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Landmark Selection and Temporal-Spatial Integration: Macrospatial Abilities in Young Adults and Elderly Adults

Deans Haggerty
Old Dominion University

Landmark Selection

and

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Macrospatial Abilities

in Young Adults and Elderly Adults

by
Deana Haggerty
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Approved by:

Kathleen C. Kirasic (Director)

Gary Allen

Glynn D. Coates

Robin J. Lewis

Abstract

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Deana Haggerty
Old Dominion University, 1986
Director: Dr. Kathleen C. Kirasic

Groups of young adults and elderly adults participated in a study examining age-related changes in macrospatial cognitive abilities. Perceptual differentiation/selection abilities were tested using a Landmark Selection task, while temporal-spatial integration abilities were explored through the use of a Scrambled Route task. In the Landmark Selection task, subjects viewed a slide presentation of a walk and then chose the landmarks which best represented the walk. For the Scrambled Route task, after viewing a slide presentation of a scrambled walk, subjects made distance estimations involving pairs of selected landmarks. Also included were self-assessment scales of spatial abilities and two psychometric tests (Picture Arrangment and Identical Pictures Test). It was hypothesized that there would be no age-related differences in the self-assessment scales and in the performance on the two route tasks, but that there would be an age-related decline in the performance on the psychometric tests.

Elderly adults exhibited a significatly lower performance level on both experimental tasks, indicating an age-related decrement in macrospatial abilities utilizing perceptual differentiation/selection and temporal-spatial integration, even though their self-assessment ratings indicated otherwise. Performance on the psychometric tests of spatial abilities proved to be predictive of performance on the experimental tests.

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Macrospatial cognition involves the acquisition and use of knowledge of the spatial attributes of an area or environment (Allen, 1985). This knowledge deals with large-scale space, which has been defined as an environment that requires more than one vantage point to perceive the whole (Kuipers, 1977; Kirasic & Allen, 1985). Large-scale space is large enough to move around in, thus it completely surrounds the individual (Acredolo, 1981; Siegel, 1981; Cohen, 1985; Weatherford, 1985). Macrospatial knowledge of large-scale space may be considered to be encoded and internally represented through a cognitive map, an individual's internal record of an experienced environment (Downs & Stea, 1973; Siegel, Kirasic & Kail, 1978).

Through the study of macrospatial cognition, also referred to as environmental knowing, researchers are better able to understand individual differences in cognitive maps. Moore and Golledge (1976) have outlined three basic assumptions involved in studying environmental knowing. First, environmental knowing is an ongoing process in which environmental information is constantly being received, selected, organized and used by the individual to function in his/her everyday life. Second, the way an individual perceives and processes the environment is often quite different from the actual dimensions of that environment, and thus, these perceptions are used differently by different groups of individuals. Third, the information processed about the environment is stored in some type of psychological space, now called the mental or cognitive map.

Cognitive mapping is important because the world as we perceive it to be serves as the basis for much of our everyday spatial behavior. Cognitive maps help organize and manipulate our knowledge about our environment. They also help us get from one place to another, to know where to locate our basic activities. Cognitive maps also vary according to a person's perspective of their world. They undergo change as a person ages and as one's experiences in the environment increases (Downs & Stea, 1977). On the more practical side, not only does cognitive mapping provide an individual with a personal understanding of the world by allowing for a vehicle though which to recall memories, it can also be used by advertisers to target products to sell and the places to sell them. In this way, the merchandiser is able to expose his product to a larger purchasing population (Downs & Stea, 1977).

Kevin Lynch's The Image of the City (1960) is considered to be one of the most important influences on the study of environmental cognition. Lynch was interested in the "legibility" of different cities, referring to how well different cities can be recognized and organized by people. Lynch stated that environmental images help to establish emotionally safe relationships between an individual and their total environment. The images act as organizers of activities and knowledge, as in the material for common memories which bind a group together and as the spatial references for a sense of familiarity.

Lynch concluded that an individual's image of the environment depends upon how distinct the environment is from another environment and how familiar the individual is with the area. According to Lynch, there are five major elements of an environment: 1) paths - common channels of movement, 2) edges - boundaries between two phases of the environment, 3) districts - medium to large sections of the environment, 4) nodes - strategic points along a path in which the observer may enter, and 5) landmarks - physical objects of point-reference along a path. Through the use of these five elements, Lynch was the first to examine the ways in which individuals come to know their environment.

According to Siegel and White (1975), macrospatial knowledge of environments are encoded in a three-step process. First, landmarks are recognized and remembered. From these landmarks, routes are constructed in which the landmarks are first ordered and later organized according to their metric interrelationships. Finally, as the individual gains experience in the environment and acquires or applies higher-order cognitive skills, configurations, or mental maps, are formed. Various routes may be organized together to allow for a multitude of navigational options.

