults displayed higher levels of self-efficacy, actual performance, and self-rated performance than older adults. The two vocabulary measures did not yield such tidy trends, however: Despite their higher self-efficacy strength scores and post-performance self-ratings on Recognition Vocabulary, younger adults did not perform at significantly higher levels than older adults on this task. The one self-rated performance variable for which no age differences were detected was WAIS-R Vocabulary; the lack of age differences on self-rated performance for this variable is in accord with the lack of age differences obtained on the actual performance of the task. Recall, however, that younger adults had endorsed higher levels of self-efficacy for this cognitive variable, pre-task, than older adults.

Correlational analyses were employed to address whether motivation levels or self-rated fatigue, as assessed by the motivation and fatigue variables of the Post-test Questionnaire, were related to cognitive performance. When including the entire sample in the analyses, motivation level was positively correlated with Recognition Vocabulary (r = .29, $p < .01$) and WAIS-R Vocabulary performance ($r = .26$, $p < .01$); no significant relationships between motivation and performance were detected for any of the spatial or reasoning measures. As with the other Post-test Questionnaire variables, correlational analyses within each age group proved to be illuminating. For younger adults, none of the cognitive measures, at the task or domain level, was related to self-rated motivation. Within the older adults, on the other hand, significant motivation-performance relationships were obtained for all six cognitive tasks (all $rs \geq .25$. all $ps < .05$). Interestingly, an almost "opposite" pattern was obtained for the fatigue variable: Self-rated fatigue was not related to performance on any of the tasks for the total sample analyses, or for older adults. For younger adults, however, the four cognitive measures of the spatial and reasoning domains were negatively related to fatigue (all $ps \geq .26$, all $rs < .05$); the two vocabulary measures were not related to fatigue within this age group.

Investigation of age group differences in self-rated motivation and fatigue, the presence of which was hinted at by the correlational findings, was conducted by way of MANOVA. Age group served as the independent variable, and motivation and fatigue were the dependent variables. The significant effect for age group at the multivariate level, $F(2, 95) = 6.22$, $p < .01$, prompted inspection of the univariate tests, which indicated age differences for both dependent variables. Inspection of the means revealed that older adults endorsed a higher level of motivation than did younger adults, while, unexpectedly, younger adults rated themselves as experiencing more fatigue during task completion than did the older adults. These age-related patterns of results raise interesting questions regarding the relationship between age, motivation, fatigue, and performance; however, the one-item means by which the constructs in question were assessed limit the conclusions that can be drawn from the present findings.

Discussion

The primary purpose of this study was to determine the mediating role of intellectual self-efficacy on the relationship between age and intellectual performance in verbal, reasoning, and spatial domains. Other objectives were to examine age differences in performance and self-efficacy in those domains, and to assess speed as a mediator of age-performance relationships. These goals were addressed by testing four hypotheses, the results of which are discussed next. Other findings are then reviewed, followed by a discussion of the theoretical implications of this study, and future directions for this line of inquiry.

Hypothesis 1--Intellectual Performance with Perceptual Speed Controlled

Hypothesis 1 predicted that, after controlling for perceptual speed, age-related intellectual performance would conform to the "classic aging pattern"; that is, younger adults would outperform older adults on both the spatial and reasoning tasks, whereas older adults would perform at levels equal to or greater than that of younger adults on the verbal tasks. This hypothesis was not tested for three of the four performance variables because speed was correlated with performance differentially for younger and older adults. Therefore, the assessment of age effects on spatial and verbal tasks was conducted without controlling for speed. As depicted in Table 1 and Figure 1, younger adults did outperform older adults on the spatial and reasoning measures, whereas no age differences were detected on either vocabulary measure; these findings are consistent with the "classic aging pattern," and thus replicate the many other investigations that have demonstrated this effect (Botwinick, 1977; Horn & Cattell, 1967; Sattler, 1982, Wang & Kaufman, 1993).

The nonsignificant Age Group X Speed interaction term for reasoning performance indicated that speed was related to performance in this domain similarly for younger and older adults; thus the planned analyses for the test of Hypothesis 1 were conducted for this single performance variable. In support of Hypothesis 1, significant age differences favoring younger adults remained after controlling for perceptual speed, as revealed by an ANCOVA and hierarchical regression analysis. These analyses both showed that age differences were reduced considerably as a result of accounting for, or partialling out the effects of, perceptual speed. This finding regarding reasoning performance--namely attenuated, but not eliminated, age differences when controlling for perceptual speed--is consistent with other research on the age, speed, and cognition relationship (Hertzog, 1989; Salthouse & Mitchell, 1990; Schaie, 1989).

In summary, the obtained age differences in intellectual performance conformed to the "classic aging pattern," as predicted. Age Group X Speed interactions for spatial, Recognition Vocabulary, and WAIS-R Vocabulary prevented testing Hypothesis 1 for the spatial or verbal domains. Support for Hypothesis 1 was obtained for reasoning performance alone: Younger adults outperformed older adults in this domain, even after controlling for perceptual speed differences.

Hypothesis 2--Intellectual Self-Efficacy Beliefs

It was expected that age differences in task-specific intellectual self-efficacy would correspond to the intellectual performance patterns dictated by the "classic aging pattern." Specifically, hypothesis 2 predicted that younger adults would display higher self-efficacy for both spatial and reasoning abilities, whereas older adults would endorse levels of verbal self-efficacy either equal to or greater than that of younger adults. This hypothesis was not supported: Significant age differences, favoring younger adults, were obtained for all self-efficacy level (SEL) and self-efficacy strength (SEST) variables, with the exception of Recognition Vocabulary SEL, for which no age differences were detected. Thus, as depicted in Figure 2, younger adults endorsed higher SEST for the spatial, reasoning, and verbal tasks. These findings appear to be congruent with past research linking older age with lower cognitive self-efficacy, a pattern that has been obtained on measures of intellectual self-efficacy beliefs and performance outcome expectations (Cornelius & Caspi, 1986; Prohaska, Parham, & Teitelman, 1984; for review, see Salthouse, 1991b), and, quite consistently, on measures of memory self-efficacy (Berry, 1987; Berry, et al., 1989; Gardiner, et al., 1997; Luszsz & Hinton, 1995; Welch, West, Thorn, & Clark, 1996). A point that should be considered when comparing the present results to other findings, however, is whether the cognitive domain for which self-efficacy was assessed is one in which older adults tend to perform more poorly, compared to younger adults. This point comes into play when one is attempting to clarify that a congruence between self-efficacy and performance obtained in older adults is related to the domain assessed, rather than indicative of lower cognitive self-efficacy in older adults on a more general level. For example, if one assesses task-specific self-efficacy and performance for a given cognitive domain and finds that older adults demonstrate both lower self-efficacy and performance relative to younger adults in that domain, one has obtained congruent age differences on self-efficacy and performance. But with such results, one cannot conclude that older adult self-efficacy was lower because of the specific domain assessed, rather than being reflective of a more global cognitive self-efficacy that may be lower in older adults. In other words, the older adults may have endorsed lower self-efficacy for any task that was cognitive in nature. The present study assessed intellectual self-efficacy in three domains, including the verbal domain, for which age differences in performance typically either favor older adults, or are nonsignificant; thus it is in a unique position to address whether age-related self-efficacy and performance patterns are congruent--even when performance patterns do not favor younger adults.

In the present study, younger adults both outperformed and endorsed higher self-efficacy than older adults in the spatial and reasoning domains; thus the results concerning the two fluid domains are comparable--and consistent--with other research assessing perceived efficacy in a domain for which robust age differences favoring younger adults are typically found (Gardiner, et al., 1997; Luszsz & Hinton, 1995; Prohaska, et al., 1984). In contrast, the finding regarding verbal self-efficacy is distinct, because the lower self-efficacy of the older adults did not mirror lower performance in older adults--the self-efficacy endorsements of the older adults were lower, relative to younger adults, in spite of the comparable performance of younger and older adults on the vocabulary measures. As such, the verbal self-efficacy results of the present study are not as comparable to lower self-efficacy findings of research assessing self-efficacy for either the fluid abilities or the memory domain. Thus it is useful to compare the present findings to those studies that included task-specific measures of self-efficacy in the crystallized, or verbal domain (Lachman & Jelalian, 1984; Ramsden and Berry, 1996). Lachman and Jelalian compared reasoning and verbal self-efficacy and performance in younger and older adults. Though younger adults outperformed older adults on the reasoning task, and older adults exhibited higher verbal performance relative to younger adults, no age differences emerged on self-efficacy for either domain when it was assessed before task performance. The results of the present study are similar to those of Lachman and Jelalian in that neither study found congruent age effects for self-efficacy and performance measures. The present findings indicating age differences in self-efficacy favoring younger adults are not consistent with the lack of age differences on self-efficacy detected by Lachman and Jelalian, however.

The present findings regarding verbal self-efficacy and performance are also inconsistent with Ramsden and Berry, who found that found that older adults endorsed higher verbal self-efficacy compared to younger adults, but had similar vocabulary scores.

Why might the present findings regarding verbal self-efficacy be distinct from the findings of Lachman and Jelalian, and Ramsden and Berry? It is tempting to attribute the superior verbal self-efficacy ratings displayed by younger adults in this study to sampling effects: These subjects were undergraduate students attending University of Richmond, a small, select liberal arts college. It could be argued that the younger participants of this study were an intellectually elite group, and that, consequently, their higher verbal self-efficacy may not be representative of adult verbal self-efficacy levels in the general population of younger adults. However, Ramsden and Berry's younger adult sample was also drawn from the student population of University of Richmond; thus, this speculation regarding sampling effects does not hold. Could it be that the uniformly higher self-efficacy beliefs obtained for younger adults in this study reflect a superior level of perceived efficacy for general intellectual functioning held by younger adults? This conclusion is congruent with the findings of Cornelius and Caspi (1986), who assessed intellectual self-efficacy in middle-aged and older adults using the Personality in Intellectual-Aging Contexts (PIC; Lachman, et al., 1982), and found that adults in their late 60s and older endorsed lower self-efficacy beliefs relative to younger adults. The PIC is a domain-general measure of intellectual self-efficacy. Thus it could be argued that Cornelius and Caspi tapped a global, or general cognitive self-efficacy that is lower in older adults. However, this idea of a global type of cognitive self-efficacy that is lower in older adults contradicts the findings of Lachman and Jelalian, who obtained no age differences in self-efficacy, and Ramsden and Berry, who found differential differences depending on the domain assessed; thus such a conclusion does not seem warranted. Further, the use of more general measures of self-efficacy, such as the PIC, makes it even more unlikely that fine differences in older adults' perceived competence regarding various domains will be detected. It is clear that further investigations employing task-specific measures of intellectual self-efficacy and performance in both fluid and crystallized domains are needed to clarify the relationship between age and intellectual self-efficacy.

One of the purposes of measuring age differences in task-specific intellectual self-efficacy was to determine whether older adults are self-aware of the patterns of differential decline and maintenance of their own spatial, reasoning, and verbal abilities. The present findings do not suggest that older adults are cognizant of their performance capabilities for the three cognitive domains of interest. The between-group analyses conducted to examine age differences in self-efficacy do not adequately address this question, however, as self-efficacy endorsements within older adults may have reflected the "classic aging pattern." That is, older adults may have demonstrated higher verbal self-efficacy relative to their ratings of spatial and reasoning self-efficacy; such differences would not necessarily be reflected in the between-group analyses of this investigation. Thus, to more accurately explore older adult self-efficacy patterns relative to performance, repeated-measures analyses were conducted within the older adult sample to assess both self-efficacy and performance patterns. For the first analysis, a self-efficacy factor was specified in which spatial, reasoning, Recognition Vocabulary, and WAIS-R Vocabulary SEST served as the four levels. This analysis detected no significant differences between the four SEST variables within the older adults. This finding contrasts with the results of the second analysis, for which the four performance variables served as the four levels: The significant multivariate effect, multi-F (3, 47) = 12.69, $p < .001$, prompted post-hoc analyses, which yielded the expected "classic aging pattern"; that is, vocabulary performance on both measures was higher than on spatial and reasoning performance, while no differences emerged between either vocabulary task, or between spatial and reasoning performance. This pattern is visually depicted in Figure 1. The results of these two repeated-measures analyses indicate that the older adults, as a group, were not aware of the performance patterns of differential decline and maintenance they displayed, and that are typically observed with increased age.

