Spatial Disorientation in Persons With Early Senile Dementia of the Alzheimer Type

Lili Liu, Louise Gauthier, Serge Gauthier

Key Words: aging • Alzheimer's disease • dementia, senile • perception

Most persons with senile dementia of the Alzheimer type (SDAT) experience visual-perceptual deficits at some stage during the disease process (Bayles & Kaszniak, 1987). Although the early clinical manifestations of SDAT may vary among persons, it is suspected that deficits of spatial skills are common in the early stages of the disease (Brancumier & DeVitt, 1983; Cogan, 1985; Cummings & Benson, 1986; Tariot et al., 1986). Spatial disorientation is becoming a greater social concern as the prevalence of dementia increases with the aging of society. For example, health professionals are increasingly concerned about identifying SDAT in persons who place themselves and others at risk when they are driving automobiles (Friedland et al., 1988; Lucas Blaustein, Filipp, Dungan, & Tune, 1988). Spatial disorientation can be manifested as wandering behavior (De Leon, Potegal, & Gurland, 1984) and as placing objects in inappropriate locations and is associated with impaired performance of many functional activities.

Few studies examine spatial skills in subjects with SDAT and fail to specify the measurement tools used (Cogan, 1985) or the disease stages of the subjects (Brouwers, Cox, Martin, Chase, & Fedio, 1984). Flicker, Ferris, Crook, Reisberg, and Bartus (1988) used two spatial tasks to compare the performance of young nondysfunctional subjects, aged nondysfunctional subjects, subjects with early SDAT, and subjects with advanced SDAT. They concluded that SDAT produces a general impairment of left-right orientation but produces no additional impairment of the ability to mentally rotate pictures of common objects.

The present paper reports a study undertaken to further understand spatial orientation in persons with early SDAT (Liu, 1988; Liu & Gauthier, 1988). Spatial orientation was defined as the person's knowledge of where he or she is in the environment and ability to navigate in that environment. Three types of spatial skills were examined in this study: perceptual spatial skills, higher cognitive spatial skills, and functional spatial skills. Perceptual spatial skills include the ability to discriminate left from right and to discriminate between shapes and sizes. Higher cognitive spatial skills include the ability to discriminate left from right and to discriminate between shapes and sizes. Higher cognitive spatial skills include the ability to discriminate left from right and to discriminate between shapes and sizes. Functional spatial skills involve the use of environmental cues and skills of the previous two skills to navigate in familiar and new environments. The originality and main advantage of this definition are that skills of various types are assessed simultaneously to allow an understanding of the underlying process of spatial orientation.

Method

Subjects and Selection Criteria

All 15 SDAT subjects were referred by the McGill Center for Studies in Aging at the Montreal General Hospital, Quebec, Canada.
Hospital. All were 80 years of age or younger and were diagnosed by the third author, a neurologist, as having probable primary progressive dementia of the Alzheimer type, according to the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 1987) and the diagnostic criteria of the NINCDS-ADRDA Work Group (McKhann et al., 1984). The Global Deterioration Scale for age-associated cognitive decline and Alzheimer disease (Reisberg, Ferris, De Leon, & Crook, 1982) was used to determine whether the subject was in Stage 3 or Stage 4 of the disease. The Global Deterioration Scale divides the progression of cognitive decline into seven stages. Stage 3, also called *early confusional stage or mild cognitive decline*, is characterized by the patient's getting lost for the first time when traveling to an unfamiliar location (Reisberg et al., 1982, 1984). Stage 4, also termed *late confusional stage or moderate cognitive decline*, is the first stage of SDAT in which the patient clearly shows a deficit in traveling to unfamiliar locations, although there is generally no deficit in the patient's ability to travel to familiar locations (Reisberg et al., 1982, 1984). All SDAT subjects scored less than 5 on the Hachinski Ischemic Scale (Hachinski et al., 1975; McKhann et al., 1984), which was used to exclude subjects with multi-infarct dementia. This scale was administered by the referring neurologist (the third author), who also verified that the subjects did not have a history of head injury or significant metabolic disease. All SDAT subjects scored a minimum of 18 out of 30 on the Mini-Mental State examination (Folstein, Anthony, Parthad, Duffy, & Gruenberg, 1985; Folstein, Folstein, & McHugh, 1975). The minimum score of 18 was chosen based on our observations that persons with SDAT who score less than 18 tend to be beyond Stage 4 of the Global Deterioration Scale. Although Reisberg et al. (1984) reported the ranges of Mini-Mental State scores of persons in Stage 3 ($n = 7$, range = 20–27) and Stage 4 ($n = 8$, range = 16–23), these ranges were based on small sample sizes. We did not establish a maximum Mini-Mental State score because the relationship between the Mini-Mental State and the Global Deterioration Scale stages has not been clearly established, and we had observed Stage 3 persons who performed near perfect on the Mini-Mental State. The subjects were community residents with at least one primary caregiver who could attend the testing sessions. Additionally, the subjects were right-handed, as tested on the 10-item version of the Edinburgh Handedness Inventory (Oldfield, 1971). The subjects walked independently, that is, without the use of aids, and consented to participate in the study. No visual deficits were detected by the referring neurologist, and the subjects who required glasses were requested to wear them.