Landmarks are identifiers of specific geographical locations (Siegel & White, 1975). They are used as course-maintaining devices from the beginning of the trip to the end, in that they link together movement through out the course of a route. A finer differentiation regarding landmarks has been described by Briggs (1973). First, end nodes form the beginning and end markers of a path and are points at which movement's purpose is realized. Second, link nodes are used as navigational devices in the environment between two end nodes. They are utilized to reach end nodes. Third, potiential nodes are landmarks that are not readily used for navigation. They serve as fillers between link nodes. It is possible that all end nodes may serve as link nodes, such as in the case where the routes's course changes direction; however, not all link nodes can function as an end nodes. Intersections, for example are strictly link nodes.

Through the sequencing of landmarks, a route may be formed that specifies a particular sensorimotor routine. Routes can be used to give shape to the spatial environment, to show movement through the environment. The relationship between landmarks and their order determines the direction of the route. Landmark knowledge is basically the sequential knowledge that as one encounters a certain series of landmarks and directional decision points, then one can be certain a particular route is being traversed (Briggs, 1973; Siegel & White, 1976).

Once a number of individual routes are formed, it is possible to integrate them into a configuration (Siegel & White, 1975). Configuration information encompasses the integration of knowledge about old routes and landmarks with ideas about possible new routes into a "unified gestalt" perception of the environment. Siegel and

White (1975) have identified three types of configuration knowledge: 1) perceived outlines of terrains, such as territorial boundaries, 2) graphic skeletons, such as road maps, and 3) figurative metaphors, such as the "boot" of Italy. These environmental perceptions are what enables people to move freely about their environment, as well as constituting the basis for the formation of cognitive maps.

It has been observed that when constructing a cognitive map, an individual often does not encode landmarks and other environmental characteristics as they are actually represented in the environment (Downs & Stea, 1973). The inconsistencies that occur between cognitive maps and the real world may take several forms. The individual may choose to represent some features while leaving out others that another individual may consider important. A person may also augment, or distort, the environment to fit their own personal beliefs. Finally, distortions may occur when the individual's subjective estimations of distance and direction deviate from the true distance and direction.

The distortion of distance estimations has been attributed to several perceptual phenomena, as the problem has been found to persist even when the exact distance between locations was known by the subject (Thornyke, 1981). Barrier effects have been shown to cause errors in distance estimations, as the distance of filled space is judged as greater than unfilled space (Cohen & Weatherford, 1980; Thorndyke, 1981). Barriers are those objects which come between the place of origin and the destination. They provide a means by which to "chunk" space and may prevent observations of the entire environment

(Newcombe & Liben, 1982). Thorndyke (1981) has concluded that subjects encode maps into memory in such a way as to attempt to preserve the spatial relations of the real maps. Then, as the subjects scan their visual image, much as a real map would be scanned, they must stop at each barrier, retrieve the city's name, and compare it to the destination. This increases the scanning time and results in a greater distance estimation.

Herman, Norton, and Roth's (1983) results disputed these conclusions. While Thorndyke's (1981) study involved knowledge acquired from cartographic maps, Herman et al. (1983) had their subjects actually walk through the environment that was to be learned. Herman et al. (1983) found no clutter or barrier effects at any age (subjects ranged from seven to 21 years of age) when subjects actually walked through the environment and when objects encountered were not large enough to obscure the view of one location from another.

With these types of results, the question as to what a barrier is arises. While Thorndyke (1981) considers barriers to be something that comes between the origin and the destination, the term does not seem appropriately applied to cartographic maps. These would seem to be more logically termed "chunking devices". Barriers may be more precisely defined as anything that hinders or blocks. In this sense, Herman et al.'s (1983) model buildings would be considered barriers and distict environmental features, while Thorndyke's (1981) city points would not.

Allen, Siegel, and Rosinski (1978) concluded that the acquisition of spatial knowledge about a novel environment begins with the perception of distinctive environmental features. Results of a study by Allen (1981) indicated that individuals are readily able to subdivide a presented route into generally well-defined sections by identifying barriers or dividing lines within the environment. Although Allen's (1981) subjects ranged from second-graders through college students, he found a general consensus, both within and between groups, as to the boundaries of these subdivisions.

Age-related Changes in Spatial Cognition

Spatial abilities have been measured in several different ways. Performance on standardized psychometric instruments may be utilized in the assessment of the cognitive abilities possessed by elderly adults. Results from these tasks have generally produced an age-related decline in cognitive functioning (Botwinick, 1977). Generally, declines in cognitive abilities have appeared in tasks that required flexibility in thinking as in abstract thought or on novel tasks, often called "fluid intelligence", rather than with tasks that involve perviously obtained knowledge, often referred to as "crystallized intelligence" (Horn & Cattell, 1967).

In the area of spatial abilities, psychometric tests also indicate the age-related decline of functioning (Kirasic & Allen, 1985). Four subtests from the Wechsler Adult Intelligence Scale clearly demonstrate the decline in performance - the Object Assembly, Picture Completion, Block Design, and Picture Arrangement. Salthouse (1982) reported an average performance decline of approximately five to ten percent per decade beginning around the age of 30. A variety of spatial abilities are evaluated by the WAIS subtests, such as straight spatial abilities in the Object Assembly task and a combination of temporal, spatial and cognitive reasoning in the Picture Arrangement task (Kirasic & Allen, 1985).