Did the self-efficacy patterns of younger adults mirror their within-group performance? Two repeated-measures analyses were conducted within younger adults to address this question; again, one analysis tested for within-group differences among the four SEST variables of interest, while the other examined the patterns of the corresponding performance variables. Both analyses were significant at the multivariate level, multi-F (3, 45) = 8.53, $p < .001$ for SEST, multi-F (3, 47) = 17.55, $p < .001$ for performance. Post-hoc analyses confirmed that younger adult performance patterns supported the "classic aging pattern," as suggested by Figure 1; that is, younger adults performed at higher levels on the two measures of fluid abilities (reasoning and spatial) than on the two vocabulary measures, whereas no differences were detected between the spatial and reasoning measures, or the two vocabulary tasks. The SEST post-hoc analyses duplicated this pattern: Younger adults displayed higher self-efficacy for the spatial and reasoning tasks than for either vocabulary task, while no differences were found between reasoning and spatial self-efficacy, or between Recognition Vocabulary or WAIS-R Vocabulary self-efficacy. These findings suggest that younger adults, in contrast to the older adults, were somewhat aware of their differential performance capabilities for the three domains, as a group. It is interesting to note that, despite the lower within-group verbal self-efficacy of younger adults relative to the other domains, the SEST scores for both vocabulary tasks reflected that younger adult vocabulary self-efficacy was still higher than that endorsed by the older adults.

Hypothesis 3--Perceptual Speed as a Mediator

Hypothesis 3 predicted that perceptual speed would partially mediate the relationship between age and intellectual performance in the spatial, reasoning, and verbal domains. Again, the Age Group X Speed interactions obtained for spatial, Recognition Vocabulary, and WAIS-R Vocabulary performance precluded the planned mediational analyses of this hypothesis for these three variables. Consequently, Hypothesis 3 was assessed solely for reasoning performance. As expected, hierarchical regression analyses that controlled for perceptual speed reduced age-related variance in reasoning performance by 86%; thus speed partially, but substantially, mediated the relationship between age group and reasoning performance. This finding is consistent with the research on speed's role in age-cognition relationships (Hertzog, 1989; Salthouse, 1994; Salthouse & Mitchell, 1990; Schaie, 1989). The research of Schaie (1989) and Hertzog (1989) is especially relevant: Both investigators included in their assessment of reasoning ability the Letter Series of the PMA, which was one of the two reasoning tasks employed in the present study. The results of this study replicated both Schaie and Hertzog's findings regarding speed's mediating role in the relationship between age and reasoning performance.

The results described above provide support for Hypothesis 3 applied to reasoning performance. Questions regarding speed's mediating role in age-related spatial and verbal performance remained, however. Thus, additional hierarchical regression analyses assessed speed as a mediator of age-performance relations within the older adult sample only. The results of these mediational analyses indicated that partialling speed considerably reduced age-related performance variance in both domains; in fact, due to the nonsignificance of age-related variance in both reasoning and spatial performance once speed was accounted for, it was concluded that perceptual speed completely mediated the relationship between age and both spatial and reasoning performance among the older adults. These findings are congruent with previous studies that have found speed to either partially, or completely, explain age-related spatial and/or reasoning performance in samples of continuous adulthood age groups (Salthouse, 1991a, 1993, 1994). As described in the Results section, mediational analyses were not conducted for either vocabulary performance measure, due to nonsignificant age effects on Recognition Vocabulary and WAIS-R Vocabulary performance.

Hypothesis 4--Intellectual Self-Efficacy as a Mediator

The 4th hypothesis addressed the primary purpose of this investigation: Does task-specific intellectual self-efficacy mediate age-related patterns of intellectual performance? It was predicted that self-efficacy would partially mediate the relationship between age and performance in spatial, reasoning, and verbal domains, after differences in perceptual speed were controlled. The analyses planned to assess speed and task-specific self-efficacy as mediators were conducted for reasoning performance alone, because this was the only dependent variable for which no Age Group X Speed interaction was obtained. The results of the hierarchical regression analysis indicated that, once speed-associated variance was partialled, task-specific self-efficacy did not further explain, or mediate, the relationship between age and reasoning performance. Thus no support was obtained for the test of Hypothesis 4 applied to reasoning performance.

Because the mediational roles of speed and intellectual self-efficacy in the other domains of interest could not be examined for the entire sample, further regression analyses were conducted to address this question within the older adult sample only. Similar to the results of the total sample, once speed was partialled, intellectual self-efficacy failed to explain additional age-related variance for spatial or reasoning performance. This was not surprising, as none of the SEST variables related to age within the older adults. As noted earlier, mediational analyses were not employed for the verbal domain, due to the lack of age-related performance variance on the vocabulary measures within the older adults.

In summary, the few mediational analyses that could be conducted within the context of this study's other findings (e.g., Age Group X Speed interactions, lack of age-related vocabulary performance variance within the older adults), yielded no support for the hypothesis that self-efficacy mediates age-cognition relations when differences in perceptual speed are controlled. Can it thus be concluded that intellectual self-efficacy plays no mediating role in age-related cognitive performance? A study that provides evidence to the contrary was conducted by Salthouse and Mitchell (1990). They administered spatial, reasoning, and perceptual speed measures to 383 adults between the ages of 20 and 83 years. Prior to completing these performance measures, participants were asked to rate their experience and ability for a variety of spatial activities (e.g., "Performing paper-folding activities such as origami," p. 848) on 5-point Likert scales. Multiple regression analyses indicated that both speed and self-rated ability reduced age-related reasoning performance variance when entered alone, although partialling speed resulted in a substantially larger attenuation than the reduction due to the partialling of self-rated ability (67% for speed and 21.6% for self-rated ability). When both predictors were entered into the equation simultaneously, age-associated variance was reduced to a greater degree (77.3%) than when speed was partialled alone (67%), indicating that self-perceived ability managed to account for additional age-related variance above and beyond that due to perceptual speed. Unfortunately, Salthouse and Mitchell did not report the effects of partialling self-rated ability, independent of the self-rated experience variables, from spatial performance; it is possible that the effect of controlling for perceived ability would have been even greater for this domain, as the self-perceived ability ratings were collected for tasks involving spatial abilities. Though their investigation did not employ a task-specific measure of self-efficacy, it is clear that Salthouse and Mitchell's findings suggest the possibility that intellectual self-efficacy might mediate age-related performance, independent of speed.

The failure to obtain support for self-efficacy's mediating role in age-performance relations in the present study may be due in part to the strong relationships obtained between intellectual self-efficacy and speed: As displayed in Figures 3 through 6, speed and SEST were significantly related, both at the bivariate level and after partialling age group, for spatial, reasoning, and Recognition Vocabulary performance, and at the bivariate level for WAIS-R Vocabulary. Though it seems plausible theoretically that intellectual self-efficacy and perceptual speed are correlated, the unexpectedly high degree of shared variance observed between these two variables raised methodological questions regarding the means by which self-efficacy was assessed in the present investigation. The measure of intellectual self-efficacy (the ISEQ) used in this study was task-specific and as such, its items reflected the speeded element embedded in most of the intellectual tests (the STAMAT) administered. Thus, for all tasks except WAIS-R Vocabulary, respondents were asked to rate their perceived ability to perform tasks under heavy time restraints. It is suspected that the ISEQ, as designed for the present study, inadvertently tapped "speed" self-efficacy, in addition to intellectual self-efficacy. If the obtained self-efficacy ratings were contaminated because the measure actually captured a composite of self-perceived speed and intellectual efficacy, it seems that the amount of shared variance of speed and self-efficacy may have been inflated. If this indeed was the case, then controlling for speed before assessing self-efficacy as a mediator may have unduly contributed to the lack of influence manifested by this metacognitive variable. When assessing task-specific self-efficacy for timed tasks, should attempts be made to somehow control for "speed" self-efficacy? Or, as is argued by some (Birren, 1974) regarding the control of speed in the measure of intellectual performance, is self-perceived speed an important aspect of task-specific intellectual self-efficacy for speeded abilities? Perhaps when examining self-efficacy and performance in conjunction, if speed effects are removed from age-related performance, attempts should be made to address the possible influence of speed on the measure of self-efficacy as well. Further, it cannot be assumed that if speed self-efficacy were somehow controlled, that intellectual self-efficacy would come forth as a mediator of age-performance relationships; the fact remains that perceptual speed has been well-established in the cognitive aging literature as a mediator of age-related intellectual performance. It is possible that speed is such a powerful predictor of performance that once its effects are controlled, self-efficacy cannot further explain or reduce age-related performance variance because there is so little age-associated variance remaining. The findings of Salthouse and Mitchell, however, do not point in this direction. Unfortunately, the results of the present study do not clearly buttress nor refute the results of Salthouse and Mitchell, due to the measurement concerns discussed. Further research is needed both to elucidate the role of intellectual self-efficacy on age-related cognitive performance, and to address the possible measurement confounds inherent in attempts to assess task-specific self-efficacy for speeded cognitive tests.

Other Findings

During the course of the planned data analyses for this study, some intriguing, albeit unexpected, results emerged. These findings are discussed below.

Age Group X Speed interactions. As noted previously , speed was related to performance differentially for younger and older adults, as indicated by significant Age Group X Speed interactions for spatial, Recognition Vocabulary, and WAIS-R Vocabulary performance. Though the interactions proved problematic for several planned analyses, their implications are quite interesting: These findings suggest that speed contributed differentially to cognitive performance in younger and older adults. Indeed, further analyses demonstrated that speed significantly predicted performance in all four cognitive variables of interest for the older adults, while speed predicted performance for younger adults only in the reasoning domain. Thus the present findings suggest that speed may influence spatial and vocabulary performance in older adults, while it has no effect on younger adult performance in these two domains. Though Age X Speed interactions have not been consistently demonstrated in the cognitive aging literature, this study does not stand alone in its suggestion that speed may differentially influence cognitive performance in younger and older adults: Salthouse (1994), for example, obtained significant Age X

Perceptual Speed interactions for spatial and reasoning performance in the direction of greater speed influences with increased age. Hertzog's (1989) investigation failed to detect Age X Perceptual Speed interactions for cognitive performance; he did, however, obtain a significant Age X Answering Sheet Speed interaction for vocabulary performance, indicating larger speed effects with increased age.

Salthouse (1991b) has pointed out, however, that drawing valid conclusions based on Age X "Variable" interactions is an intricate process. He discussed a number of investigation and sample-specific characteristics that can have an impact on the significance of such interactions, and should be taken into account when attempting to interpret or generalize from age-related interactions. One such characteristic is the shape of the distributions for the criterion variables of interest. The four primary cognitive variables of this study were examined for normality for younger and older adults separately via several means: visual inspection, calculating skew/SE skew, and both the Shapiro-Wilks and K-S (Lilliefors) tests of normality. It was determined that a distribution would be considered non-normal if three out of four of these indices pointed to problems with normality. The only variable that met this criterion was Recognition Vocabulary: Visual inspection indicated that this variable was negatively skewed for both younger and older adults, reflecting ceiling effects in both age groups. It could be argued that ceiling effects were also present in younger adult spatial performance; this variable, with two out of three normality measures indicating problems, approached negative skew. The presence of ceiling effects on cognitive tasks suggests that the measure employed may not have accurately assessed the performance for those individuals whose abilities surpass the level of skill represented by the range of the measure. In the present case, then, it cannot be assumed that some of the "top performers" of Recognition Vocabulary would not have scored even higher if the test was more difficult. Similarly, it seems possible that some of the younger adults may have performed at higher levels on the measures of spatial ability with more challenging tasks that could have measured performance at higher levels.

What do these ceiling effects have to do with the interpretation of the Age Group X Speed interactions in question? It is clear that negatively skewed distributions pose serious problems for concluding that speed affected the cognitive performance of younger and older adults differentially when one considers that, if the performance measures had been more challenging, then some of the faster younger adults may have outperformed some of their slower peers; if this were the case, speed would be acting as a significant predictor of younger adult performance--and, if speed's influence on younger adult performance was comparable to that of the older sample, then the problematic Age Group X Speed interaction term would be nonsignificant. It is apparent, then, that the ceiling effects observed for Recognition Vocabulary cloud the interpretation of the Age Group X Speed interaction obtained for this variable. Similarly, the hint of ceiling effects detected for younger adult spatial performance warns against drawing conclusions regarding speed's differential influence for younger and older adults in this domain. The one variable for which an Age Group X Speed interaction was detected--and that appears to have normally distributed performance patterns for both younger and older adults--is WAIS-R Vocabulary. Thus it can be cautiously concluded that speed may predict and thus possibly influence WAIS-R Vocabulary performance differentially in younger and older adults, with a greater influence in older adults. How could this be so, especially considering the untimed nature of the WAIS-R Vocabulary test? Salthouse (1994) demonstrated that speed can influence age-related performance on untimed fluid and memory tasks. Though he did not assess verbal performance in this investigation, such findings warn against assuming that speed does not play a role in tasks that lack an overt speeded aspect. It is speculated that speed may have influenced WAIS-R Vocabulary performance of the older adults in present study because of the fluid decline of this age group; Horn and Cattell (1967) discussed that one's crystallized abilities are linked, in part, to one's fluid intelligence. Perhaps, then, the slowest adults--who happen to be in the older age group--are those who show decline in other areas, such as vocabulary performance. In such a case, speed would be related to vocabulary performance in older adults. The slowest younger adults, on the other hand, barely overlapped with the fastest oldest adults in terms of speed scores; thus the slow younger adults are not really in the same "slow" category as the slowest older adults. Younger adult performance, then, demonstrates more "robustness" against speed, because of the younger age group's faster status, which may be, in part, indicative of their stronger abilities overall--both fluid and crystallized. Again, these reflections are purely speculative; it is clear that further research is needed to investigate the possibility of differential speed effects on age-related performance in a variety of domains.