The control group was composed of spouses of the SDAT subjects, members of the Montreal branches of the Fondation de L'Age d'Or du Quebec, and healthy volunteers followed longitudinally at the Douglas Hospital Center in Montreal. A medical history was taken for all 15 control subjects. These subjects met the same age and handedness criteria as the SDAT subjects. The control subjects scored within the normal range on the Global Deterioration Scale (Stage 1) and scored at least 28 out of 30 on the Mini-Mental State.

**Procedure**

All testing was conducted by the first author, and each subject was assessed alone. The assessment session took place over a period of 2 to 3 hr, including a 10-min rest period after each hour. Perceptual spatial skills were assessed first, followed by cognitive spatial skills and functional spatial skills. To control for learning effects, the tasks within each level were administered randomly with the use of a list of random numbers.

The response time was not restricted, because slower psychomotor speed may not provide an accurate indication of cognitive performance under a limited time condition (Flicker, Ferris, Crook, Bartus, & Reisberg, 1986; Monge, 1967). The instructions were standard, and each subject was asked to summarize the instructions prior to the administration of the tests. Instructions were repeated during the performance of the tasks, as needed. With these instructions, all of the subjects were able to perform the tasks.

**Materials**

*Perceptual spatial skills.* Figure-ground perception was assessed with the Figure-Ground Perception subtest of the Southern California Sensory Integration Tests (SCSIT) (Ayres, 1972). This subtest consists of two parts, each containing 24 items. Part 1 uses diagrams of common objects, and Part 2 uses diagrams of geometric shapes. The complete subtest was administered, and 1 point was allocated for each simple figure correctly identified, with a maximum score of 48 points.

Visual shape recognition was assessed with another subtest of the SCSIT. The subject received 1 point for each shape correctly matched. Tactual shape recognition was tested with the use of a shield to occlude vision. The hands were alternated during each test item. One point was allotted for each shape correctly identified, with a maximum of 10 points.

Visual size discrimination was assessed with a subtest of the Ontario Society of Occupational Therapy (OSOT) Perceptual Evaluation (Boys, Fisher, Holzberg, & Reid, 1988; OSOT, Study Group on the
Brain-Damaged Adult, 1977). Each subject was presented with six randomly arranged disks of varying sizes and was asked to arrange the disks in size order, from largest to smallest. The subject's score was the number of correct responses, with a maximum of 6 points.

Tactual size discrimination was assessed with the use of a shield to occlude vision. The subject was asked to indicate which of two disks was larger and was told not to compare the disks by placing them over each other and not to exchange the disks between the hands. A point was allotted for each correct response, with a maximum score of 15 points.

Position in space was assessed with the Position in Space subtest of the SCSIT. Only the first two parts were used. For Part 1, the stimulus cards were placed under each item of the response cards to facilitate the matching of the correct items. Part 2 was more difficult because the stimulus cards were always to the left of the response cards. Each part consisted of eight items, yielding a maximum score of 16 points for the entire test.