The problem with the use of psychometric test performance as an indicator of elderly individuals' cognitive abilities is that most of the tests were designed for use on a different population. The tests were created for use on young adults, standardized on young adults and validated on young adults. This means that the cognitive abilities of older adults are being measured using the average performance for young adults. Another problem that arises is in test administration. Instruction comprehension, answer sheet coordination, fatigue, and finding meaningfulness in the task have often been problems associated with testing adults, of any age (Kirasic & Allen, 1985).

A decline in spatial performance has been indicated through the use of psychometric tests, and this is supported by the recent studies using experimental tasks. Two such areas of research have been in spatial rotation and spatial memory (Craik, 1977; Poon, Fozard, Cermak, Arenberg, & Thompson, 1980). Perlmutter, Metzger, Nezwkorski and Miller (1981) found an aging-related decline in performance on a spatial memory task using building locations on a map. Subjects were presented three maps containing eight buildings each. After studying each map, subjects were required to indicate the original location of each building for that map. The young adults ($\bar{x}$ age = 20) were better able to indicate the proper location of the building on an outline map than were older adults ($\bar{x}$ age = 64). These findings were confirmed by Park, Puglisi, and Lutz (1982) with their study of memory for drawings and their locations. Older adults were able to recognize and recall significantly less spatial information than were college students.

Older adults' ability to perform mental rotation tasks typically has been shown to be inferior to that of young adults. Krauss, Quayhagen, and Schaie (1980) found this to be the case, especially when the subject was required to remember the test stimulus. It has also been shown that older adults are slower in their decision-making processes when comparing two items in a rotation task (Gaylord & Marsh, 1975). Cerella, Poon, and Fozard (1981) replicated the results of Gaylord and Marsh (1975) and also found the age-related decline in mental rotation abilities.

Studies of perspective-taking ability have shown 20-year-olds to be more accurate than 60- to 70-year-olds. This decline has been reported to be caused by a generalized slow down in cognitive processing (Herman & Coyne, 1980). It has been hypothesized that children's poor performance in perspective taking tasks could in part be due to the effects of irrelevant information, and this same factor may contribute to the poor performance in older individuals (Rabbitt, 1965). In other words, too much inconsequential information could diminish the performance of the elderly subject. This hypothesis is supported by the results of McCormack's (1982) study of the coding of spatial information. While young adults did perform better in free recall of stimulus words, there was no difference found between young adults and elderly adults for ability to identify the target location.

It should be emphasized, however, that these studies were conducted in a laboratory setting using tasks of spatial abilities that could be considered esoteric. What these tests reflect with regard to large-scale space or real-world spatial abilities is unclear. A greater emphasis on the study of macrospatial abilities may yield a more valid, relevant picture of an individual's capabilities in real-world spatial tasks (Kirasic & Allen, 1985).

By removing the elderly individual from a strict laboratory setting and placing them in a more common or familiar type of environment, a more valid assessment of their level of functioning on a daily basis may be obtained. This is due in part to the relevancy of the task presented. When the task is similar to an act of daily life, the elderly individual is better able to comprehend the instructions and draw from existing knowledge concerning how to approach such a situation. The task is not as confusing or pointless, as may be the case with other experimental tasks (Kirasic & Allen, 1985).

Results from studies involving macrospatial tasks have produced more favorable findings concerning the spatial abilities of elderly adults. In a study in which two neighborhoods of elderly adults were matched on demographics, Walsh, Krauss, and Regnier (1981) found substantial correlations between spatial abilities and the accuracy with which the subjects were able to locate major neighborhood landmarks. Also indicated in the findings was evidence that cognitive spatial abilities play a measurable role in determining the level at which older individuals use the neighborhood. In turn, a greater knowledge of the neighborhood landmarks was related to greater use of the services located in the neighborhood.

In a study concerned with ecologically valid spatial behavior, Kirasic (1981) examined the performance of supermarket shopping in young adults and elderly adults. Here, the subject's ability to shop efficiently in his/her usual supermarket was compared with that in a novel market. Results indicated that the performance of the young adults was not affected by the familiarity of the setting. The elderly adults, however, performed more accurately and efficiently in the familiar market than in the unfamiliar market.

These are but two studies in a widely unexplored area. Although available research indicates that the macrospatial cognitions of elderly individuals may not be as impaired as psychometric and other experimental studies suggest. Much more research is required to substantiate this possiblity and to identify important processes involved in cognitive mapping (Kirasic & Allen, 1985).

The Present Study

In studying the acquisition of macrospatial knowledge in the elderly, two hypothesized processes are of particular interest: perceptual differentiation/selection and temporal-spatial integration. The process of perceptual differentiation/selection may be examined through the task of landmark selection, while learning a route under conditions of temporal-spatial discontinuity is a result of temporal-spatial integration. Landmark knowledge enables an individual to recognize specific features in the environment and thus increase the individual's movement capacity (Allen, Siegel, & Rosinski, 1978). The types of landmarks selected determine how useful the environmental knowledge will be. Once the landmarks have been selected, the ability to organize them in their proper sequence, temporal-spatial integration, determines how well the individual maneuvers in the environment.