Speed-self-efficacy relationships in younger and older adults. As reviewed earlier, the observed relationships between speed and intellectual self-efficacy were unexpectedly pervasive and strong (see Figures 3 through 6). When speed-SEST relations were broken down by age group, however, distinct patterns emerged in that speed and self-efficacy were related for younger adults only in the reasoning domain, but related in all three domains for older adults (see Table 7). These differential relationships between speed and self-efficacy were also reflected by the significant Age Group X Speed interactions obtained when predicting for spatial, reasoning, and Recognition Vocabulary SEST. Such interactions are interesting in that they imply speed was more associated with the spatial, reasoning, and Recognition Vocabulary self-efficacy ratings of older adults than to those of younger adults. The notion that a person's perceptual speed status was predictive of, and perhaps even influenced, her or his self-efficacy endorsements is congruent with the speculation that the ISEQ somehow captured an element of "speed self-efficacy," as discussed earlier. The obtained Age Group X Speed interactions, however, suggest that spatial, reasoning, and Recognition Vocabulary self-efficacy were more related to speed in older adults than in younger adults. Again though, care must be taken when interpreting such interactions (Salthouse, 1991b). Hence, the distribution of each SEST variable was assessed for normality for younger and older adults separately by means of visual inspection, skew/SE skew, and the Shapiro-Wilks test of normality. Ceiling effects emerged for younger adult spatial SEST. Further, it appeared that reasoning and Recognition Vocabulary SEST for younger adults were approaching negative skews as well. As was the concluded in the previous section on ceiling effects, these negatively skewed SEST distributions hinder drawing conclusions based on the Age Group X Speed interactions because it is not known whether the same patterns would have emerged if the SEST measures had somehow assessed a higher range of self-efficacy strength. For example, the fastest younger adults may have distinguished themselves from other young subjects by endorsing higher SEST, if the measurement tool had allowed this. Thus, it cannot be concluded that the Age Group X Speed interactions in question were not an artifact of the means by which SEST was assessed, rather than an indication of speed's differential influence on spatial, reasoning, and Recognition Vocabulary self-efficacy for younger and older adults in general.

The observed relationships of speed and self-efficacy for older adults suggest that age differences in speed may have somehow contributed to the age patterns observed on the SEST variables. This possible mediation of age-SEST relations by speed is visually evident upon examining the Age Group-SEST paths of Figures 3 through 6: For all four measures of SEST, the significant relationship between age group and SEST observed at the bivariate level was reduced to a nonsignificant level once the effects of speed were controlled. The implications of speed's possible contribution to self-efficacy judgments are intriguing: Did the older adults endorse lower self-efficacy ratings because they are slower? Such speculation directs attention once again to the measurement of intellectual self-efficacy in the present study. It is possible that the ISEQ, in emphasizing the timed elements of the intellectual tasks in question, directed older adults to lower ratings of self-efficacy. On the other hand, older adults may have endorsed lower self-efficacy, in part because of their status as "slower," even if the ISEQ had not included any hint of the speeded aspects of the cognitive abilities of interest. It is unfortunate that the Age Group X Speed interactions for SEST precluded the mediational analyses necessary to confirm speed's influence on age-related differences in self-efficacy for all SEST variables, with the exception of WAIS-R Vocabulary. Mediational analyses were conducted to ascertain the effect of controlling for speed on age-related WAIS-R Vocabulary SEST variance. The regression analyses suggested that partialling out speed from WAIS-R Vocabulary SEST explained 100% of the age-related variance in self-efficacy for this performance measure. As WAIS-R Vocabulary was the only untimed measure administered, these findings suggest that speed's influence on self-efficacy ratings was not solely the result of the older adults reacting to the timed aspect of the cognitive tasks in question, as presented by the ISEQ. Firm conclusions regarding speed's influence on age-related WAIS-R Vocabulary SEST cannot be made based on the results of the present study, however: As reviewed earlier, speed did not predict self-efficacy for this task once the influence of age group was controlled. The finding that speed did not relate to WAIS-R Vocabulary SEST once age-associated variance was partialled brings into question speed's status as a mediator of the age-SEST relationship.

In summary, the observed relationships between speed, SEST, and age group suggest that speed may have contributed to the self-efficacy endorsements of the older adults of this study. This implication sheds light on both the difficulty of measuring intellectual self-efficacy for timed cognitive measures, independent of tapping some type of "speed self-efficacy," and the possible influence that speed may have on intellectual self-efficacy pertaining to untimed cognitive tasks (e.g., WAIS-R Vocabulary). Though the present findings hint that speed may play an interesting role in the self-efficacy endorsements of older adults, firm conclusions cannot be drawn due to the limitations of the analyses and measures, as discussed above. It is clear that research elucidating the connection between speed and intellectual self-efficacy is needed to further the understanding of the processes involved in age-cognition relationships.

Subjective speed ratings. Participants were asked to rate their speed in performing tasks of increasing complexity on a 7-point Likert scale on the "Questionnaire," which consisted of three items. As described in the Results section and displayed in Table 8, the relationship between self-rated speed and actual speed performance was equivocal. Specifically, the significant correlations between self-rated speed and speed performance for the total sample were not always obtained for younger and older adults separately (see Table 8). Recall that younger adults rated themselves as "speedier" than older adults on all three Questionnaire items; this pattern duplicated the age differences on actual speed performance, which also favored younger adults. Despite these parallel effects for mean age differences on subjective and objective speed measures, the correlations between these variables within younger and older adults (Table 8) were inconsistent and did not seem to suggest any predictive relationship between rating one's speed and one's actual speed ability. Though it is possible that these Questionnaire analyses reflect a lack of awareness in both younger and older adults regarding their speed capabilities, it seems more likely that the inconsistent patterns displayed in Table 8 may have resulted from the ambiguity of the three self-rated speed items; thus it was concluded that findings regarding self-rated speed in this study must be viewed as quite tentative.

Exploratory measures. In addition to vocabulary, reasoning, and spatial tests, the STAMAT includes the Number Addition and Word Fluency tests; both of these measures were administered for exploratory purposes. Number Addition is a highly-timed test that asks subjects to indicate whether provided answers to simple addition problems are correct or incorrect. The Word Fluency test asks subjects to write down as many words as possible that begin with the letter "s" within 5 minutes. As displayed in Table 1, older adults outperformed younger adults on the test of Number Addition, F (10, 87) = 7.73, $p <$ .01 (M = 21.28, SD = 8.03 for younger, and M = 26.94, SD = 11.82 for older). This finding is consistent with other investigations assessing age-related performance on this measure (Hertzog, 1989; Schaie, 1989). As Schaie noted, the Number Addition test is considered a measure of crystallized intelligence. Though highly timed, this test requires one to quickly assess whether the sums of simple numbers are correct; thus it seems that experience with adding small numbers, in which older adults may have an edge relative to younger adults, would increase performance on this test. Interestingly, older adults demonstrated both lower Number Addition self-efficacy level (SEL) and strength (SEST), than did younger adults (see Table 3). A different pattern emerged on Word Fluency: Younger adults significantly outperformed older adults on this task, F (10, 87) = 49.01, p < .001 (M = 46.10, SD = 8.73 for younger, and M = 32.67, SD = 10.24 for older). Again, this result is consistent with the SLS (Schaie, 1994), that has examined age-related performance on this measure with both longitudinal and cross-sectional analyses and found that increased age is associated with decreased performance on Word Fluency. The task demands of this measure include both speed and verbal memory; thus, though it seems that word knowledge would boost performance on this test, its memory and speed aspects put older adults at a disadvantage. The age-related self-efficacy patterns for Word Fluency mirrored performance patterns: Younger adults endorsed significantly higher SEL and SEST for this task, as displayed in Table 3.

Theoretical Implications

The research questions of the present study were motivated both by the consistent emergence of the "classic aging pattern" when age-related intellectual performance is assessed (Botwinick, 1977), and the contention put forth by self-efficacy theory (Bandura, 1977, 1989) that task-specific self-efficacy beliefs are both influenced by past performance experiences, and exert an influence on future cognitive performance.

As expected, the age-related performance differences obtained in this study clearly conformed to the "classic aging pattern." The present findings are also congruent with the body of literature indicating speed's critical role in older adult spatial and reasoning performance. Moreover, this study lends some support to self-efficacy theory. Specifically, self-efficacy beliefs, independent of both age and speed influences, predicted intellectual performance in spatial, reasoning, and verbal domains. The current study cannot, however, claim that self-efficacy predicts performance independent of underlying cognitive ability, because pre-existing ability was not measured in the present study. What about the primary question of intellectual self-efficacy's "efficacy" in explaining age-related performance variance? If self-efficacy beliefs do act to shape performance behavior, and such beliefs change with age, it follows that self-efficacy may very well contribute to age-related performance patterns. As reviewed earlier, this study did not offer clear support for this hypothesis; however, due to the measurement concerns expressed regarding task-specific self-efficacy, the present findings regarding intellectual self-efficacy as a mediator must be considered inconclusive.

The discordant patterns of vocabulary self-efficacy and performance for the older adults of the present study were unexpected, and seem incongruent with the predictions made by self-efficacy theory. On the other hand, this finding seems to underscore the importance of assessing self-efficacy beliefs, and their impact on performance. As Salthouse and Mitchell (1990) expressed, "If the self-ratings are merely alternative indicators of general cognitive ability, then they are of limited interest as potential mediators or moderators of age-related differences in cognitive functioning" (p. 851). The present findings concerning vocabulary self-efficacy and performance in older adults clash with the speculation that one's perceived ability is a proxy for one's actual ability. Rather, these results shed light on the complexity of self-efficacy as a construct, and the utility of attempting to address its potential influence on age-related behavior and performance.

Future Directions

Two potentially major weaknesses of the present research that have been reviewed earlier are the non-normal distributions evident for some of the performance and self-efficacy variables, and measurement concerns regarding intellectual self-efficacy. These, along with other limitations of this study, are discussed below.

As described in detail earlier, several ceiling effects were detected for the performance and self-efficacy variables of interest. Though the analyses of the present study were robust against non-normality due to equal cell sizes for age group, these negatively skewed distributions confounded the interpretation of the several Age Group X Speed interactions obtained. More fundamentally, it is speculated that the truncated range of performance assessed by the tests for which ceiling effects were obtained contributed to the presence of the Age Group X Speed interactions--the interactions that prevented adequate examination of several of the hypotheses of this investigation. Further, ceiling effects for both performance and self-efficacy variables may have minimized age differences on these measures; for example, if ceiling effects were not obtained on the Recognition Vocabulary performance for the older adult sample, it is possible that age differences favoring older adults would have been detected on this task. Such problems resulting from ceiling effects highlight the need for cognitive aging researchers to select and pilot their performance measures carefully, and to consider the implications of younger adults to "top out" on task-specific measures of self-efficacy; these concerns seem especially relevant to investigations attempting to employ mediational analyses.

Another weakness of this study was the ambiguity regarding the assessment of self-efficacy via the ISEQ. As discussed earlier, it is speculated that the ISEQ's measurement of self-efficacy may have been contaminated in that its scales were assessing a composite of speed and intellectual self-efficacy. However, it is difficult to distinguish between this possibility, and the speculation that speed and task-specific self-efficacy are highly related and predictive of each other, independent of whether respondents are explicitly aware of the timed element of the tasks for which self-efficacy is being assessed. Thus, the observed relationships established between speed and self-efficacy generate several questions for future research to attack, related to both the measurement of task-specific self-efficacy, and the variables that shape the beliefs of adults regarding their cognitive abilities.

Another limitation of the present research is its somewhat singular focus on speed and self-efficacy as explanations of age-intellectual performance relationships. Other variables that have been shown to influence age-related cognitive performance include working memory (Salthouse, 1991a, 1992a, 1992b), sensory acuity (Lindenberger & Baltes ,1994), and physiological decline (Libon, Glosser, Malamut, Kaplan, Goldberg, Swenson, & Sands 1994). It should be noted that such mediators may interact with each other, producing decreases in cognitive performance across the lifespan. For example, Salthouse (1992a) examined perceptual speed and working memory as mediators of age-related reasoning performance. Both variables reduced age-related variance in reasoning accuracy, though partialling perceptual speed resulted in a greater attenuation than did partialling working memory. Further analyses revealed that perceptual speed contributed significantly to variance in working memory. It seems likely that unmeasured mediators, such as the variables listed above, contributed in some way to the age-related patterns obtained on both performance and intellectual self-efficacy variables of this study.

