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Gender Differences in Spatial Ability in Old Age: Longitudinal and Intervention Findings[1]

Sherry L. Willis[2] and K. Warner Schaie
The Pennsylvania State University

Gender differences in spatial ability in old age were examined longitudinally and the effectiveness of cognitive training in reducing these differences was assessed. The mental rotation ability of older participants (N = *229;* M *age = 72.8 years) from the Seattle Longitudinal Study was examined over a 14-year period (1970–1984) from late middle age into old age. Both men and women exhibited normative age-related decline in spatial ability performance across the 14-year period; the magnitude of the gender difference remained constant across this period of decline. A significantly greater proportion of the age-related decline was associated with a drop in speed of problem solving for men than for women. Following training on mental rotation ability, there was no significant gender difference in spatial ability performance. Women exhibited significantly greater pretest–posttest gains, on average, than did men. A greater proportion of training improvement for women compared to men was attributable to increased accuracy. Training was particularly effective for older women who had experienced prior age-related decline.*

There has recently been increased attention and debate regarding gender differences in spatial ability (Linn & Petersen, 1985; McGee, 1979). Mental rotation ability is that dimension of spatial functioning that has exhibited

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[2] To whom reprint requests should be addressed at Department of Individual and Family Studies, S-110 Human Development Building, The Pennsylvania State University, University Park, Pennsylvania 16802.

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the most consistent and reliable gender differences. Much of the research on which this debate is based has focused on the periods of childhood and adolescence, since these are the developmental periods associated with the emergence of gender differences in spatial ability (Pellegrino, Alderton, & Shute, 1984). Recent reviews of the spatial ability literature report gender differences in mental rotation performance to occur by age 8, or as early developmentally as the ability can be measured (Linn & Petersen, 1985). However, Sherman (1978) and Hyde (1981) have noted that these gender differences, while statistically reliable, are small in magnitude and account for only a limited proportion of individual differences.

Much less attention has been given to mental rotation ability in middle and later adulthood. Most studies have been cross-sectional in design and have focused on age differences in mental rotation performance, with only secondary interest in gender differences. Research on adult cognitive development (Willis, 1985) indicates the increasing importance of individual differences in life experiences in accounting for variability in adult intellectual functioning; however, the relationship between experiential factors and gender differences in spatial ability in adulthood has received only limited attention. The period of later adulthood is of particular interest, since normative age-related decline in spatial ability begins to occur, and there has been little research regarding the relationship between experiential variables and gender differences during this period of decline.

Cross-sectional studies conducted within an information-processing approach have reported a slowing of mental rotation speed in later adulthood, suggesting that behavioral slowing is the primary component associated with age differences (Cerella, Poon, & Fozard, 1981; Gaylord & Marsh, 1975). No age differences in rate of commission errors have been found in these studies. In a study by Berg, Hertzog, and Hunt (1982), age differences and gender differences were examined in young middle-aged and older adult samples. Age differences were found in speed of mental rotation, but there were no significant age differences in error rates. Older women were found significantly slower in speed of rotation when compared with older men; there were no gender differences in error rate in later adulthood. When practice effects over a four-day period were examined, older women showed significantly greater improvement than other groups; this improvement was reflected in a significant decrease in rotation time.

The Seattle Longitudinal Study (SLS) is one of the few longitudinal studies to examine age-related changes in mental rotation in middle and later adulthood (Schaie, 1983). The SLS has examined age-related changes in intellectual abilities from a psychometric approach, based on Thurstone's primary mental abilities. SLS findings indicate that, on average, significant decrement in mental rotation performance first becomes evident in the early 60s. However, there are wide individual differences in the timing of age-related change. Schaie and Willis (1986) found that while 40% of the subjects aged 60–93 years, exhibited reliable age-related decline in spatial ability over the previous 14-year period, 60% showed no reliable age-related decline over this interval.