Allen, Kirasic, Siegel, and Herman (1979) compared the landmark selection and use in second-graders, fifth-graders, and college students. Their findings indicated that young adults and children do not spontaneously choose the same landmarks. Young adults tend to select more reference points that reflect actual or potential changes in direction than children. Also, young adults exhibit more accurate distance knowledge of the presented walk than the children on peer-selected reference points. Older children were able to make more accurate distance judgments than younger children when using adult-selected rather than peer-selected reference points. Allen et. al. (1978) determined that repeated visual exposure to an environment allows for more refined calculations of the temporal-spatial relationships between landmarks. As the number of exposures increase, subjects scale their own mental representation of the area accordingly until it approaches the actual dimensions of the environment (Lynch, 1960). These findings suggest that as an individual matures, their abilities to select more relevant landmarks and make more accurate distance estimations increase.

Unfortunately, this research did not focus on the stability of these abilities in the later years of life. What has been shown is that the results of standarized psychometric tests have generally produced trends showing an age-related decline in spatial abilities. An age-related decline in spatial abilities has also been demonstrated in research using experimental tasks. Environmental tasks appear to be the first area in which the abilities of elderly adults do not fall below that of younger adults. The research of Allen et al. (1978) and Allen et al. (1979) provides one approach to examining landmark selections and temporal-spatial integration in elderly adults.

Slide presentations were used in the present study to acquaint subjects with two walks. Slide presentations have been used with success in previous research as a substitute for actually walking the route. Jenkins, Wald, and Pittenger (1978) presented subjects with a slide presentation of a scrambled walk in which every third picture had been omitted. Subjects were then tested on their ability to recognize pictures from the walk, pictures omitted from the walk, and control pictures that did not belong in the walk. Subjects were 85% accurate in choosing the pictures presented in the actual walk, 54% accurate in identifying those pictures that belonged in the walk but had been omitted, 4% correct in choosing control slides. These findings indicate subjects' ability
to learn temporal-spatial relationships among presentation slides, thus successfully representing large-scale space.

The research of Allen et al. (1978) also demonstrated quite convincingly that slide presentations provide subjects with spatial information which is stored in the representation of a walk, or route. Furthermore, correlational data from this study illustrated that viewing slides in a random ordering provides sufficient information for the acquisition of route knowledge. Also, accurate route knowledge may be obtained after only two viewings of a slide presentation.

In the present study, young adults and elderly adults performed two macrospatial tasks involving slide presentations of walks. In the Landmark Selection task, subjects first viewed a walk and then were asked to select the 12 landmarks that best represented the route. In the Scrambled Route task, subjects viewed a scrambled walk and then estimated the distance between 12 sets of pre-selected landmark slides. Performance on the Landmark Selection task reflected perceptual differentiation abilities while performance on the Scrambled Route task reflected temporal-spatial integration abilities.

A significant, though modest, positive relationship was expected between the performance on the Landmark Selection task and the Scrambled Route task. This prediction was based on the fact that while each task involve different processes, both demand that subjects acquire route information from a slide presentation. It was also predicted that there would not be a significant difference between the performance of the young adults and the elderly adults on these two tasks, as both groups are required to use the same macrospatial cognitive processes to interpret the environment.

In addition to the two experimental tasks, subjects also completed two self-assessment scales - one concerning spatial, way-finding abilities and one concerning distance estimation abilities. Other measures used were the Identical Pictures Test and five subtests from the Picture Arrangement Test from the WAIS-R.

It was predicted that there would be no significant difference between the age groups on the self-assessment scales, but the age-related decline in performance was predicted on the standardized tests. This performance decline was expected in light of previous resesearch involving psychometric tests.

Method

Subjects

Thirty males and 29 females from each of two adult populations were used in this study. Young adults ($\overline{x}$ age = 26.7; range = 18 to 33) were undergraduate and graduate students who volunteered to participate for experimental credit. The elderly adults ($\overline{x}$ age = 69.6; range = 57 to 85) were paid five dollars for their participation. Elderly adults were recruited from senior centers, a retired officers club, and a retirement village. All subjects were treated in accordance with the "Ethical Principles of Psychologists" (American Psychological Association, 1981).

Material

Measures of spatial abilities were obtained through the use of the Identical Pictures Test (published by Educational Testing Services, 1975) and the Picture Arrangement subset items 2, 3, 5, 7, and 9 from the WAIS-R (1981). The Search for A's Test (published by Educational Testing Services, 1975) was used as an interpolated task. Included in the preliminary measures were two self report questions concerning the subjects' rating of their own spatial (way-finding) and distance estimation abilities. The scales ranged from one to five, with one being very poor in ability and five being very good.

Also used in the experiment were two walking routes of approximately two kilometers in length, both of which were unfamiliar to the subjects. The first route, the Landmark Selection walk, was represented in both slide and color print form. The walk proceeded through residential, recreational and commercial environments. Photographs used in the walk were taken with a 35mm camera mounted with a 50mm lens. Pictures were taken every 10 to 20 meters as required by the conditions of the terrain. Sixty-four slides represented this walk.