Another possible criticism of the present research concerns the differential means used to recruit the younger and older adult participants making up the sample. As delineated in the Method section, the 50 younger adults were primarily University of Richmond students who were required to either participate in psychology research, or write a paper in lieu of such participation. The older adults, however, were residents of the city of Richmond and surrounding areas, who either responded to a newspaper article discussing the need for older volunteers, or were recruited through acquaintances. Thus, it seems the younger and older adults were motivated to participate in this study for very different reasons--at least at the group level. Hopefully, the various reasons to participate in this study had a negligible effect on participants' responses. As might be recalled, however, self-rated motivation for doing well on the tests completed was assessed in this study through a single item on the Post-test Questionnaire; analyses of this item reflected that older adults endorsed higher levels of motivation relative to younger adults. Further, self-rated fatigue, also assessed via a single item of the Post-test Questionnaire, revealed that younger adults rated themselves as having experienced more fatigue during the testing session compared to that of older adults. The age-related findings regarding these two items were surprising--until viewed in the light of the differential recruiting means used for younger and older adults. Could these responses indicate that older adults were both more interested in the project topic ("thinking and reasoning"), and more motivated to perform at their best? This is possible; however, as noted earlier, the one-item means used to assess motivation and fatigue limit the conclusions that can be drawn regarding these variables. As described in full in the Results section, both the fatigue and motivation variables were differentially related to intellectual performance for younger and older adults; thus it appears that neither variable had an impact on performance across both age groups in the present study. These findings, which suggested possible differential motivation and interest between age groups, underscore the importance of careful and uniform recruitment means when using participants of disparate age groups.

In summary, though the present investigation did not find support for the hypothesis that intellectual self-efficacy mediates age-performance relationships, it yielded a rich array of surprising, yet intriguing, patterns and relationships between the variables of age, speed, task-specific self-efficacy, and performance. These findings have raised questions for future research regarding the means by which task-specific intellectual self-efficacy is assessed, the nature of lower intellectual self-efficacy in older adults for domains that do not reflect age decrements in performance, and the relationship between speed and intellectual self-efficacy. The investigations that undertake these issues will shed light on the intricacies of self-efficacy's influence on age-related cognitive performance.

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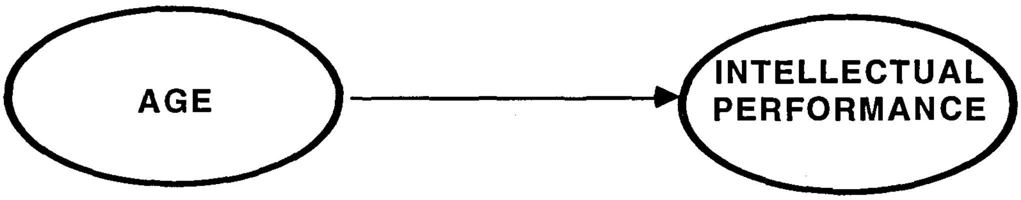
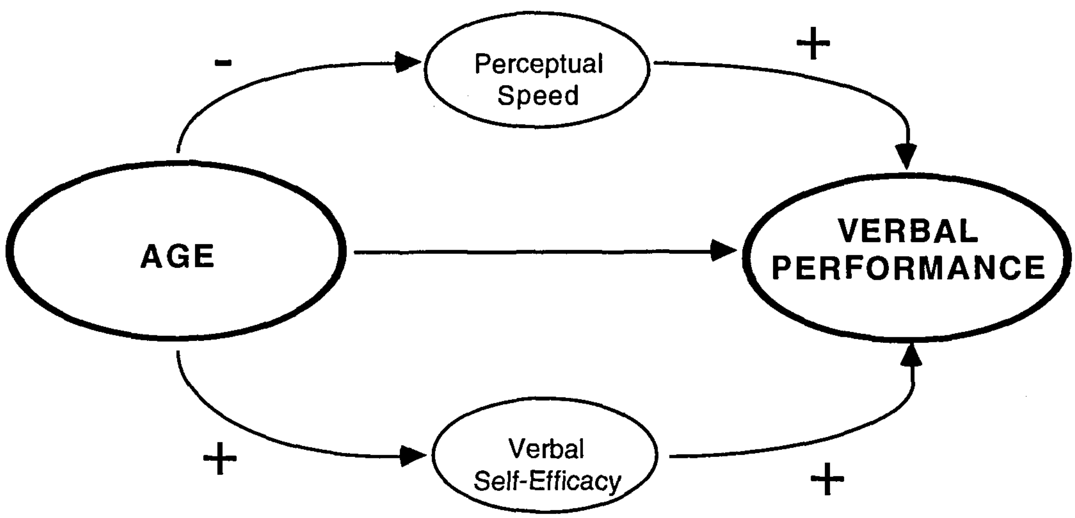
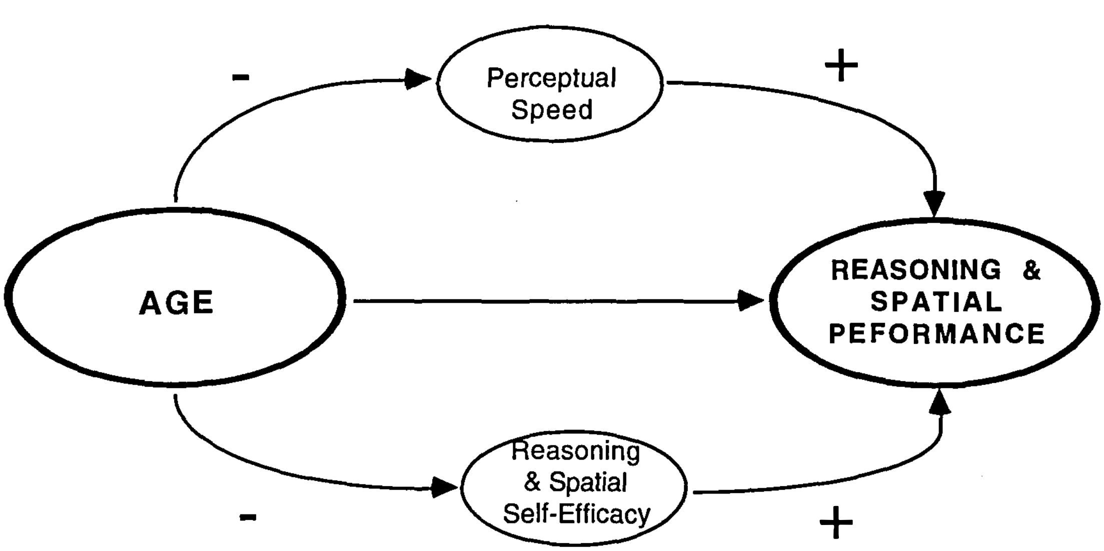
Appendix A

Models of Age-Cognition Relationships







TASK RATING QUESTIONNAIRE

On the following pages, you will be asked to indicate whether or not you think you can perform several different types of tasks. We have provided several examples of each type of task. Take the time you need to read through the examples to make sure you understand what we are asking you. Please don't hesitate to ask questions to clarify ANYTHING about the tasks or questionnaire.

The purpose of these questions is to find out what you think about your own abilities. **There are no right or wrong answers.**

DIRECTIONS:

There are several statements describing tasks on the following pages.

Please CIRCLE NO if you think you cannot do the task described in the statement.

Please CIRCLE YES if you think you CAN do the task described in the statement.
**If you answer YES, please indicate HOW CERTAIN you are about being able to perform the task in the statement by circling a percentage on the scale provided -- from 10% to 100%. The values between 10% and 100% represent how sure or certain you feel, with 10% being completely uncertain, and 100% being completely certain.

Recognition Vocabulary

The following statements refer to your ability to recognize which word means the same as a given word. Provided below are some example items.

Examples:

Which word means the same as

QUIET?	**Blue**	**Still**	**Tense**	**Watery**
BRAVE?	**Hot**	**Cooked**	**Red**	**Courageous**
ANCIENT?	**Dry**	**Long**	**Happy**	**Old**

Complete the following statements: Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how sure you are, on the scale provided.

1. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for 1 to 5 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for 6 to 10 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for 11 to 15 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for 16 to 20 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for <u>21 to 25</u> of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for <u>26 to 30</u> of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for <u>31 to 35</u> of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for <u>36 to 40</u> of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for <u>41 to 45</u> of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If I were given a list of 50 vocabulary words to work on *for 4 minutes*, I could identify which word meant the same as the given word for <u>46 to 50 (all)</u> of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Figure Rotation

The following statements refer to your ability to indicate which figures ARE LIKE THE TARGET FIGURE--but rotated in different directions. Provided below are some example items. You do not need to complete the example items.

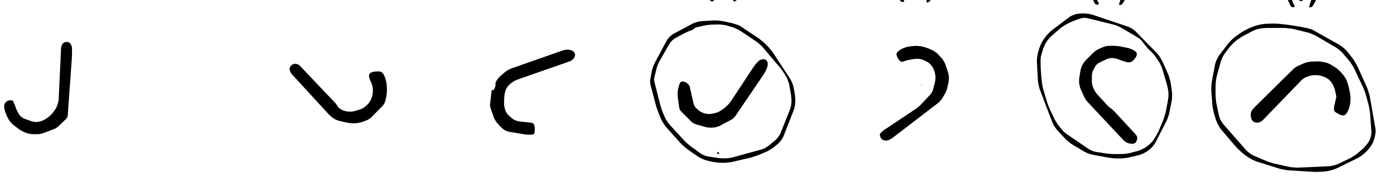
Examples:

Look at the row of figures below. The first figure is the letter **F.** All the other figures are like the first one, but they have been rotated in different directions.

Now look at the next row of figures. The first figure is like the letter **F.** However, none of the other figures would look like an F, even if they were rotated to an upright position. They are all made backward.

Some of the figures in the next row are like the first figure. Some are made backward.

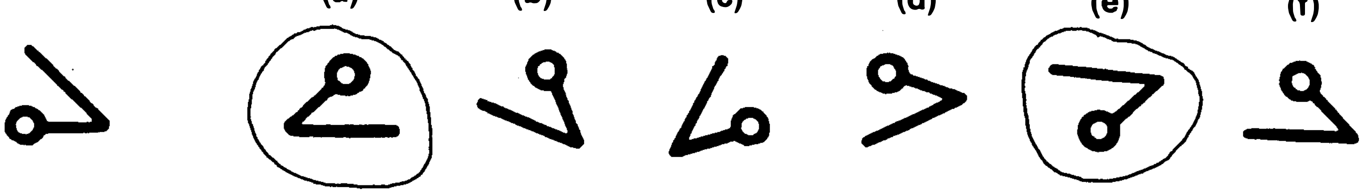
(a) (b) (c) (d) (e) (f)



Figures (c), (e), and (f) are LIKE the first figure and have been circled. Notice that ALL the figures that are LIKE the first figure have been circled.

Some of the figures in the next row are like the first figure. Some are made backward.

(a) (b) (c) (d) (e) (f)



Figures (a) and (e) are LIKE the first figure and have been circled. The other figures would not look like the first figure no matter how they are rotated.

<u>Complete the following statements:</u> Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how <u>sure</u> you are, on the scale provided.

1. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>1 to 3</u> of the figures.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>4 to 6</u> of the figures.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>7 to 9</u> of the figures.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>10 to 12</u> of the figures.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>13 to 15</u> of the figures.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>16 to 18</u> of the figures.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a set of 20 target figures to work on *for 5 minutes*, I could identify which figures were like the target figure but rotated in different directions for <u>19 to 20 (all)</u> of the figures.

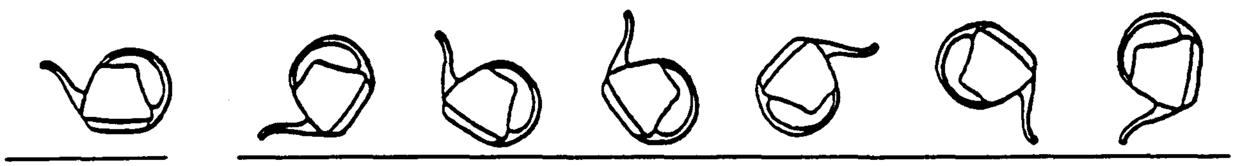
NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Object Rotation

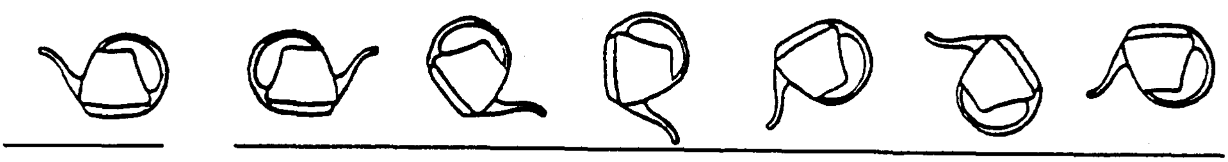
The following statements refer to your ability to indicate which objects ARE LIKE THE TARGET OBJECT--but rotated in different directions. Provided below are some example items. You do not need to complete the example items.