Spatial relations were assessed with the Space subtest of the SCSIT. To shorten the duration of this test, we used every other test item. One point was allotted for each correct answer, with a maximum score of 15 points.

Left-right discrimination was tested with a 10-item questionnaire from the SCSIT. A point was allotted for each correct response, yielding a maximum score of 10 points.

Higher cognitive spatial skills. The Porteus Maze Test (Porteus, 1959) was used to assess spatial planning and decision making. This test consists of 11 mazes with a ceiling score of 17 test years.

The Extrapersonal Orientation Test (Semmes, Weinstein, Ghent, & Teuber, 1955) was used to assess spatial problem solving. Only the five visual maps were used in this study. Each route was illustrated on a map that contained nine circles and a route through certain circles. The circles were also represented on the floor, and the subject was asked to trace the route by stepping on the appropriate circles. The total score was the number of correct turns in all five maps, with a maximum of 35 correct turns.

The Road Map Test of Sense Direction (Alexander, Walker, & Money, 1964) was used to test the subject's ability to mentally rotate directions. The subject was presented with a route drawn on a map and was instructed to pretend to walk along the route. The map was kept upright at all times and the subject verbalized, at each turn, whether the turn would be to his or her right or left. The maximum score for this test was 32, that is, 1 point for each correct turn.

Corsi's Block-Tapping Test (Milner, 1971, 1980) was used to evaluate immediate spatial memory. This test consists of nine wooden blocks irregularly placed on a wooden board. The blocks are numbered on the sides facing the examiner so that the subject's performance can be numerically coded. The examiner taps a sequence of blocks and the subject is asked to tap the blocks in the same sequence. The test began with a block span of three, and the examiner repeated each block sequence once. The score was the actual block span obtained by the subject. The largest possible span was nine. Hebb's Digit Span Test (Milner, 1970), a verbal version of Corsi's Block-Tapping Test, was also administered to determine whether deficits observed on the spatial test were selectively due to spatial deficits. The maximum span obtained on this test was also nine.

A modified version of the Stylus Maze Test (Milner, 1965) was used to assess spatial learning. The test involved the use of a black wooden board with 25 brass bolts forming a 12.7 cm by 12.7 cm array. The subject's task was to discover through trial and error and to remember a hidden path from the lower left corner to the upper right corner of an array. The subject was instructed to use a metal-pointed stylus and to proceed horizontally or vertically but not diagonally. Two paths were used, the first of which was a trial path, and the subjects were provided with five trials. The score was the number of errors on the fifth trial (see Figure 1).

Mental representation of the familiar environment was assessed through the subjects' drawing of a floor plan. A sample floor plan on a 21.6 cm by 27.9 cm sheet of white paper was shown to the subject, who was then provided with a piece of white paper of the same size and a fine blue marker. The subject was instructed to draw a floor plan of the main level of his or her home, to include all relevant rooms, and to
identify the rooms verbally or in writing. Scoring consisted of two ratios. The first ratio was the number of rooms identified over the actual number of rooms. The second ratio was the number of rooms correctly placed in relation to the other rooms over the actual number of rooms. The denominators of these ratios, or the actual number of rooms, were verified during a home visit. A perfect score on either was a ratio of 1.

Mental representation of the new environment was evaluated after assessment of functional spatial orientation in the new environment. The subjects were asked to draw a map of the five rooms whose identification and locations were learned during functional spatial orientation. The scoring method also involved two ratios, as with mental representation of the familiar environment.

Functional spatial skills. Functional spatial orientation in the familiar environment was assessed through a visit to the homes of all of the subjects. During these visits, the subjects were asked to lead the way to all of the major rooms on the main level of their homes. A ratio was obtained based on the number of rooms identified over the actual number of rooms.

The examiner (the first author) tested functional spatial orientation in the new environment by leading the subjects to five rooms on the main level of the building in which the research was conducted. These rooms were identified as the laboratory, kitchen, classroom, waiting room, and bathroom. After three trials, the subjects were asked to lead the examiner to each of the five rooms in random order. Purposeful navigation, as opposed to wandering behavior, was ensured by having the subjects identify each of the rooms once it was reached. The maximum score was 5, or a ratio of 1.