Schaie and Willis (1986) have also examined the effectiveness of cognitive training on mental rotation ability with older subjects from the SLS. The research examined whether cognitive training was effective in remediating the mental rotation performance of the elderly showing an age-related decline over the prior 14-year period and in improving the performance of the elderly exhibiting no reliable decline. Significant training effects were found for both stable and decline subjects. These effects were shown at the level of ability factor scores, indicating training improvement occurred at the latent construct level and thus was not test specific. Moreover, after training 40% of the decline subjects' scores were equal to or better than they had been 14 years previously.

This article reports findings regarding gender differences in mental rotation ability during later adulthood for SLS participants. The purpose of this report is twofold. First, longitudinal data on gender differences in mental rotation ability are presented over a 14-year period from late middle age to old age. The magnitude of gender differences in old age is examined, during the period when normative age-related decline begins to occur. Second, the effectiveness of cognitive training in attenuating gender differences in old age is assessed. Recent training studies have reported elimination of significant gender differences in young adult samples (Alderton, Pellegrino, & Lydiatt, 1984). However, there has been little research on the modifiability of gender differences in spatial orientation in old age. That is, would behavioral intervention be effective even in old age in attenuating gender differences, after a lifelong pattern of differences in performance levels between men and women?

METHOD

Subjects

Subjects were 229 older adults [male (M) = 97; female (F) = 132] from the Seattle metropolitan area, who had been participants in the SLS since 1970 or earlier (Schaie, 1983). All subjects are, or had been members of the Group Health Cooperative of Puget Sound, a health maintenance organization. This health organization includes members from a wide range of occupational categories, representing the upper 75% of the socioeconomic status range. Mean age of the total sample in 1984 was 72.8 years (range = 64–95; *SD* = 6.41). Mean educational level was 13.9 years (range = 6–20; *SD* = 2.98). There were no gender differences in age or educational level. Mean income level was $19,879 (range = $1000–$33,000; *SD* = $8520). All subjects were community dwelling. Most of the subjects were Caucasian. Prior to the 1984 phase of the study, each subject's physician was contacted and asked to indicate whether the subject suffered any known physical or mental disabilities (e.g., sensory, motor, memory deficits) that would interfere with participation in the study; subjects identified as incompetent to take part in test taking or training activities were not included in the study.

Design and Procedure

The design of the study involved two phases.

Phase 1. In the first phase, longitudinal change in spatial orientation ability over a 14-year period was examined. Subjects were assessed at 7-year intervals in 1970, 1977, and 1984 on the Thurstone primary abilities (Thurstone & Thurstone, 1949), including the Primary Mental Abilities (PMA) Spatial Orientation test.

Subjects' test performance on the Thurstone PMA Spatial Orientation and Inductive Reasoning tests were classified as having remained stable or as having declined over the 14-year interval (1970–1984). The statistical criterion for the definition of decline was one standard error of measurement or greater (Space = 6 raw score points). Subjects were first classified by defining a 1 SEM confidence interval about their observed 1970 score (cf. Dudek, 1979). If their 1977 score fell below this interval, they were provisionally considered to have declined; otherwise, they were considered to be stable. Next, their 1984 score was considered. Decline subjects who in 1984 returned to within the confidence interval about their 1970 score were then reclassified as stables. Stable subjects, whose 1984 score dropped to 1 SEM below their 1977 score, were reclassified as decliners.

There were 142 subjects (62%) classified as having remained stable on the PMA Spatial Orientation measure; 87 subjects (38%) had declined. As would be expected from prior descriptive research on age-related cognitive decline, decliners (*M* = 74.4 years, *SD* = 6.84) were significantly older than stables (*M* = 70.9 years, *SD* = 5.35; $p < .001$). There were no gender differences on age or education within status groups. That is, male and female stable subjects did not differ in age or education, nor did male and female decliners.