Examples:

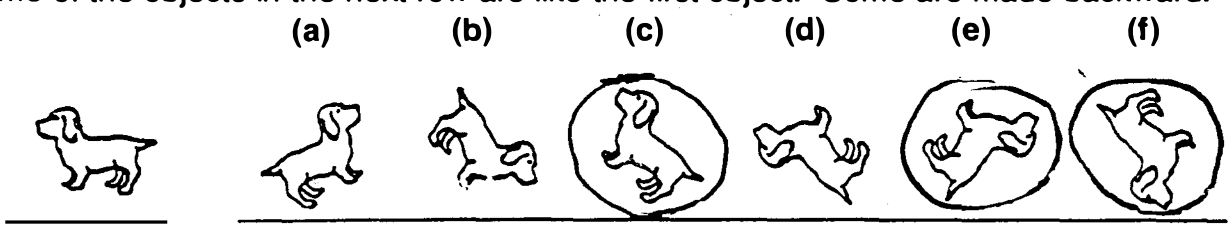
Look at the row of objects below. The first object is a pitcher. All the other objects are like the first one, but they have been rotated in different directions.



Now look at the next row of objects. The first object is a pitcher. However, none of the other objects would match this view of the pitcher even if they were rotated to an upright position. They are all made backward.

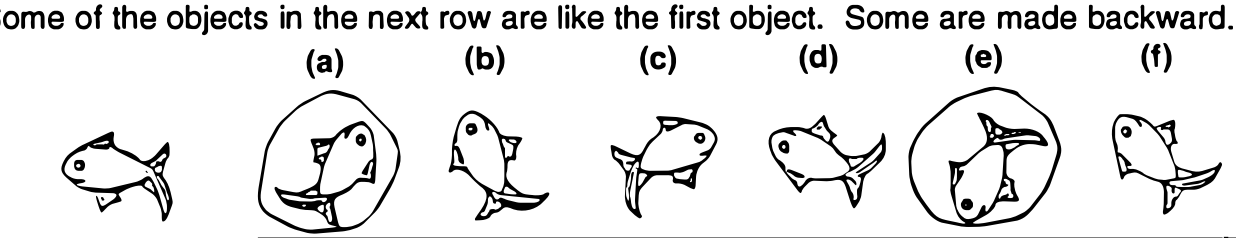


Some of the objects in the next row are like the first object. Some are made backward.



Figures (c), (e), and (f) are LIKE the first object and have been circled. Notice that ALL the objects that are like the first object have been circled.

Some of the objects in the next row are like the first object. Some are made backward.



Figures (a) and (e) are LIKE the first object and have been circled. The other objects would not look like the first figure no matter how they are rotated.

<u>Complete the following statements:</u> Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how <u>sure</u> you are, on the scale provided.

1. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>1 to 3</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>4 to 6</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>7 to 9</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>10 to 12</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>13 to 15</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>16 to 18</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a set of 20 target objects to work on *for 5 minutes*, I could identify which objects were like the target object but rotated in different directions for <u>19 to 20 (all)</u> of the objects.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Letter Series

The following statements refer to <u>your ability to study a series of letters and indicate (from a set of choices) which letter should come next in the series.</u> Provided below are some example items. You do not need to complete the example items.

<u>Examples:</u>

Study the series of letters below. What letter should come NEXT?

<u>answer choices:</u>

a b a b a b a b **(a) b c d e**

This series goes like this: **ab ab ab ab**. The NEXT letter in the series should be **a.** The letter **a** has been circled.

Now study the series of letters below. What letter should come NEXT?

<u>answer choices:</u>

c a d a e a f a **c d e f (g)**

This series goes like this: **ca da ea fa.** The NEXT letter in the series should be **g.**

Now study the series of letters below. What letter should come NEXT?

<u>answer choices:</u>

a a a b b b c c c d d **a b c (d) e**

This series goes like this: **aaa bbb ccc dd.** The NEXT letter in the series should be **d**

Now study the series of letters below. What letter should come NEXT?

<u>answer choices:</u>

a b c d a b c e a b c f a b c **a b c f (g)**

This series goes like this: **abc dabce abcf abc.** The NEXT letter in the series should be **g.**

<u>Complete the following statements:</u> Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how <u>sure</u> you are, on the scale provided.

1. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>1 to 3</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>4 to 6</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>7 to 9</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>10 to 12</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>13 to 15</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>16 to 18</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in <u>19 to 21</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in 22 to 24 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in 25 to 27 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If I were given a set of 30 letter series to work on *for 6 minutes*, I could indicate (from a set of choices) which letter should come next in 28 to 30 (all) of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Word Series

The following statements refer to your ability to study a series of words and indicate (from a set of choices) which word should come next in the series. Provided below are some example items. You do not need to complete the example items.

Examples:

Example 1:

Study the series of words below.
What word should come NEXT?

	answer choices:
January	**January**
February	**February**
January	**March**
February	**April**
January	**May**
February	
January	
February	

This series goes like this: **January February**

January February

January February

January February

The NEXT word in the series should be **January.** The word **January** has been circled.

Example 2:

Now study the series of words below.
What word should come NEXT?

	answer choices:
March	**March**
January	**April**
April	**May**
January	**June**
May	**July**
January	
June	
January	

This series goes like this: **March January**

April January

May January

June January

The NEXT word in the series should be **July.** The word **July** has been circled.

Example 3:

Now study the series of words below.
What word should come NEXT?

January	answer
January	choices:
February	January
February	February
March	March
March	April
April	May
April	

This series goes like this: **January**
January

February
February

March
March

April
April

The next word in the series should be **May.** The word **May** has been circled.

Example 4:

Now study the series of words below.
What word should come NEXT?

January	answer
February	choices:
Thursday	August
March	September
April	October
Thursday	November
May	Thursday
June	
Thursday	
July	
August	
Thursday	

This series goes like this: **January**
February
Thursday

March
April
Thursday

May
June
Thursday

July
August
Thursday

The next word in the series should be **September.** The word **September** has been circled.

Complete the following statements: **Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how sure you are, on the scale provided.**

1. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 1 to 3 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 4 to 6 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 7 to 9 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 10 to 12 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 13 to 15 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 16 to 18 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in 19 to 21 of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in <u>22 to 24</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in <u>25 to 27</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If I were given a set of 30 word series to work on *for 6 minutes*, I could indicate (from a set of choices) which word should come next in <u>28 to 30 (all)</u> of the series.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Number Addition

The following statements refer to <u>your ability to quickly check sums of addition problems and indicate if the answers are Right or Wrong</u>. Provided below are some example items.

<u>Examples:</u>

At the right are two columns of numbers that have been added.

(A)	(B)
16	42
38	61
45	83
99	176
(R) W	R **(W)**

The answer to problem (A) is Right, and **R** below the problem has been circled. The answer to (B) is Wrong, and **W** below the problem has been circled.

<u>More examples:</u>

35	63	17
28	17	84
61	89	29
124	169	140
(R) W	**(R)** W	R **(W)**
The answer is Right, and **R** has been circled.	The answer is Right, and **R** has been circled.	The answer is Wrong, and **W** has been circled.

Complete the following statements: Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how sure you are, on the scale provided.

1. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 1 to 5 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 6 to 10 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 11 to 15 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 16 to 20 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 21 to 25 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 26 to 30 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 31 to 35 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 36 to 40 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 41 to 45 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 46 to 50 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 51 to 55 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

12. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 56 to 60 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

13. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 61 to 65 of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

14. If I were given a set of 70 addition problems with provided sums to work on *for 6 minutes*, I could indicate which sums were Right or Wrong for 66 to 70 (all) of the problems.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Word Fluency

The following statements refer to your ability to write down as many words as possible that start with a given letter. Any word would be all right if it began with the given letter. If you were to think of a word you could not spell, you would be asked to just spell it the best you can. Once a word has been used, it could not be used in a series, past tense, or plural. Provided below are some example items.

Examples:

Look at the words in the two lists below.

Each word in this list begins with **d.**

doll
dinner
daisy
doughnut

Each word in this list begins with **t.**

tall
tight
town
trip

Complete the following statements: Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how sure you are, on the scale provided.

1. If I were given *5 minutes,* I could write down 1 to 5 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given *5 minutes,* I could write down 6 to 10 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given *5 minutes,* I could write down 11 to 15 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given *5 minutes,* I could write down 16 to 20 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given *5 minutes,* I could write down 21 to 25 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given *5 minutes,* I could write down 26 to 30 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given *5 minutes,* I could write down 31 to 35 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If I were given *5 minutes,* I could write down 36 to 40 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. If I were given *5 minutes,* I could write down 41 to 45 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If I were given *5 minutes,* I could write down 46 to 50 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. If I were given *5 minutes,* I could write down 51 to 55 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

12. If I were given *5 minutes,* I could write down 55 to 60 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

13. If I were given *5 minutes,* I could write down 61 to 65 words that started with a provided letter.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Vocabulary

The following statements refer to your ability to write down what a given word means. Unlike the preceding tasks, the statements below describe a task that is *untimed*. Provided below are some example items.

Examples:

summer
auspicious

Complete the following statements: Please circle No or Yes. If you answer yes, circle a percentage rating, that is, how sure you are, on the scale provided.

1. If I were given a list of 35 words, I could define 1 to 3 of the words (given all the time I needed).

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. If I were given a list of 35 words, I could define 4 to 6 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. If I were given a list of 35 words, I could define 7 to 9 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. If I were given a list of 35 words, I could define 10 to 12 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. If I were given a list of 35 words, I could define 13 to 15 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. If I were given a list of 35 words, I could define 16 to 18 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

7. If I were given a list of 35 words, I could define 19 to 21 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If I were given a list of 35 words, I could define 22 to 24 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. If I were given a list of 35 words, I could define 25 to 27 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. If I were given a list of 35 words, I could define 28 to 30 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

11. If I were given a list of 35 words, I could define 31 to 33 of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

12. If I were given a list of 35 words, I could define 34 to 35 (all) of the words.

NO YES 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Adapted from Schaie, K. W. (1985). Schaie-Thurstone Adult Mental Abilities Test (STAMAT). Palo Alto, CA: Consulting Psychologists Press.

Appendix C

Questionnaire

Please answer the following questions by circling a number on each scale.

1. How would you rate your speed in completing simple tasks, like copying a list of letters onto a sheet of paper, or filling in bubbles with a pencil?

1	2	3	4	5	6	7
very slow			average			very fast

2. How would you rate your speed in completing slightly more complex tasks, like scanning a group of shapes to determine which ones are the same?

1	2	3	4	5	6	7
very slow			average			very fast

3. Overall, how would you rate your speed in working out word problems or word puzzles?

1	2	3	4	5	6	7
very slow			average			very fast

Appendix D
Post-test Questionnaire

The following questions attempt to address how familiar you were with the types of problems you just completed -- whether the types of problems on the tests you completed were completely novel or new to you, or somewhat familiar to you, or maybe completely familiar to you.

Please answer the following questions by circling a number on each scale.

Below is one of the items from the multiple-choice vocabulary test you just completed:

MOIST	**Curt**	**Humane**	**Damp**	**Moderate**

1) How familiar did this type of problem seem to you?

1	2	3	4	5	6	7
not at all familiar			somewhat familiar			very familiar

2) Please rate your performance on the multiple-choice vocabulary test you just completed:

1	2	3	4	5	6	7
very poor			average			very good

Below are three of the items from the vocabulary test of written definitions you just completed:

Bed -

Tranquil -

Audacious -

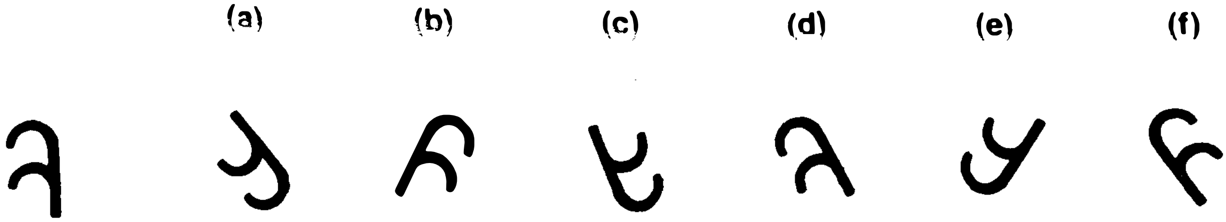
3) How familiar did this type of problem seem to you?