Results

Subjects’ Characteristics

A comparison of the subjects’ characteristics is shown in Table 1. The two groups were comparable in sex distribution, age, and number of years of education. As expected, the SDAT group showed impairment on the mental status questionnaire.

Perceptual Spatial Orientation

The results of the basic spatial orientation skills are shown in Table 2. No group difference was observed for performances on visual shape discrimination, visual and tactual size recognition, and left-right discrimination. This could be explained by the lack of sensitivity as seen by the ceiling effects on these tests or could indicate that the skills required to perform these tasks are intact. Significant group differences in figure-ground perception, tactual shape recognition, position in space, and spatial relation tasks were present.

Table 1
Demographics of Subjects

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SDAT Group</th>
<th>Control Group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 15)</td>
<td>(n = 15)</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>5</td>
<td>ns*</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>65.60</td>
<td>66.60</td>
<td>ns**</td>
</tr>
<tr>
<td>SD</td>
<td>9.25</td>
<td>5.87</td>
<td></td>
</tr>
<tr>
<td>Education (in years)</td>
<td>11.21</td>
<td>11.87</td>
<td>ns**</td>
</tr>
<tr>
<td>SD</td>
<td>4.46</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>Mini-Mental State*</td>
<td>22.87</td>
<td>29.53</td>
<td>≤.001**</td>
</tr>
<tr>
<td>SD</td>
<td>3.56</td>
<td>0.74</td>
<td></td>
</tr>
</tbody>
</table>

Note. SDAT = senile dementia of the Alzheimer type. ns = not significant.

* Chi-square. **Two-tailed t test for independent samples.

Table 2
Comparison of Performance on Perceptual Spatial Orientation Tasks

<table>
<thead>
<tr>
<th>Skill</th>
<th>Maximum Score</th>
<th>SDAT Group (n = 15)</th>
<th>Control Group (n = 15)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Figure-ground perception (total)</td>
<td>26.33 (6.61)</td>
<td>36.47 (6.33)</td>
<td>≤.0001</td>
<td></td>
</tr>
<tr>
<td>Figure-ground perception (Part 1)</td>
<td>16.00 (5.59)</td>
<td>20.53 (1.19)</td>
<td>≤.0002</td>
<td></td>
</tr>
<tr>
<td>Figure-ground perception (Part 2)</td>
<td>10.33 (4.15)</td>
<td>15.93 (5.00)</td>
<td>≤.001</td>
<td></td>
</tr>
<tr>
<td>Shape (visual)</td>
<td>9.67 (0.82)</td>
<td>10.09 (0.00)</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Shape (tactual)</td>
<td>6.13 (2.26)</td>
<td>8.93 (1.34)</td>
<td>≤.0005</td>
<td></td>
</tr>
<tr>
<td>Size (visual)</td>
<td>6.00 (0.00)</td>
<td>6.00 (0.00)</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Size (tactual)</td>
<td>14.33 (1.23)</td>
<td>14.87 (0.35)</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Position in space (total)</td>
<td>11.93 (4.01)</td>
<td>15.53 (0.82)</td>
<td>≤.004</td>
<td></td>
</tr>
<tr>
<td>Position in space (Part 1)</td>
<td>7.20 (1.42)</td>
<td>7.93 (0.26)</td>
<td>≤.06</td>
<td></td>
</tr>
<tr>
<td>Position in space (Part 2)</td>
<td>4.73 (2.92)</td>
<td>7.40 (0.74)</td>
<td>≤.002</td>
<td></td>
</tr>
<tr>
<td>Spatial relations</td>
<td>11.47 (2.67)</td>
<td>14.73 (0.59)</td>
<td>≤.0002</td>
<td></td>
</tr>
<tr>
<td>Left-right discrimination</td>
<td>9.67 (0.72)</td>
<td>10.00 (0.00)</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

Note. SDAT = senile dementia of the Alzheimer type. ns = not significant.