Given the classification procedure described above, there was the possibility of statistical regression effects occurring such that 1970 high scorers would have been erroneously classified in the decline group and the low scorers in the stable group. To examine the possible regression effects, a time-reversed control analysis was performed (cf. Baltes, Nesselroade, Schaie, & Labouvie, 1972; Campbell & Stanley, 1966). This analysis did not support the presence of substantial regression effects that would increase the classification error rate above that specified by the chosen confidence interval (Schaie & Willis, 1986).

Phase 2. The second phase of the study, conducted in 1984, involved a pretest-treatment-posttest control group design. Subjects were pre- and posttested on a five-hour psychometric ability battery, including the Thurstone primary abilities. The 1984 longitudinal data point served as the pretest. Subjects were assigned to the Space training program, based on the classification status, described above. Subjects who had declined on Space but not on Reasoning were assigned to the Space training program. Subjects who had remained stable on both Space and Reasoning, or had shown decline on both abilities, were randomly assigned to space training or to a treatment control condition involving Reasoning training. Space training subjects (*N* = 118) included 51 (M = 23; F = 28) stables and 67 decliners (M = 29; F = 38).

All subjects had previously participated in the SLS and were informed via a series of letters that a new phase of the study was beginning. Subjects indicating an interest in participation in the training phase were visited in their homes by a staff member. The purpose of the home visit was to discuss details of the study and to answer question, to assess sensory handicaps that might interfere with participation, and to determine whether the home was a suitable place for conducting the training sessions.

Following the pretest, subjects assigned to Space training participated in 5 one-hour individually conducted training sessions. The majority of subjects were trained in their homes. Two middle-aged trainers, with prior educational experience in working with adults, served as trainers. Subjects were randomly assigned to the trainers within pragmatic constraints.

Space Training Program

The focus of the Space training program was on facilitating the subject's use of effective cognitive strategies identified in previous descriptive research on mental rotation ability (Cooper & Shepard, 1973; Egan, 1981; Kail, Pellegrino, & Carter, 1980). Cognitive strategies that were focused upon in training included (1) development of concrete terms for various angles; (2) manual rotation of figures prior to mental rotation; (3) rotation of drawings of concrete, familiar objects prior to rotation of abstract figures; (4) subject-generated names for abstract figures; and (5) attention to two or more features of the figure during rotation. Prior research had shown that these strategies were useful in facilitating speed and accuracy of mental rotation. Strategies, such as use of concrete terms for angles and encouraging subjects to generate familiar names for abstract figures, were designed to reduce memory load and thus facilitate speed of mental rotation. Following training, subjects were assessed on a posttest battery involving the same measures administered at pretest. Subjects were paid $100 for participation in the study.

Measure and Scoring Procedure

The findings reported in this study are based on data for the PMA Spatial Orientation test (Thurstone & Thurstone, 1949), since this is the spatial ability measure for which both longitudinal and training data are available. The PMA Spatial Orientation test is a multiple response measure of two-dimensional mental rotation ability. In each of the 20 test items, the subject is shown a model line drawing and is asked to identify in which of six answer choices the model is shown in a different spatial orientation (45°, 90°, 135°, and 180° angles). Two or three answer choices in each test item are rotated drawings of the model (same image); the remaining three or four choices are mirror images of the model.

A subject's responses (maximum 120) can be categorized into four subscores (rights, wrongs, omits, mirror). The rights subscore is the sum of the correctly marked same image figures; maximum score = 54. The mirror subscore is the sum of the mirror-image figures that were not marked, within the total number of items attempted. The wrongs subscore is the sum of the mirror images that were incorrectly marked as being the same image as the model. The omits subscore is the sum of the same image figures that were not marked (omitted) within the total number of items attempted. The total number of correct responses equals the sum of the rights and mirror subscores. The total number of incorrect responses equals the sum of the wrongs and omits subscores. The attempts score is the sum of the right, wrong, omit, and mirror subscores.