1	2	3	4	5	6	7
not at all familiar			somewhat familiar			very familiar

4) Please rate your performance on the vocabulary test of written definitions you just completed:

1	2	3	4	5	6	7
very poor			average			very good

Below is one of the items from the figure rotation test you just completed, on which you were asked to identify which figures were the same as the target figure, but rotated:



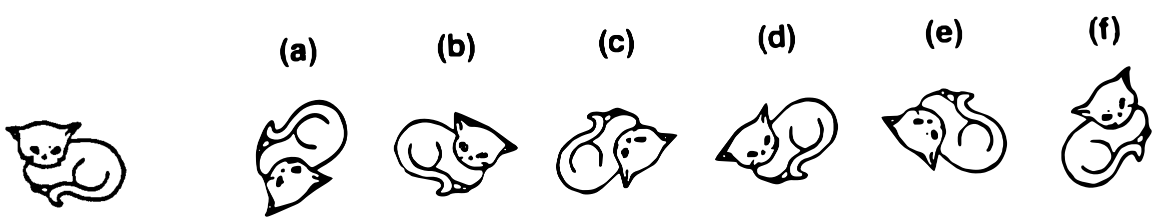
5) How familiar did this type of problem seem to you?

1	2	3	4	5	6	7
not at all familiar			somewhat familiar			very familiar

6) Please rate your performance on the figure rotation test you just completed:

1	2	3	4	5	6	7
very poor			average			very good

Below is one of the items from the object rotation test you just completed, on which you were asked to identify which objects were the same as the target object, but rotated:



7) How familiar did this type of problem seem to you?

1	2	3	4	5	6	7
not at all familiar			somewhat familiar			very familiar

8) Please rate your performance on the object rotation test you just completed:

1	2	3	4	5	6	7
very poor						very good

Below is one of the items from the letter series test you just completed, on which you were asked to select the next letter of the series, based on the pattern of the series given:

a a b c c d e e f g g

Answers:
a c f g h

9) How familiar did this type of problem seem to you?

1	2	3	4	5	6	7
not at all familiar			somewhat familiar			very familiar

10) Please rate your performance on the letter series test you just completed:

1	2	3	4	5	6	7
very poor			average			very good

Below is one of the items from the word series test you just completed, on which you were asked to select the next word of the series, based on the pattern of the series given:

January
January
February
March
March
April
May
May
June
July
July

Answers:
January
March
June
July
August

11) How familiar did this type of problem seem to you?

1	2	3	4	5	6	7
not at all familiar			somewhat familiar			very familiar

12) Please rate your performance on the word series test you just completed:

1	2	3	4	5	6	7
very poor						very good

13) How motivated were you to do well on the tests you just completed?

1	2	3	4	5	6	7
not at all motivated			somewhat motivated			very motivated

14) How much fatigue did you experience in completing the tests you were just administered?

1	2	3	4	5	6	7
no fatigue			some fatigue			extreme fatigue

15) Please rate the difficulty of each task you were administered by circling a number for each.

	Very Easy			Moderately Easy/Difficult			Very Difficult
Multiple-Choice Vocabulary	1	2	3	4	5	6	7
Vocabulary Test of Written Definitions	1	2	3	4	5	6	7
Figure Rotation	1	2	3	4	5	6	7
Object Rotation	1	2	3	4	5	6	7
Letter Series	1	2	3	4	5	6	7
Word Series	1	2	3	4	5	6	7

Appendix E

List of Questionnaires and Psychometric Measures

Consent Form

Background questionnaire

Mental Status Questionnaire

*Questionnaire

*Intellectual Self-Efficacy Questionnaire

*STAMAT Form OA:

- Recognition Vocabulary (4 minutes)
- Figure Rotation (5 minutes)
- Object Rotation (5 minutes)
- Letter Series (6 minutes)
- Word Series (6 minutes)
- Number Addition (6 minutes)
- Word Fluency (5 minutes)

*Salthouse perceptual speed measures:

- Pattern Comparison (2 trials, 30 seconds each)
- Letter Comparison (2 trials, 30 seconds each)

WAIS-R Vocabulary test

Post-test Questionnaire

* The Questionnaire, the ISEQ, the STAMAT, and perceptual speed tasks were counterbalanced such that half the participants received the Questionnaire first, followed respectively by the ISEQ, the STAMAT, and perceptual speed measures, and the remainder received the perceptual speed tasks first, followed by the ISEQ, the STAMAT, and the Questionnaire, in that order.

Table 1

Summary Statistics for Performance Variables by Age Group

	Young	Old	
Variable	M (SD)	M (SD)	p
Spatial ability			
Figure Rotation	33.74 (10.22)	16.56 (9.37)	.00
Object Rotation	44.10 (9.31)	25.23 (11.96)	.00
Reasoning ability			
Letter Series	24.00 (4.25)	11.83 (5.27)	.00
Word Series	23.60 (4.03)	13.50 (4.69)	.00
Verbal ability			
Recognition Vocabulary	41.28 (5.74)	42.27 (8.18)	.49
WAIS-R Vocabulary	51.24 (6.47)	49.29 (9.47)	.24
Exploratory measures			
Number Addition	21.28 (8.03)	26.94 (11.82)	.01
Word Fluency	46.10 (8.73)	32.67 (10.24)	.00
Perceptual speed			
Pattern Comparison	18.51 (3.78)	11.69 (3.18)	.00
Letter Comparison	12.75 (2.67)	7.98 (2.05)	.00

Table 2

Bivariate Correlations of Performance Variables with Perceptual Speed for Younger and Older Adults

	Age group	
Performance variable	Younger	Older
Spatial performance	-.01	.56**
Reasoning performance	.49**	.57**
Recognition Vocabulary	.13	.45**
WAIS-R Vocabulary	.04	.34**

**$p < .01$, one-tailed.

Table 3
Summary Statistics for Self-Efficacy Measures by Age Group

	Self efficacy level			Self efficacy strength		
	Young	Old		Young	Old	
Variable	M (SD)	M (SD)	p	M (SD)	M (SD)	p
Spatial self-efficacy						
Figure Rotation	6.83 (0.48)	6.28 (1.44)	.01	.82 (1.46)	.59 (2.33)	.00
Object Rotation	6.81 (0.61)	6.00 (1.55)	.00	.81 (1.61)	.56 (2.49)	.00
Reasoning self-efficacy						
Letter Series	9.50 (1.03)	8.23 (2.57)	.00	.75 (1.74)	.53 (2.44)	.00
Word Series	9.50 (1.22)	8.34 (2.53)	.01	.77 (1.81)	.59 (2.70)	.00
Verbal self-efficacy						
Recognition Vocabulary	9.13 (1.65)	8.55 (2.45)	.18	.70 (2.15)	.54 (2.73)	.00
WAIS-R Vocabulary	11.08 (1.50)	9.98 (2.90)	.02	.69 (1.89)	.57 (2.73)	.01
Exploratory Measures Self-efficacy						
Number Addition	12.23 (2.36)	10.64 (4.35)	.03	.66 (1.98)	.51 (2.95)	.01
Word Fluency	10.48 (2.71)	9.00 (3.78)	.03	.60 (2.29)	.45 (2.58)	.00

Table 4

Results of Hierarchical Regression Examining Age-Related Variance in Reasoning Performance Before and After Controlling for Perceptual Speed and SEST

Criterion Variable	Predictor Variables	R^2	sr^2	F	p
Reasoning performance					
	Age group	.65	.65	178.96	.00
	Perceptual speed	.73	.08	29.06	.00
	Age group		.09		
	Reasoning SEST	.74	.01	4.20	.04
	Perceptual speed		.05		
	Age group		.09		
	Total set of predictors	.74		91.09	.00

Note. sr^2 denotes the squared semipartial correlation between the variable of that row and the criterion after the predictor variables of that step have been entered. F and p indicate the F and significance of either the increment in R^2 (sr^2) associated with the variable added at that given step, or with the total set of predictor variables.

Table 5

Results of Hierarchical Regressions Examining Age-Related Variance in Performance Before and After Controlling for Perceptual Speed and SEST in Older Adults

Criterion Variable	Predictor Variables	R^2	sr^2	F	p
Spatial performance					
	Age	.09	.09	4.32	.04
	Perceptual speed	.31	.22	14.29	.00
	Age		.01		
	Spatial SEST	.34	.03	2.15	.15
	Perceptual speed		.09		
	Age		.01		
	Total set of predictors	.34		7.52	.00
Reasoning performance					
	Age	.16	.16	8.81	.00
	Perceptual speed	.36	.20	14.60	.00
	Age		.04		
	Reasoning SEST	.37	.01	.68	.41
	Perceptual speed		.12		
	Age		.04		
	Total set of predictors	.37		8.82	.00

Note. sr^2 denotes the squared semipartial correlation between the variable of that row and the criterion after the predictor variables of that step have been entered. F and p indicate the F and significance of either the increment in R^2 (sr^2) associated with the variable added at that given step, or with the total set of predictor variables.

(table continues)

Table 5

Results of Hierarchical Regressions Examining Age-Related Variance in Performance Before and After Controlling for Perceptual Speed and SEST in Older Adults

Criterion Variable	Predictor Variables	R^2	sr^2	F	p
Recognition Vocabulary					
	Age	.02	.02	1.17	.28
	Perceptual speed	.18	.16	8.56	.01
	Age		.00		
	Recog Vocab SEST	.21	.02	1.38	.25
	Perceptual speed		.08		
	Age		.00		
	Total set of predictors	.21		3.80	.02
WAIS-R Vocabulary					
	Age	.00	.00	.10	.75
	Perceptual speed	.15	.15	8.27	.01
	Age		.04		
	WAIS-R Vocab SEST	.27	.11	7.18	.01
	Perceptual speed		.06		
	Age		.02		
	Total set of predictors	.27		5.56	.00

Note. sr^2 denotes the squared semipartial correlation between the variable of that row and the criterion after the predictor variables of that step have been entered. F and p indicate the F and significance of either the increment in R^2 (sr^2) associated with the variable added at that given step, or with the total set of predictor variables.

Table 6

Bivariate Correlations of Age, Perceptual Speed, SEST and Performance Variables from Hierarchical Regressions of Older Adults

	Age	PS	SSE	SP
Age	--	-.38**	-.24	-.30*
Perceptual speed (PS)		--	.57**	.55**
Spatial SEST (SSE)			--	.47**
Spatial performance (SP)				--
	Age	PS	RSE	RP
Age	--	-.38**	-.19	-.40**
Perceptual speed (PS)		--	.53**	.57**
Reasoning SEST (RSE)			--	.38**
Reasoning Performance (RP)				--
	Age	PS	RVSE	RVP
Age	--	-.34**	-.11	-.16
Perceptual speed (PS)		--	.46**	.43**
Recognition Vocabulary SEST (RVSE)			--	.33*
Recognition Vocabulary Performance (RVP)				--
	Age	PS	WRVSE	WRVP
Age	--	-.38**	.00	.05
Perceptual speed (PS)		--	.32*	.34**
WAIS-R Vocabulary SEST (WRVSE)			--	.45**
WAIS-R Vocabulary Performance (WRVP)				--

Note. The four bivariate correlations between age and perceptual speed above are not identical due to missing data on some of the variables employed in the regressions that were not consistent for the four analyses conducted.

*$p < .05$, **$p < .01$, one-tailed.

Table 7

Bivariate Correlations of Self-Efficacy Strength (SEST) Variables with Perceptual Speed for Younger and Older Adults

	Age group	
SEST variable	Younger	Older
Spatial SEST	-.05	.57**
Reasoning SEST	.24*	.53**
Recognition Vocabulary SEST	.07	.46**
WAIS-R Vocabulary SEST	.04	.32*

*$p \leq .05$, **$p < .01$, one-tailed.

Table 8

Bivariate Correlations of Questionnaire Items with Perceptual Speed for Total, Younger Adult, and Older Adult Sample by Condition

	Total		Younger		Older	
Questionnaire Item	Cond 1	Cond 2	Cond 1	Cond 2	Cond 1	Cond 2
Item 1	.39**	.56**	.56**	.29	.04	.47**
Item 2	.27*	.47**	.03	-.13	.37*	.21
Item 3	.45**	.40**	.36*	-.12	.36*	.20

*$p < .05$, **$p < .01$, one-tailed.

Table 9

Bivariate Correlations of Post-test Questionnaire Items with Corresponding Performance Measures for Total, Younger, and Older Adult Sample

Post-test Questionnaire item	Total sample performance	Younger performance	Older performance
Figure Rotation familiarity	.39**	.04	.25*
Figure Rotation difficulty	-.38**	-.36**	-.39**
Figure Rotation self-rated performance	.66**	.48**	.50**
Object Rotation familiarity	.41**	.01	.44**
Object Rotation difficulty	-.42**	-.35**	-.38**
Object Rotation self-rated performance	.66**	.53**	.47**
Letter Series familiarity	.51**	.20	.25*
Letter Series difficulty	-.32**	-.44**	-.21
Letter Series self-rated performance	.60**	.55**	.30*
Word Series familiarity	.39**	.22	.10
Word Series difficulty	-.30**	-.40**	-.24*
Word Series self-rated performance	.58**	.50**	.38**
Recognition Vocabulary familiarity	.43**	.11	.67**
Recognition Vocabulary difficulty	-.45**	-.43**	-.53**
Recognition Vocabulary self-rated performance	.44**	.53**	.47**
WAIS-R Vocabulary familiarity	.15	.05	.21
WAIS-R Vocabulary difficulty	-.30**	-.16	-.37**
WAIS-R Vocabulary self-rated performance	.43**	.27*	.49**

*p < .05, **p < .01, one-tailed.