* Two-tailed t test for independent samples.
The Figure-Ground Perception and Position in Space tests were further analyzed by part. The SDAT group was significantly more impaired than the control group on Parts 1 and 2. The performance of the SDAT group on the common object items (Part 1) was compared with performance on the geometric items (Part 2) with the paired t test. This comparison was also made for the control group. Both groups demonstrated significantly poorer performance on Part 2. The t value for the SDAT group was t(14) = 5.40, p = .0002; for the control group, t(14) = 5.18, p = .0003.

The Position in Space test also contained two parts that were further analyzed separately. Interestingly, the SDAT group did not differ from the control group in their performance on Part 1 of the test, whereas they did perform significantly poorer than the control group on Part 2.

Cognitive Spatial Orientation

Table 3 shows a summary of the results for these tasks of higher cognitive spatial orientation. The SDAT group showed deficits in performance on the Porteus Maze Test, the Extrapersonal Orientation Test, and the Road Map Test of Sense Direction, all of which required spatial planning and mental rotation.

As on Corsi's Block-Tapping Test for short-term spatial memory, the SDAT group was impaired in comparison with the control group on Hebb's Digit Span Test for short-term verbal memory. The control group scored a mean of 7.60 ± 1.50; the SDAT group, 5.87 ± 1.41 (p ≤ .01).

Table 3 also lists the mean ratios of performances on the task of mental representation of the familiar and new environments and the results of a between-groups analysis. Whereas the control group scored almost perfectly on maps of both familiar and new environments, the SDAT group scored a much lower average on both maps. A within-group analysis was also conducted. The results were not statistically significant, which indicates that the subjects did not perform differently when asked to draw a map of the new environment compared with a map of the familiar environment.

Functional Spatial Orientation

The subjects in the SDAT and control groups were spatially oriented to the main level of their homes. The mean ratio for both groups was 1.00 ± 0.00 (not significant). At the time of the home visit, environmental cues were not used in any of the homes of the subjects of both groups. In the new environment, however, the control group was oriented (mean ratio = 1.00 ± 0.00), whereas the SDAT group showed definite impairment in their ability to navigate (mean ratio = 0.49 ± 0.29). When the raw data, which were ordinal in nature, were analyzed with the Mann Whitney U test, the difference between the two groups was statistically significant (p < .0001).

Discussion

Perceptual Spatial Orientation

The better performance of both groups on Part 1 of the Figure-Ground Perception test than on Part 2 may be attributed to two factors. First, Part 1 was administered before Part 2, so fatigue may have contributed to a poorer performance on the latter. Second, and most probable in our view, familiarity with common objects may have contributed to a better performance in Part 1.

The impairment of the SDAT group on the tactual version of shape recognition could indicate an impairment in the ability to mentally represent shapes. Vision may also be important for the SDAT subjects in

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Table 3

Comparison of Performance on Higher Cognitive Spatial Orientation Tasks

<table>
<thead>
<tr>
<th>Test</th>
<th>Maximum Score</th>
<th>SDAT Group (n = 15) M (SD)</th>
<th>Control Group (n = 15) M (SD)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porteus Maze Test*</td>
<td>17</td>
<td>7.58 (3.02)</td>
<td>15.93 (6.62)</td>
<td>≤ .0001</td>
</tr>
<tr>
<td>Extrapersonal Orientation Test*</td>
<td>35</td>
<td>13.80 (11.26)</td>
<td>34.80 (12.50)</td>
<td>≤ .0001</td>
</tr>
<tr>
<td>Road Map Test of Sense Direction*</td>
<td>32</td>
<td>20.93 (9.78)</td>
<td>28.87 (7.49)</td>
<td>≤ 01</td>
</tr>
<tr>
<td>Block Tapping Test*</td>
<td>9</td>
<td>5.33 (1.23)</td>
<td>5.20 (0.68)</td>
<td>≤ 0001</td>
</tr>
<tr>
<td>Stylist Maze Test* (no. of errors)</td>
<td>--</td>
<td>6.77 (6.30)</td>
<td>0.60 (0.74)</td>
<td>≤ 02</td>
</tr>
<tr>
<td>Mental representation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home (relational)†</td>
<td>1</td>
<td>0.29 (0.59)</td>
<td>0.98 (0.66)</td>
<td>≤ 0001</td>
</tr>
<tr>
<td>Home (no. of rooms)‡</td>
<td>1</td>
<td>0.55 (0.40)</td>
<td>1.00 (0.00)</td>
<td>≤ 0002</td>
</tr>
<tr>
<td>New environment (relational)†</td>
<td>1</td>
<td>0.19 (0.28)</td>
<td>0.93 (0.26)</td>
<td>≤ 0001</td>
</tr>
<tr>
<td>New environment (no. of rooms)‡</td>
<td>1</td>
<td>0.45 (0.28)</td>
<td>1.00 (0.00)</td>
<td>≤ 0001</td>
</tr>
</tbody>
</table>