PMA Spatial Orientation Test Score. Traditionally, the PMA test has been scored as the rights subscore minus the wrongs subscore (i.e., the number of same images marked correctly minus the number of mirror images incorrectly marked as being the same image as the model). Data from this scoring procedure is reported as the PMA Spatial Orientation test score.

Accuracy and Speed Change Scores. In addition to the traditional score, accuracy and speed change scores were computed for the longitudinal and the training phases of the study to examine the nature of gender differences in age-related decline and in training improvement. The traditional scoring procedure provides little information on the nature of behavioral differences or change, given that the score is based on the raw number of items attempted and does not reflect relative changes in accuracy as the number of items attempted varies across occasions. For example, as the number of items attempted decreases as a function of age-related decline, accuracy (i.e., proportion of attempted items answered correctly) may decline or may not decline.

The change in accuracy for each of the two phases of the study (1970–1984; Pretest–Posttest) was computed by the following procedure: First, an accuracy score was computed as the proportion of the attempted answer choices marked correctly (e.g., 1970 rights subscore + 1970 mirror subscore/1970 attempts score). An expected score for the second occasion was computed, assuming that level of accuracy remained constant across the two occasions. For example, the 1984 expected score was computed as the proportion of 1970 correct responses (1970 rights + mirrors) multiplied by the 1984 attempts score. The change in accuracy between 1970 and 1984 was computed as the observed 1984 correct responses (e.g., 1984 rights + 1984 mirrors) minus the 1984 expected score. A speed of problem-solving change score was then obtained by subtracting the 1984 accuracy change score from the observed change score. The observed change score was computed as the change in the total number of correct responses (e.g., the sum of the 1970 right + mirror subscores minus the sum of the 1984 right + mirror subscores).

RESULTS

Findings are reported separately for the 1970– 1984 longitudinal (Phase 1), and the training (Phase 2) phases of the study. For each phase, data are presented for the PMA Spatial Orientation test score, and for the accuracy and speed scores.

Phase 1

Longitudinal Change in PMA Spatial Orientation Test Score. Longitudinal change over the 14-year period was examined via a 2 Status (Stable, Decline) × 2 Gender × 2 Occasion (1970, 1984) analysis of variance (ANOVA). Significant occasion and gender main effects and a significant Status × Occasion interaction were found. The significant occasion main effect

$[F(1,225) = 69.81; p < .001]$ indicated significant age-related decline across the 14-year period. The significant gender main effect $[F(1,225) = 7.02; p < .008]$ indicated that males' scores were significantly higher than females' at both occasions. The significant Status × Occasion interaction indicated that socres of decliners were below those of stables only in 1984 $(F(1,225) = 88.12; p < .001]$.

To examine gender differences in the magnitude of age-related decline across the 14-year period, a difference score (1984 score minus 1970 score) was computed for males and females in the decline group; there was no significant gender difference in the magnitude of decline. Table I presents the PMA Spatial Orientation test scores separately by gender and status for the three occasions of measurement. Figure 1 presents mean test scores separately for men and women for the three occasions (1970, 1984/pretest, posttest). Figure 2 presents these data separately by status.

Table I. Raw Score Means for Males and Females at Three Occasions: PMA Spatial Orientation Test Score and Subscore Scores