The slides were projected using a rear projection screen, allowing for direct viewing by the subjects. The prints, four by six inches in size, were mounted on poster-board of approximately 127 centimeters by 81.5 centimeters (50 x 32 inches). The prints were arranged left to right, top to bottom, and were clearly numbered from one to 64 in the upper right hand corner.

The second route, the Scrambled Route walk, was represented by 61 slides and was photographed in a different city than the Landmark Selection walk. The slides were photographed and projected in the same manner as those used in the Landmark Selection walk. The slides for the Distance Estimation walk were randomly scrambled. Twelve of these slides were chosen by the experimenter and three raters as those scenes which possessed the highest landmark potiential.

Procedure

Subjects were tested in groups, with the maximum possible in each group being five. Subjects were asked to rate their abilities using two scales, one rating spatial abilities (i.e., the ability to get around a new shopping mall or the ability to read a map) and the other rating distance estimation abilities (i.e., the ability to judge the distance between two points or the height of buildings). Next, two psychometric measures were administered. Subjects completed two subtests of the Identical Pictures Test, each containing 96 items. They were given a minute and a half for each subtest. And the final preliminary measurement, the Picture Arrangement Test, was administered to subjects individually. Therefore, the Search for A's Test was employed as an interpolated task for those subjects not working on the Picture Arrangement Test. If the subject had not generated a satisfactory solution to a Picture Arrangement item by the end of a two minute period, their partial solution was recorded. Time was not measured as a dependent variable in the Picture Arrangement Test. It was used, rather, to prevent subjects from working on any one item for an extended period of time.

The two routes were presented to groups of subjects in a counterbalanced order. In the Landmark Selection task, the subjects viewed the slide presentation of the route, then the corresponding prints of the walk, and finally, a second viewing of the slides. Subjects were required to choose 12 scenes, from the 64 presented prints they thought contained the highest landmark potiental. Subjects were given the example that they had to explain to a friend how to travel from the beginning to the end of the route using only 12 landmarks in their description. The numbers of the pictures containing the choosen landmarks were recorded by the subject on a pre-numbered answer sheet.

In the Scrambled Route task, subjects viewed the randomly-ordered slide presentation twice. Subjects were then shown 11 pairings of 12 pre-selected landmark reference points. The pairings represented the forward directional pairings of slide 1 through slide 12, excluding the pairing of slide 1 to slide 1. The presentation of the pairings was randomly ordered and presented in a left to right fashion. Although subjects were required to use the same scale throughout the task, distance estimations for each pair of slides were made by using any metric the subjects' preferred (i.e., feet, yards, blocks, miles, or any arbitrary scale of units). Specific instructions may be found in Appendix A. Estimations were reported by the subject on a pre-numbered answer sheet. Subjects were provided the opportunity to explain their scaling method on the back of their answer sheet if they so desired. When subjects completed the final task, they were de-briefed concerning the purpose of the research. The experimenter answered any questions the subjects had concerning the study.

Results

It was hypothesized that a) there would be no age-related difference on the self-assessment scales, b) there would be age-related differences on psychometric tasks, c) that there would be a positive relationship between perceptual differentiations and temporal-spatial integrations, and d) no age-related changes in performance would be detected on the two experimental (route) tasks. Statistical procedures used to evaluate these hypotheses included Multiple Analysis of Variance, followed by Analysis of Variance and post hoc Scheffé's on significant relationships, Stepwise Regressions, and a Pearson Product Correlation. All significant analyses reflect an alpha level of .05 or less.

To obtain standardized scores for the two experimental tasks, the following score transformations were undertaken. The score obtained from the Landmark Selection task reflected the percentage of agreement between two groups tested on the same task. The landmarks chosen in this study were matched with landmarks chosen by a previously tested group of young adults and elderly adults. The score from the Scrambled Route task was a correlation of the actual distance between the presented slide pairs and the estimated distance between the slides. The r -score was then transformed into a z -score.

To examine any age-related differences in task performance on the Landmark Selection task and the Scrambled Route task, a MANOVA (see Table 1) was performed using the variables Landmark Agreement and Scrambled Route. The Hotelling's trace produced significant F 's only for the variable Group, F (2, 113) = 39.65. No significance was found for Sex or Group by Sex. The subsequent ANOVA (see Table 2) performed on Landmark Agreement produced a significant difference for Group only, F (1, 114) = 60.28, with the post hoc Scheffé indicating young adults as having a significantly greater percentage of landmark agreements ($\bar{x}$ = 0.64) with the previous group than did the older adults ($\bar{x}$ = 0.47). No other significant effects were indicated. Similar results were found for the ANOVA (see Table 3) on the Scrambled Route task with Group, F (1, 114) = 15.15, and the post hoc Scheffé indicating young adults as making more accurate distance estimations ($\bar{x}$ = 0.55) than the older adults ($\bar{x}$ = 0.25). Thus, an age-related difference in performance on the two tasks was indicated.