Note: SDAT = senile dementia of the Alzheimer type.

* Two-tailed test for independent samples.
making use of other environmental information. Both the visual and actual versions of size discrimination were not sensitive to SDAT. Possibly, this was due to the insensitivity of the test or because size discrimination ability is not affected by early SDAT. It would be of interest to examine the ability of SDAT subjects to distinguish sizes of other shapes.

The performance of the control group on the Position in Space task was comparable to the normative data collected by M. A. Sieve, D. F. Bullock, & S. C. Zoltan, 1986. When Parts 1 and 2 were analyzed separately, the difference in performance between the two groups was significant only in Part 2. The second part was more demanding in that it required memory and planning abilities. Stimulus cards were located on the left-hand page, and all of the response choices were revealed. This required the ability to remember choices already eliminated and to concentrate on one response choice at a time. The lack of difference in performance between the two groups in Part 1 suggests that the basic ability to discriminate between the position of shapes is intact in Stages 3 and 4 of SDAT. What is impaired then is the ability to remember choices made, to selectively focus on one response item at a time, and to plan a strategy to solve the task. Similarly, on the Figure-Ground Perception test, we observed that the SDAT subjects tended to repeat choices already made, had difficulty focusing on disembedding one shape at a time, and tended not to approach the task in a systematic way in order to consider all possible answers. We made similar observations during the performance of all of the higher cognitive spatial orientation tasks.

On the spatial relations task, the subjects are required to perceive the position of two objects in relation to themselves and to each other and to mentally rotate the position of the shapes. Thus, deficits in this task may be similar to those seen on the Porteus Maze Test and may be perceptual in nature or due to memory impairment. This task requires the additional ability to actively transform spatial planning and mental representations into actual body movements. The inability to visualize all of the circles on the floor at any one moment could have made the task more demanding, because rather than relying on vision, the subject was required to plan actions based on a mental image of the locations of the nine circles on the floor. The Road Map Test of Sense Direction could be viewed as a static version of the Extrapersonal Orientation Test, because on this test the subjects were also required to follow a route on a stationary map and to keep track of the directions of turns made.

On both Corsi’s Block-Tapping Test and its verbal counterpart, Hebb’s Digit Span Test, the control subjects, as compared with the SDAT subjects, could perform a span of two more items. This suggests that the SDAT group showed a deficit in the ability to register information regardless of whether it was spatial or verbal.

The large range of the number of errors made by the SDAT subjects on the Stylus Maze Test indicates that these subjects were less consistent than the control subjects. Perseveration was observed among the SDAT subjects when errors made on previous trials were immediately repeated. These subjects also had difficulty remembering instructions. Problem solving was also impaired, as indicated when the SDAT subjects moved toward the origin instead of toward the destination.

On the mental representation tasks, the SDAT group was impaired in recalling the number of rooms as well as in placing these rooms in correct relation to

Cognitive Spatial Orientation

A common observation on the Porteus Maze Test was that prior to drawing the actual route, the control subjects mentally traced the routes from the point of exit to the point of origin. Although this strategy was also used by the SDAT subjects, they attempted either to begin the route from the point of exit or from the point of origin but could not remember the route previously traced in their minds. The SDAT subjects also tended to repeat errors on subsequent trials. These observations suggest that the lower mean obtained by the SDAT group was due to a deficit in the ability to plan, to try other options, or to mentally represent the various turns of a route, and to remember previous errors.