	Occasion					
	1970 (N = 204)		1984-Pre (N = 229)		Post-T[a] (N = 118)	
Variable	M	F	M	F	M	F
Total group						
PMA space[b]	20.94	17.27	16.72	13.00	18.60	19.27
Subscores						
Rights	23.23	20.04	20.19	17.31	21.86	22.83
Mirror[c]	35.78	32.03	32.63	30.16	33.85	35.83
Wrongs	2.81	2.71	3.47	4.37	3.26	3.56
Omits[d]	8.34	8.38	7.17	8.75	6.33	7.41
Attempts	70.16	63.16	63.46	60.59	65.28	69.60
Stable						
PMA space	20.61	16.30	21.16	16.89	23.13	21.25
Subscores						
Rights	22.86	18.46	23.50	19.82	26.30	23.89
Mirror	34.86	30.01	35.27	33.10	38.21	37.03
Wrongs	2.87	2.80	2.34	2.93	3.17	2.64
Omits	7.88	8.42	5.21	7.47	5.34	6.46
Attempts	68.47	59.69	66.32	63.32	73.02	70.02
Decline						
PMA space	21.39	18.52	10.66	7.95	14.93	17.82
Subscores						
Rights	23.77	22.27	15.68	14.10	18.34	22.05
Mirror	37.11	34.86	29.02	26.41	30.32	34.93
Wrongs	3.00	2.59	5.02	6.21	3.41	4.24
Omits	9.00	8.33	9.83	10.38	7.10	8.10
Attempts	72.88	68.05	59.55	57.10	59.17	69.32

[a] Scores for space training group at posttest.
[b] PMA scores computed as rights minus wrongs.
[c] Mirror images correctly not marked, within attempted items.
[d] Same-image items incorrectly omitted (not marked), within attempted items.

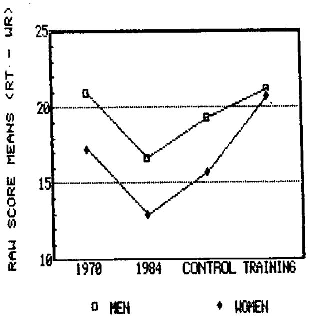

Fig. 1. PMA Spatial Orientation test raw score means for men and women in 1970 and in 1984 (pretest), and separately at posttest for control group men and women, and Space training group men and women.

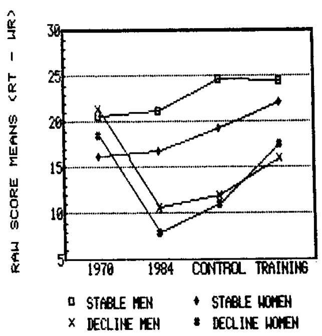

Fig. 2. PMA Spatial Orientation test raw score means for men and women, who had remained stable and who had declined on spatial ability. Scores are shown for total group in 1970 and in 1984 (pretest), and separately for the control group and for the Space training group at posttest.

*Longitudinal Change in Accuracy and Speed. The 1970–*1984 change scores for accuracy and for speed are presented on the left-hand side of Fig. 3, for the total group (top figure), for stable subjects (middle figure), and for decliners (bottom figure).

For the group as a whole, there was no significant gender difference in the magnitude of total decline. However, there was a significant gender difference in the speed change score [$F(1,202) = 4.52$; $p < .03$]. A greater proportion of the total decline was attributable to a decrease in problem-solving speed for men than for women. There was a trend for women to exhibit a greater decline in accuracy [$F(1,202) = 2.93$; $p < .08$].

For stable subjects, there was a significant gender difference in the speed change score [$F(1,118) = 4.33$; $p < .04$]. A greater proportion of the total decline was attributable to a decrease in problem-solving speed for stable men than for stable women.

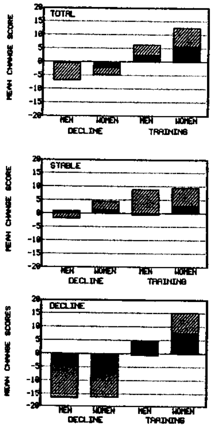

Fig. 3. (Top) Accuracy and speed mean change scores for total group: decline (1970–1984 change) and training (pre–posttest change). (Middle) Accuracy and speed mean change scores for stable subjects: decline (1970–1984), and training (pre–posttest). (Bottom) Accuracy and speed mean change scores for decline subjects: decline (1970–1984) and training (pre–posttest).

For the decline subjects, there was a trend toward a gender difference in the accuracy change score [$F(3,10)$; $p < .08$], suggesting a greater decline in accuracy for decline women than for decline men.

Phase 2

In the second phase of the study, the effects of cognitive training were examined with respect to gender and status.