Figure Captions

Figure 1. Age differences in spatial, reasoning, and vocabulary performance.

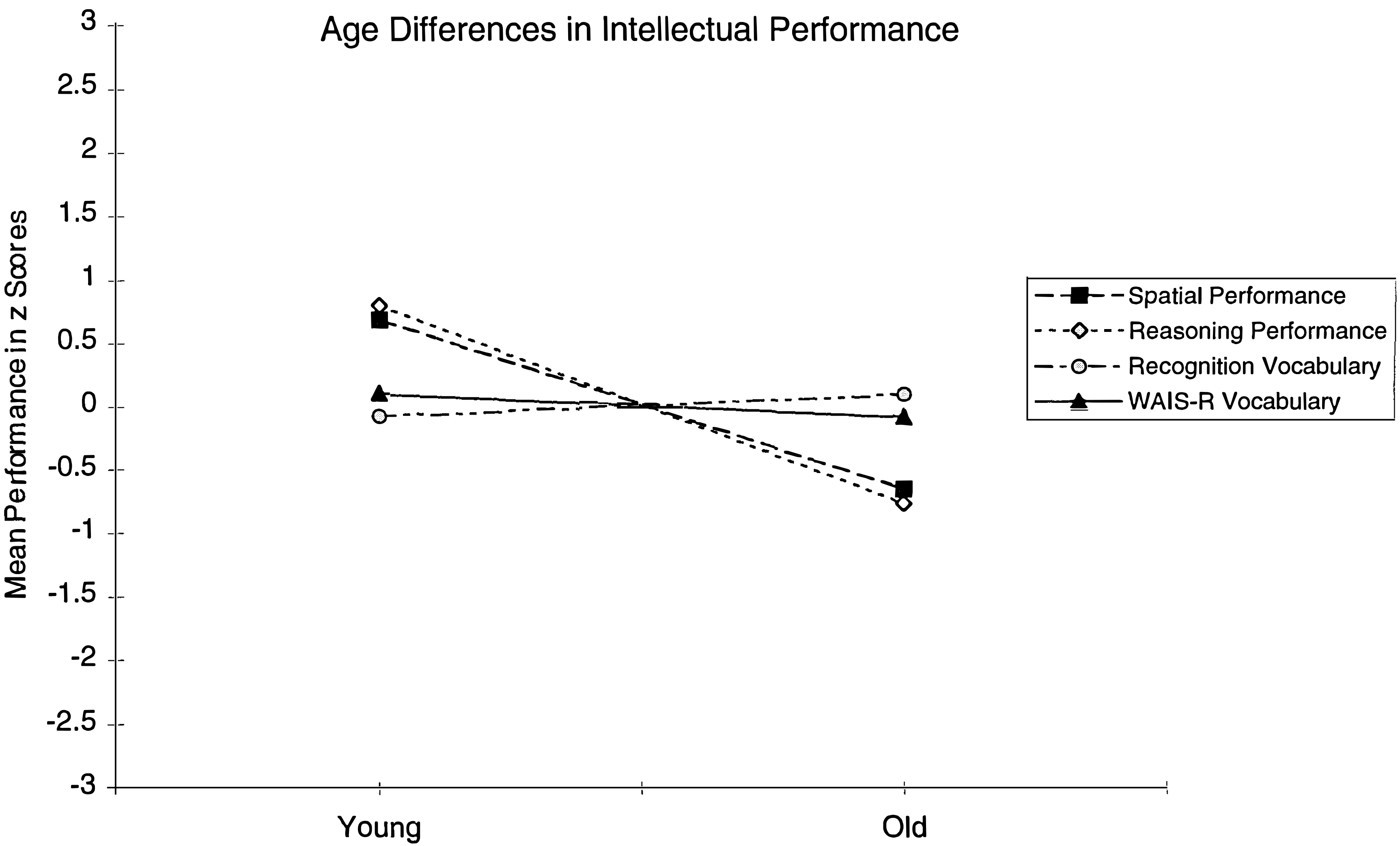
Figure 2. Age differences in spatial, reasoning, and vocabulary self-efficacy strength (SEST).

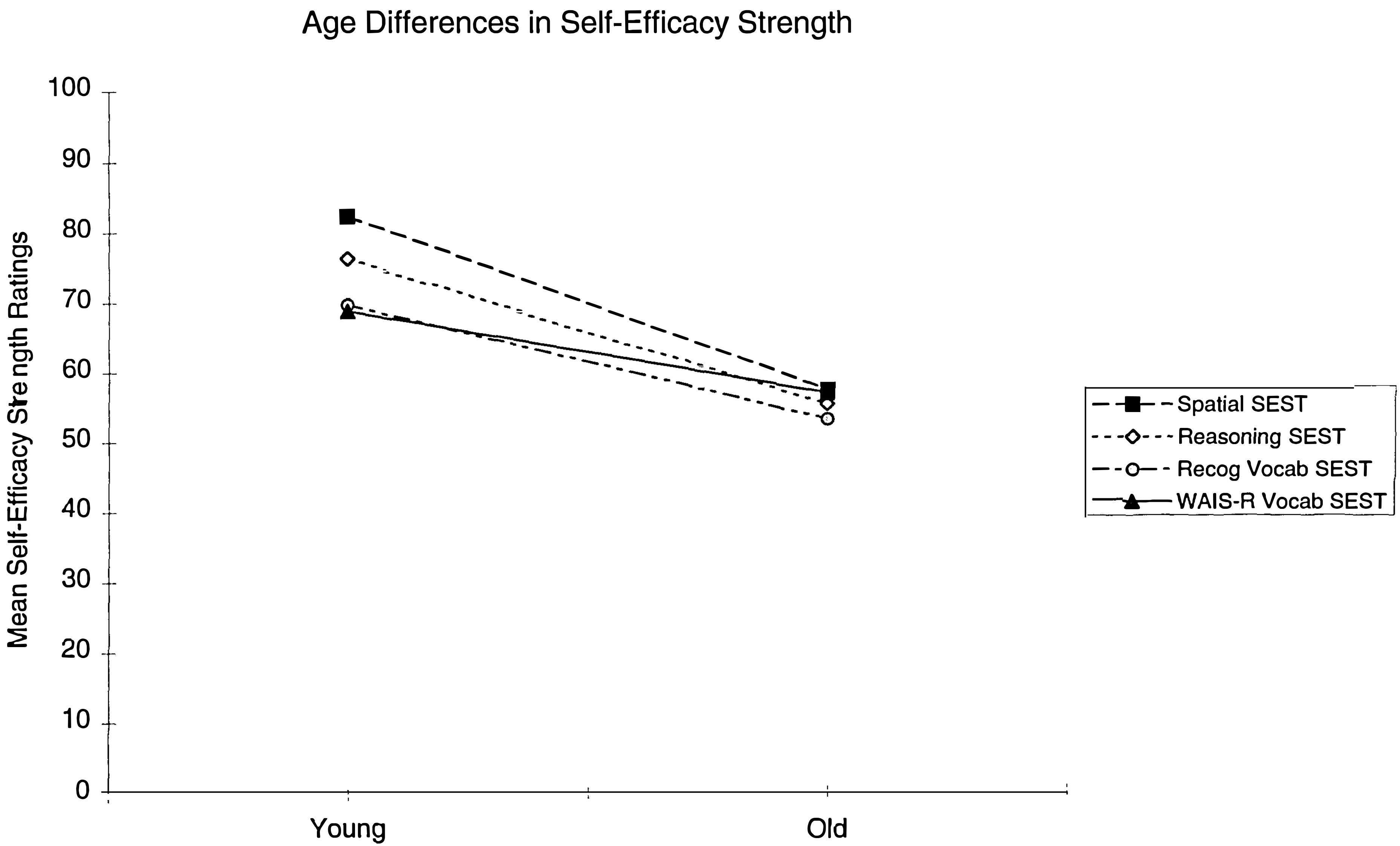
Figure 3. Path diagram displaying bivariate and partialled relationships between age group, perceptual speed, spatial SEST, and spatial performance.

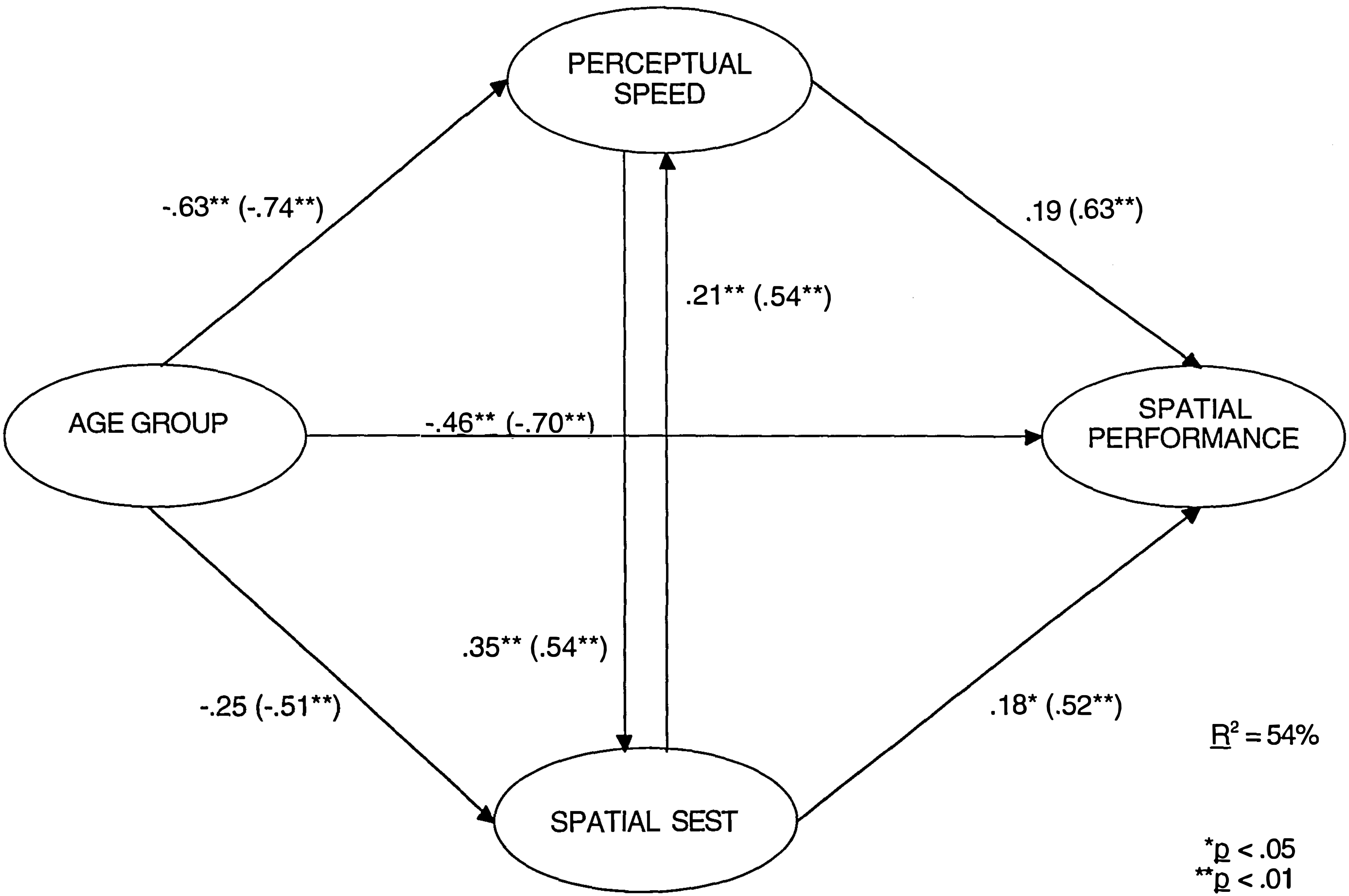
Figure 4. Path diagram displaying bivariate and partialled relationships between age group, perceptual speed, reasoning SEST, and reasoning performance.