Insert Tables 1, 2 and 3 about here

A MANOVA was also performed to examine any age-related differences in performance on the psychometric measures - Picture Arrangement Test, Identical Picture Test, self rating of Spatial Abilities, and self rating of Distance Estimation Abilities (see Table 4). The Hotelling's trace produced significant F 's for the variables Sex, F (5, 110) = 2.98, Group, F (5, 110) = 38.42, and Group by Sex, F (5, 110) = 3.94. The results of the subsequent ANOVA's may be found in Tables 5, 6, 7, and 8. The ANOVA performed on Picture Arrangement produced significant results for Sex, F (1, 114) = 4.30, Group, F (1, 114) = 11.95, and Group by Sex, F (1, 114) = 14.76. The post hoc Scheffé indicated that males ($\bar{x}$ = 5.43) performed at a significantly higher level than did females ($\bar{x}$ = 4.57), while young adults ($\bar{x}$ = 5.73) performed significantly better than older adults ($\bar{x}$ = 4.28). The results also indicated that young females ($\bar{x}$ = 6.10) performed significantly better than old males ($\bar{x}$ = 5.50), young males ($\bar{x}$ = 5.37) or old females ($\bar{x}$ = 3.04), with no significant difference produced between old males ($\bar{x}$ = 5.50) and young males ($\bar{x}$ = 5.37); however, old males ($\bar{x}$ = 5.50) and young males ($\bar{x}$ = 5.37) did perform significantly better than did old females ($\bar{x}$ = 3.04). The Identical Picture ANOVA produced significance only for the variable Group, F (1, 114)= 169.42, where the post hoc Scheffé indicated young adults (x = 65.31) performed at a significantly higher level than older adults ($\bar{x}$ = 37.93), which also was the result of the ANOVA on the self rating of Spatial Abilities, Group F (1, 114)= 6.65, although here, the post hoc Scheffé indicated older adults gave themselves significantly higher rating ($\bar{x}$ = 4.00) than did the young adults ($\bar{x}$ = 3.61). Both Sex, F (1, 114) = 4.96, and Group, F (1, 114) = 18.25, were significant in the ANOVA on self rating of Distance Estimation Abilities. Here, post hoc Scheffé analyses males gave themselves significantly higher ratings in the ability to estimate distances ($\bar{x}$ = 3.60) than did females ($\bar{x}$ = 3.22) while older adults rated their own abilities significantly higher ($\bar{x}$ = 3.78) than did the young adults ($\bar{x}$ = 3.04). These results indicate that there was an age-related difference in the performance on the psychometric measures as well as a sex-related difference in performance.

Insert Tables 4, 5, 6, 7 and 8 about here

An indication as to which variables would best predict task performance was produced through the results of two Stepwise Regressions (see Tables 9 and 10). For the variable Landmark

Agreement, two variables were found to be the best predictors of the regression equation. Age contributed the greatest variance with 35%, followed by the Identical Pictures Test which contributed an additional 4% to the variance. The Stepwise Regression performed on Scrambled Route also produced two best predictors of the regression equation. The Picture Arrangement Test contributed the greatest variance with 15%, followed by Age, adding an additional 6% of the variance.

Insert Tables 9 and 10 about here

Finally, to determine the relationship between the experimental tasks and the other variables, a correlational analysis (see Table 11) was conducted using all of the variables obtained. Significant results from this procedure indicated a negative relationship between Sex and Distance Estimation Abilities with females rating their abilities lower, or poorer, than males ($\underline{r} = -.19$). Also, there was a significant negative relationship between Landmark Agreement and Age, with older subjects, having a lower percentage of Landmark Agreements with the previously tested group ($\underline{r} = -.60$). However, a positive significant relationship existed between the percentage of Landmark Agreements and the Identical Picture score ($\underline{r} = .59$), suggesting that both tasks involve the use of perceptual differentiation. Finally, a negative significant relationship was found between the self-rating for Distance Estimation Abilities and the percentage of Landmark Agreements ($\underline{r} = -.32$).

When correlated with Age, both the Picture Arrangement Test and the Identical Picture Test produced a significant negative relationship with older subjects obtaining lower scores on both tasks (Picture Arrangement $\underline{r}$ = -.31; Identical Picture $\underline{r}$ = -.77). However, Age correlated positively and significantly with both self-rating scores (Spatial Abilities $\underline{r}$ = .21; Distance Estimation Abilities $\underline{r}$ = .35). For the Scrambled Route score and Age, a significant negative correlation was produced, with older subjects having a lower correlation between the actual distance and the estimated distance ($\underline{r}$ = -.36) than young adults. A positive significant correlation was found between scores on the Picture Arrangement Test and the Identical Pictures Test, ($\underline{r}$ = .26). Also found was a significant negative relationship between the Picture Arrangement Test and the self-ratings of abilities (Spatial Abilities $\underline{r}$ = -.18; Distance Estimation Abilities $\underline{r}$ = -.18). The relationship between the Picture Arrangement and the Scrambled Route score was significantly positive ($\underline{r}$ = .38). While Picture Arrangement correlated positively and significantly with both self-rating abilities scales, the Identical Pictures Test was significantly correlated only with the Distance Estimation Abilities rating, a negative relationship ($\underline{r}$ = -.23). However, there was a positive significant relationship between the Identical Pictures score and the Scrambled Route score ($\underline{r}$ = .31).