Training Effects: PMA Spatial Orientation Test Score. Training effects were examined via a 2 Treatment (Training, Control) × 2 Status (Stable, Decline) × 2 Gender × 2 Occasion (1984–Pretest, Posttest) ANOVA with repeated measures. There were significant main effects for status [$F(1,221) = 26.14$; $p < .001$], gender [$F(1,221) = 5.70$, $p < .05$], and occasion [$F(1,221) = 90.68$; $p < .001$]. The status and gender main effects reflect the lower scores of the decliners and of women, respectively. The occasion main effect indicates retest/training improvement. The significant Treatment × Occasion interaction [$F(1,221) = 13.38$; $p < .001$] indicates higher performance for the spatial training group at posttest, compared to the reasoning training group. The significant Treatment × Status × Occasion interaction [$F(1,221) = 4.73$; $p < .05$] reflects greater training gain for the decliners than for the stables at posttest. A significant Gender × Occasion interaction [$F(1,221) = 3.78$; $p < .05$] reflects larger retest/training effects for women at posttest.

The mean test scores at posttest for males and females in the training condition are shown in Table I and presented graphically in Fig. 1. The control group's mean posttest score as shown in Fig. 1 was obtained for the total group by incrementing the total group's pretest mean by the average gain on space experienced by the control group, which received training on Inductive Reasoning. The Space Training mean posttest score as shown in Fig. 1 was obtained for the total group by incrementing the pretest mean for the total group by the average gain on space experienced by those subjects who received Space training.

Training Effects: Accuracy and Speed Change Scores. Pre–posttest changes in accuracy and speed were examined for the Space training group.

For the total training group, there was a gender difference in the accuracy change score [$F(1,116) = 4.67$; $p < .03$]. Women exhibited greater training improvement than did men.

For the stable group, there was no significant gender difference in the magnitude of total training gain. However, there was a gender difference in the accuracy change score [$F(1,49)$; $p < .05$]. A greater proportion of the total training gain was attributable to an increase in accuracy for stable women than for stable men.

For the decline group, women exhibited a significantly greater total training gain than did men. There was a significant gender difference in the speed change score in favor of decline women [$F(1,65) = 7.35$; $p < .009$]. A greater proportion of the total training gain was attributable to an increase in problem-solving speed for decline women than for decline men.

DISCUSSION

Findings from this research contribute to a life-span perspective on gender differences in spatial ability. Longitudinal data indicated that both men and women experienced age-related decline in mental rotation ability across a 14-year period from late middle to early old age. Gender differences favoring men were maintained across the period of age-related decline. However, it is important to note that there was no gender difference in the magnitude of age-related decline; men and women experienced about the same amount of drop in performance level.

There were, however, significant gender differences in the nature of the age-related decline. For older men, a greater proportion of the total decline was associated with behavioral slowing than for older women. While our data only permit us to examine slowing in terms of a decrease in the number of items attempted, it is likely that this decrease reflects a decline in speed of mental rotation. Several cross-sectional studies of spatial ability have reported that age differences between young and older adults are primarily attributable to differences in the speed of mental rotation (Berg et al., 1982; Cerella et al., 1981). Although our older male and female subjects do not differ in mean age, it should be recognized that there is a gender difference in average life expectancy, in favor of women. Our older male subjects are likely to be, on average, closer to death, and thus may be expected to experience increased behavioral slowing. While behavioral slowing appears the more parsimonious reason for the gender difference in number of items attempted, given the corroborative findings from information-processing studies on age differences in speed of mental rotation, an alternative explanation would focus on an age-related increase in cautiousness. There is some research within the aging literature (Botwinick, 1978) indicating that older adults are more cautious in responding to certain types of problem-solving tasks than are young adults; older adults become more careful in order to avoid making mistakes. However, gender differences have not been noted in the age-related cautiousness literature.