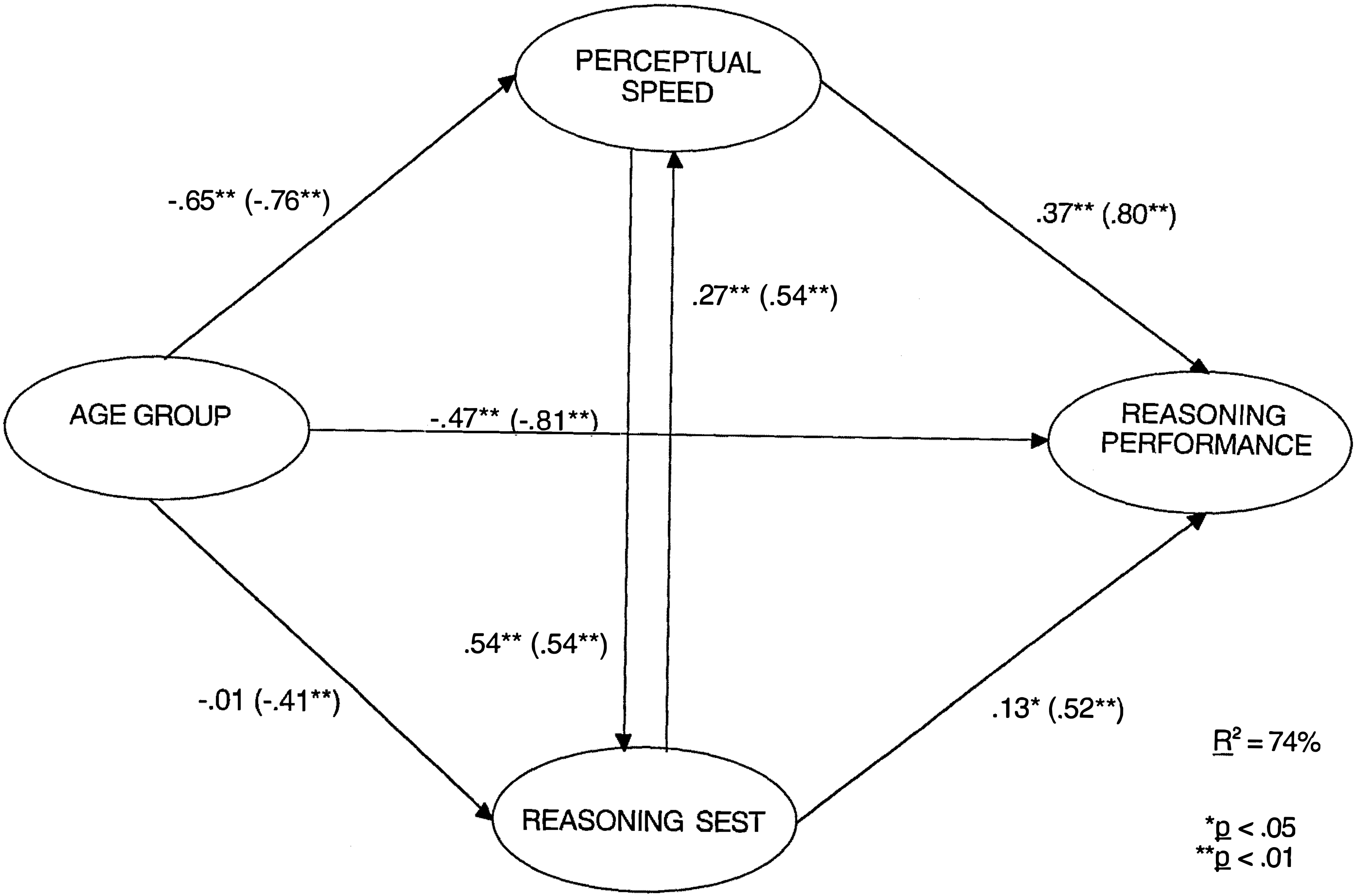
Figure 5. Path diagram displaying bivariate and partialled relationships between age group, perceptual speed, Recognition Vocabulary SEST, and Recognition Vocabulary performance.

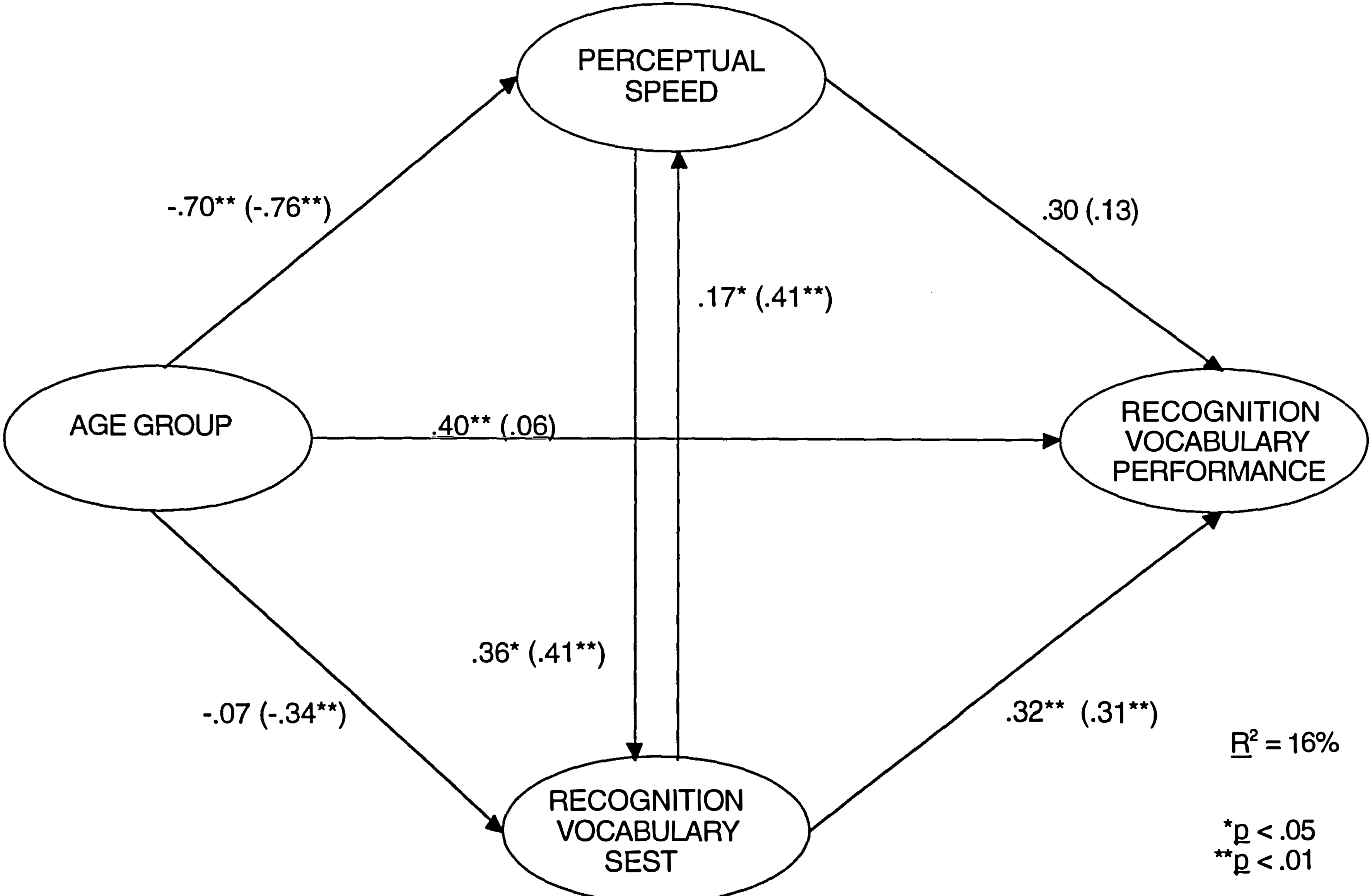
Figure 6. Path diagram displaying bivariate and partialled relationships between age group, perceptual speed, WAIS-R Vocabulary SEST, and WAIS-R Vocabulary performance.


Age Differences in Intellectual Performance
Mean Performance in z Scores
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
Young
Old
Spatial Performance
Reasoning Performance
Recognition Vocabulary
WAIS-R Vocabulary


Age Differences in Self-Efficacy Strength
Mean Self-Efficacy Strength Ratings
100
90
80
70
60
50
40
30
20
10
0
Young
Old
Spatial SEST
Reasoning SEST
Recog Vocab SEST
WAIS-R Vocab SEST

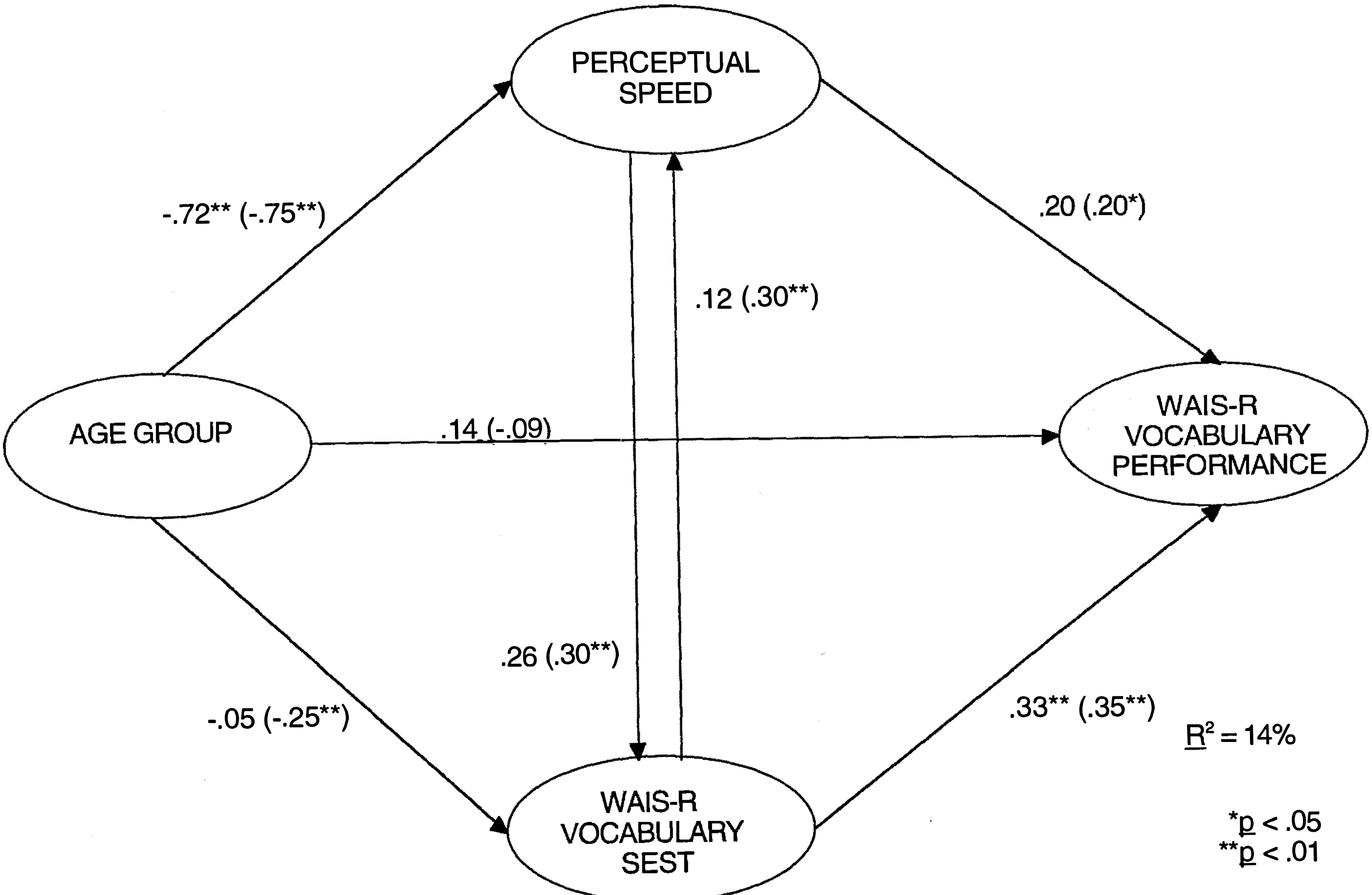

PERCEPTUAL SPEED
AGE GROUP
SPATIAL PERFORMANCE
SPATIAL SEST
-.63** (-.74**)
.19 (.63**)
.21** (.54**)
-.46** (-.70**)
.35** (.54**)
-.25 (-.51**)
.18* (.52**)
R² = 54%
*p < .05
**p < .01


PERCEPTUAL SPEED
AGE GROUP
REASONING PERFORMANCE
REASONING SEST
-.65** (-.76**)
.37** (.80**)
.27** (.54**)
-.47** (-.81**)
.54** (.54**)
-.01 (-.41**)
.13* (.52**)
R² = 74%
*p < .05
**p < .01



$\underline{R}^2 = 16\%$

*$\underline{p} < .05$
**$\underline{p} < .01$



$\underline{R}^2 = 14\%$

*$\underline{p} < .05$
**$\underline{p} < .01$