Subjects were consistent in their self-ratings of abilities with a positive significant relationship existing between the Spatial Abilities rating and the Distance Estimation Abilities rating

($\underline{r}$ = .23). Finally, a significant negative correlation was found between the self-ratings on Distance Estimation Abilities and the Scrambled Route score ($\underline{r}$ = -.27).

Insert Table 11 about here

Discussion

The results of the present study indicate a positive relationship between the macrospatial cognitive abilities involved with the processes of perceptual differentiation/selection and temporal-spatial integration. However, the relationship between these two processes and aging was found to be negative. The evidence suggests that as an individual grows older, his/her ability to process and utilize information from the environment may decline.

An age-related difference was indicated by the lower level of performance by the elderly adults on the Landmark Selection task and the Scrambled Route task. The performance of the young adults support the findings of Jenkins et al. (1978) and Allen (1981) in that they appear to be accurately extracting relevant information from environments presented in slide form and incorporating that information into relatively accurate cognitive representations. The age-related changes documented by Perlmutter et al. (1981) and Park et al. (1982) was also supported. The results from these studies indicated that older adults were able to recognize and recall significantly less spatial information from maps than young adults. The older subjects' performance in the present study also indicated that they were unable to successfully manipulate the presented environmental information in a way which would provide the maximum and most accurate information.

The generalized slow down in cognitive processing with age as proposed by Herman and Coyne (1980) is also suggested by the results. The perspective-taking ability of the elderly subjects in the study was apparently less proficient than that of the young adults. The elderly adults were less accurate at the Landmark Selection task and the Scrambled Route task, thus indicating a drop in the ability to manipulate the environmental information. This problem was particularly evident in the Scrambled Route task. It is unclear, however, if this poorer performance is in any way connected to the effects of irrelevant stimulation in the presentation as proposed by Rabbitt (1965) and McCormack (1982), or to integrative capabilities.

Two studies that may be considered when examining these results are those of Walsh et al. (1981) and Kirasic (1981). The results of both of these studies indicated that no age-related difference in performance is evident when the elderly subjects were working in a familiar environment. When the older subject was placed in a novel environment their performance declined. Both of the slide presentations used in the present study represented novel environments for the subjects. Thus, the poor performance found in this study does not contradict the results of ecologically based research.

The regression results indicated that the two psychometric instruments utilized were relatively good predictors of an idividual's performance on the two major tasks. The Identical Pictures Test and the Picture Arrangement Test both employ the functions involved in perceptual differentiation and temporal-spatial integration. Combined with the results of the correlational analysis, the indications are that as the ability to manipulate the elements of the tasks increases, the higher the percentage of agreeing landmarks chosen and the more accurate the distance estimation judgements. But once again, the elderly adults performed at a lower level than did the young adults. Sex differences were also found with the Picture Arrangment Test, with males performing at a higher level than did females. However, when the results are broken down by sex verses age group, young females performed the task better than old males, young males, and old females, respectively. Also, old males performed better than old females, as did the young males. No sigificant difference was idicated between the old males and young males on this task.

With these findings one would be tempted to say that macrospatial abilities could be predicted through the use of psychometric tests, however, the results of Walsh et al. (1981) and Kirasic (1981) must still be considered. Previous research had focused on the comparison of experimental tasks, such as mental rotations and visualization abilities, with psychometric tests. Previously utilized psychometric tests required flexible, abstract evaluation of novel tasks, such as Object Assembly and Block Design from the WAIS, while the psychometric tests employed in this research could be more readily compared to the experimental tasks. Few inferences can be drawn between the skills used in traditional research involving spatial abilities and those used with the perceptually-based analyical and integrative skills used in macrospatial cognition.

Interestingly enough, one's assessment of one's own abilities is not necessarily a good indication of one's actual abilities. As the age of the subjects increased, their ratings of their spatial abilities and distance estimation abilities also increased. Also found was that males tend to rate their own macrospatial abilities higher than do females. However, the confidence the elderly adults had in their abilities was not represented in the results of the study. Older adults produced significantly poorer performances on the psychometric tasks as well as the experimental tasks. Only on the Landmark Selection task did subjects' rating correlate positively with performance, and that was for the self-rating of Distance Estimation Abilities. Thus, it appears that while older adults seem to think they possess good macrospatial abilities, these abilities are not manifested when experimentally tested. And, with the results of the Picture Arrangement Test, females may not be aware of their macrospatial ability's potential.

The results of the correlational analysis performed on the relationship between the tasks and the other variables were not extremely strong. This is an indication that the two tasks may not be that highly correlated. The subjects are possibly being required to use two separate processes in order to organize and manipulate the environmental information presented. Jenkins et al. (1978) had great success when their subjects were required to recognize pictures from a scrambled walk presented to them; however, they were not required to order the slides or make distance estimations. Older subjects may have little trouble actually identifying the scenes from the walk but may not be able to sort them into their logical order.