On the Extrapersonal Orientation Test, the SDAT group experienced difficulty following the lines of the route on the maps. This was evident when a subject would break the route by following another part of the route or by retracing a part of the route. These difficulties are similar to those seen on the Porteus Maze Test and may be perceptual in nature or due to memory impairment. This task requires the additional ability to actively transform spatial planning and mental representations into actual body movements. The inability to visualize all of the circles on the floor at any one moment could have made the task more demanding, because rather than relying on vision, the subject was required to plan actions based on a mental image of the locations of the nine circles on the floor. The Road Map Test of Sense Direction could be viewed as a static version of the Extrapersonal Orientation Test, because on this test the subjects were also required to follow a route on a stationary map and to keep track of the directions of turns made.

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On the mental representation tasks, the SDAT group was impaired in recalling the number of rooms as well as in placing these rooms in correct relation to
each other. The significant impairment of the SDAT subjects in map drawing can be attributed to an impaired ability to mentally construct an image of the rooms and their locations relative to each other.

Functional Spatial Orientation

The functional disorientation of the SDAT group in the new environment indicates that this impairment begins in the early stages of the disease process. Poor mental representation of shapes was seen to be alleviated with vision. This suggests that SDAT patients rely on visual cues. Thus, to facilitate orientation in any environment, we must provide the patient with Alzheimer disease with adequate visual aid and lighting. The spatial design of living environments should be such that major rooms are in view of each other and that a map is not required for navigation within the environment. This applies particularly to new environments such as an institution and does not necessarily hold true for familiar environments.

Studies are needed in the area of intervention. Investigators should examine the use of environmental cues in facilitating spatial orientation. The use of pictorial signs and color coding, although widely used in the clinic, have not been studied for their effectiveness in reducing disorientation. The results of the present study suggest that if pictorial signs are used, they should involve pictures of common objects, as opposed to geometric shapes.

Clinical Assessment

Results from a questionnaire revealed that more than half of the subjects with SDAT in the present study had been lost outside of the home. This suggests that spatial orientation should be a greater concern for clinicians and caregivers, even at the beginning stages of SDAT. The clinical assessment of spatial orientation warrants more than asking the person for the names of his or her hospital, city, and country. We have shown that specific spatial tasks are useful in the identification of the deficits that may be associated with spatial disorientation. Tactual shape recognition and map drawing provide information about mental representation. The Porteus Maze Test and Extraper-sonal Orientation Test are useful tools for examining spatial planning abilities. The Stylus Maze Test provides some indication of spatial memory. It is equally important for us to remember, however, that patients with early Alzheimer disease should be assessed functionally. This should be done especially in new environments and does not necessarily have to involve the clinician directly; caretakers could ask the patient to lead the way to destinations in various types of environments.

Conclusion

The general findings of this study were that persons in the early stages of SDAT were impaired on all tasks of higher cognitive spatial orientation skills. Some of the basic spatial orientation skills were intact, namely, visual recognition of shape, visual and tactual discrimination of size, and left-right discrimination. There is evidence that the poor performance on the other basic spatial tasks were due to higher level processes. The SDAT group was also impaired in both mental representation and functional spatial orientation in the new environment. Poor spatial memory, as seen on the other spatial tasks, could contribute to this. Although mental representation of the home was also impaired, functional spatial orientation at home was intact. These results may mean that the apparent visuospatial deficits seen in early SDAT, such as getting lost or misplacing objects, are probably due to the impairment of the higher order processes rather than to visual-perceptual skills.

The results of this study have research implications. The tools that we used need to be assessed for validity and reliability. Although this study looked only at specific spatial orientation skills, it was unique in that skills of three types were studied together. This has provided valuable information that would otherwise not have emerged. For example, deficits of mental representation were observed to occur with functional spatial disorientation in the new environment. Other researchers may consider doing the same. Researchers should also examine deficits of spatial orientation skills in persons who are in the late stages of SDAT. Conceivably, as the disease progresses, more basic spatial skills become impaired.

This paper has reported results from a preliminary study. We are currently investigating the validity, reliability, and other psychometric properties of these assessment tools, which we have named the Spatial Orientation Skills Battery.

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