For older women, in contrast, a greater proportion of age-related decline appears associated with a decrease in accuracy. Age-related decline for women thus involves not only a slowing in behavior, but also an increase in the number of commission errors. This finding at first appears discrepant with the Berg et al. (1982) study, in which no significant age or gender differences in error rates were found. However, the Berg et al. study was cross sectional and considered accuracy only in terms of correct responses, while accuracy as computed in this study reflects changes in both correct and incorrect responses. Since our findings regarding decreased accuracy for women represent only trends ($p < .08$), the data must be interpreted cautiously until replication studies become available.

If age-related decline in older women is associated, in part, with decreased accuracy, then training procedures that emphasize cognitive strategies may be particularly advantageous for these older women. The findings from the training phase support this hypothesis in two ways. First, the magnitude of training improvement is somewhat greater for women. In particular, women who had shown previous decline showed greater training gain. Second, the proportion of training improvement associated with increased accuracy was greater for women than for men. It should also be noted that, although decline men showed a smaller training effect than decline women, the training effect for men reflected primarily an improvement in accuracy. In contrast, for stable men who were already highly accurate, training improvement reflected primarily an increase in speed.

The training data may also be examined in terms of gender differences in the remediation of age-related decline. Both stable men and women exhibited mean performance levels following training that are above the mean levels shown 14 years previously (Fig. 2). Women experiencing age-related decline showed, on average, a remediation of this loss. In contrast, for decline men, training improvement resulted, on average, in only a partial remediation of age-related decline.

These data suggest that there may be individual differences in the nature of the performance decline shown in longitudinal studies. For some individuals, decline may occur as a function of reduced societal roles and a decrease in the level of intellectual stimulation in their environment, occurring, for example, as the result of events, such as retirement or widowhood. For individuals experiencing this type of decline, behavioral interventions, such as our training program, may be particularly effective in partially remediating this experientially related decline. For other individuals, performance decline may reflect health problems and terminal drop; cognitive training of the type included in this study may be less useful in remediating health-related decline. Results from this study provide some suggestive evidence that decline for many older women may be experientially based, and thus cognitive interventions are often effective. Training is also useful for men experiencing deficits in stimulating environments. However, for men whose cognitive decline reflects sensory or health problems, this type of training may be less effective.

Findings from this study illustrate the importance of examining gender differences in old age within a longitudinal context. In addition to gender differences, there are wide individual differences in the timing of age-related decline. Researchers examining gender differences in childhood or young adulthood may accurately assume that their subjects have suffered no age-related decline and are functioning at their highest developmental level. However, performance differences between older males and females may reflect not only long-term gender differences, but also differences in the proportion of older males vs females experiencing age-related decline. Given gender differences in average life expectancy, older males when compared to females of the same age are, on average, more likely to have suffered significant age-related decline, and thus gender differences may appear somewhat attenuated. It is only when prior longitudinal data is available that issues of stability vs decline can be examined and disentangled from gender differences.

The data reported here provide support for other recent findings regarding cohort differences in the magnitude of gender differences in spatial ability. Linn and Petersen (1985) report that for recent cohorts of children and adolescents the magnitude of the gender difference has been on the order of .25 *SD* for measures of mental rotation. In the present longitudinal data, the gender difference amounts to .33–.40 *SD*, suggesting a somewhat larger gender difference in earlier born cohorts. However, it should be noted that the magnitude of the gender effect in this study is still modest. The gender difference effect size in this study as measured by the statistic *d* was .37; Cohen (1969) considers a *d* of .20 as representing a small effect, and a value of .50 as a medium-sized effect.

These findings indicate that cognitive intervention is effective, even in old age, in reducing gender differences in spatial orientation ability that have been observed reliably for a 14-year period. When considered in conjunction with recent training studies with young adults (Alderton et al., 1984), our results permit a view of training research on gender differences from a life-span perspective. There, indeed, appears considerable plasticity in women's and men's spatial performance throughout the adult life span.

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