The results from this study suggest that older adults' macrospatial cognitive abilities are not as proficient as those of younger adults. The next step is to determine why the deficits occurred and how, if possible, they may be remediated. It might be useful to consider a training program to improve the abilities of elderly adults. Plemons, Willis, and Baltes (1978) produced results that indicated it may be possible to modify the fluid intellectual abilities of elderly adults. The effects of the training on Figural Relations procedures used were sustained over the six months retest period. The Figural Relations task requires subjects to identify relations between figures in a pattern and to produce one element missing from the pattern. These are some of the same functions required in macrospatial cognitions -- perceptual differentiation and spatial integration.

Increasing environmental distinctiveness is another area that should be explored as a method of improving the macrospatial cognitive processes in elderly adults. Appleyard (1976) found that the function and physical distinctiveness of a building predicted an individual's ability to recall specific buildings in a city. Similar results were obtained by Evans, Fellows, Zorn, and Doty (1980) in their study of the effects of color coding a building's interior. Subjects in the color coded interiors made fewer errors than those in the monochromatic interiors. Weber, Brown, and Weldon (1978) also found that nursing home patients were better able to identify different areas of the nursing home when the areas were higher in visual distinctiveness

Thus, while it appears that elderly adults are not able to encode and utilize macrospatial information in as an effective a manner as young adults, there are possibly several methods that may be employed to remediate any deficits. The environment, as a whole, could also be made more unique to so as to assist older adults through mere distinctiveness of place. Programs could also be established to help older adults maintain and/or regain the cognitive functions that decline as a result of the aging process.

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Appendix A

Instructions to subjects for making distance estimations:

"In making your distance estimations, you may use any scale you desire. For example, you may use blocks, feet, yards, miles, or any arbitary scaling of units. If you wish to use an arbitary scale please remember to use the same scaling units throughout the task, as in: the distance from point A to point B is X, and the distance from point A to point C is twice the distance of A to B; therefore, the distance from point A to point C is 2X."

Table 1

MANOVA for Landmark Agreement and Scrambled Route

Source	Hotelling's trace
Sex	$F(2, 113) = 0.59$
Group	$F(2, 113) = 39.65$*
Group x Sex	$F(2, 113) = 1.52$

*$p < .01$

Table 2

ANOVA for Landmark Agreement

Source	df	F
Sex	(1, 117)	0.11
Group	(1, 117)	60.28*
Group x Sex	(1, 117)	1.57

*$p < .01$

Table 3

ANOVA for Scrambled Route

Source	df	F
Sex	(1, 117)	1.12
Group	(1, 117)	15.15*
Group x Sex	(1, 117)	1.29

$*p < .01$

Table 4

MANOVA for Psychometric Measures

Source	Hotelling's trace
Sex	$F(5, 110) = 2.98$*
Group	$F(5, 110) = 38.42$*
Group x Sex	$F(5, 110) = 3.94$*

*$p < .02$

Table 5

ANOVA for Picture Arrangement

Source	df	F
Sex	(1, 117)	4.30*
Group	(1, 117)	11.95*
Group x Sex	(1, 117)	14.76*

*$p < .05$

Table 6

ANOVA for Identical Picture

Source	df	F
Sex	(1, 117)	3.74
Group	(1, 117)	169.42*
Group x Sex	(1, 117)	2.51

*$p < .01$

Table 7

ANOVA for Estimates of Spatial Abilities

Source	df	F
Sex	(1, 117)	1.63
Group	(1, 117)	6.65*
Group x Sex	(1, 117)	0.14

*$p < .01$

Table 8

ANOVA for Estimates of Distance Estimation Abilities

Source	df	F
Sex	(1, 117)	4.96*
Group	(1, 117)	18.25*
Group x Sex	(1, 117)	1.44

*$p < .05$

Table 9

Stepwise Regression for Landmark Agreement

Variable	R	R	Beta	df	F
Age	.3477	.3477	-0.0022	(1, 116)	8.77*
Identical Picture	.3909	.0432	0.0029	(2, 115)	8.17*

*$p < .05$

Table 10

Stepwise Regression for Scrambled Route

Variable	R	R	Beta	df	F
Picture Arrangement	.1453	.1453	-0.0048	(1, 116)	9.34*
Age	.2095	.0642	0.0519	(2, 115)	11.79*

*$p < .05$

Table 11

Correlations

	Sex	Lmk Agr	Age	Order	Arr	Pict	Abil	Abil	Route	Group
Sex	1.000	0.025	0.033	-0.071	-0.172	-0.114	-0.115	-0.189*	-0.092	0.000
Lmk Agr		1.000	-0.590*	-0.015	0.164	0.587*	-0.151	-0.319*	0.153	-0.584*
Age			1.000	0.044	-0.308*	-0.771*	0.211*	0.349*	-0.358*	0.984*
Order				1.000	-0.167	-0.015	0.040	0.076	-0.124	0.051
Pict Arr					1.000	0.261*	-0.177	-0.179*	0.381*	-0.287*
Ident Pict						1.000	-0.137	-0.231*	0.310*	-0.765*
Spa Abil							1.000	0.234*	0.031	0.233*
D Est Abil								1.000	-0.270*	0.363*
Scram Route									1.000	-0.338*
Group										1.000

*$p < .05$