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REVIEW

Intervention strategies for spatial orientation disorders in dementia: A selective review

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Abstract

Purpose: This article provides a brief overview of the intervention strategies aimed at reducing spatial orientation disorders in elderly people with dementia.

Methods: Eight experimental studies using spatial cues, assistive technology programs, reality orientation training, errorless learning technique, and backward chaining programs are described. They can be classified into two main approaches: restorative and compensatory, depending on whether they rely or not on residual learning ability, respectively.

Results: A review of the efficacy of these intervention strategies is proposed. Results suggest that both compensatory and restorative approaches may be valuable in enhancing correct way-finding behavior, with various degrees of effectiveness. Some issues concerning (a) variability in participants' characteristics and experimental designs and (b) practicality of intervention strategies do not permit to draw a definite conclusion.

Conclusions: Future research should be aimed at a direct comparison between these two strategies, and should incorporate an extensive neuropsychological assessment of spatial domain.

Keywords: *Alzheimer's disease*, *spatial orientation disorders*, *topographical disorientation*, *spatial memory*, *intervention strategies*, *review*

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Introduction

Dementia is an irreversible neurodegenerative disease of the brain leading to a permanent loss of neurons and to a progressive impairment of higher cognitive functions, together with personality changes and strong behavioral modifications [1, 2]. People suffering from dementia experience decline in social and occupational functioning, and in the advanced stages of the disease, they are no longer able to take care of themselves, requiring (a) continuous assistance to perform even the simplest everyday activities and (b) specific forms of support to replace aberrant behavior (e.g. wandering) with more socially acceptable ones [3–7]. Among other early symptoms, which tend to worsen over time, they can show disorders in spatial and topographical orientation, at first restricted to new and unfamiliar environments, and then extended to familiar ones [8], with negative implications on autonomy, independence and self-confidence [9, 10].

Over the past decades, a number of strategies for reducing spatial orientation disorders in people with dementia, and especially in persons with Alzheimer's disease (AD), have been proposed. Following a basic dichotomy [11], these strategies can be easily clustered into two main categories: compensatory and restorative strategies. Compensatory strategies employ new ways of performing cognitive and behavioral tasks bypassing cognitive deficits. Interventions using compensatory techniques for

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reducing spatial orientation disorders in dementia include the use of spatial cues [12, 13] as well as assistive technology (AT) programs [14, 15]. Restorative strategies aim to restore functioning in specific domains with the ultimate purpose of returning functioning in those domains to pre-morbid levels, or slowing the progression of the disease. Interventions employing restorative techniques in spatial orientation disorders include reality orientation (RO) training [16], errorless intervention procedures [17] as well as backward chaining programs [18, 19].

The aim of this article is to provide an outline of the methods used to promote spatial orientation in people with dementia, in order to critically review and compare them in terms of outcomes and practicality/affordability. Furthermore, suggestions for future research and clinical implications are discussed.

Method

MEDLINE (1971–2012, http://www.ncbi.nlm.nih.gov/pubmed) and SCOPUS (1823–2012, http://www.scopus.com) databases were searched using the following terms: spatial orientation, topographical disorientation, way finding, route finding, room finding; each of these items was coupled with the terms dementia, AD, elderly patients, and with the terms intervention, rehabilitation, training. In addition, a manual search was conducted on the references listed in the articles selected by the searching on databases, in order to identify other appropriate articles. Selected articles were then included in the present review if they met the following criteria: the experimental sample or the single patient was suffering only from dementia or from AD, structured cognitive and/or behavioral rehabilitation protocols were well-described and applied, the study used a quantitative approach and presented data and statistical analysis specific to the questions, and the article was written in English. Articles were excluded if they recruited participants with more than one type of dementia and/or other neuropathological diseases, or if they presented pooled results from various populations having different neuropathological diseases. We decided to conduct a qualitative review of the evidence, and not to perform a meta-analysis, because of the poor number and of the methodological variability of the studies included.

Interventions for reducing spatial orientation disorders

Eight articles pertaining to intervention strategies for reducing spatial orientation disorders were included. Table I provides the list of those articles. For each study, the table reports the number and the age of the participants, their stage in the progression of dementia, the experimental design, a brief description of the intervention protocol, the intervention strategy (compensatory vs. restorative), and the outcome, in terms of the effectiveness on way-finding abilities.

The studies covered a period of over 30 years (i.e. from 1981 to 2013), the age of participants varied from 67 to 90 years old, and all of them had formally received a diagnosis of dementia. Participants from six studies were suffering from AD [12–15, 17, 19], whilst the participants of the other two studies had a diagnosis of senile dementia [16] or non-specified dementia [18]. The level of the participants' dementia varied from mild to extremely severe, as assessed by Mini Mental State Examination (MMSE) [20], Clinical Dementia Rating (CDR) [21] or Global Deterioration Scale (GDS) [22]. The MMSE scores ranged from 4 to 24, CDR scores varied from 1 to 3, and GDS mean scores were around 5. For one study [18], it was impossible to identify the stage of the dementia because no specific information was reported. Patients from three studies [14, 15, 17] were reported to be on pharmacological treatment in the form of donepezil and memantine. No information about pharmacological treatment or cognition-enhancing drugs was reported in the other papers. Six studies employed a single-case experimental design [12–17], and the other two employed a case-control study. In all but one of the studies [12], a pre-test or a baseline was performed before the beginning of the intervention phases. Four studies had one or two post-tests, which occurred between one week and three months after the end of the intervention [13, 16, 18, 19]. The other four had no post-test measurements. Four studies employed a compensatory strategy [12–15], while the other four a restorative one.

Compensatory strategies

Use of spatial cues

External memory aids, such as calendars, memory notebooks, shopping lists, and instruction cards to take medication properly are frequently used by both older adults and individuals with brain injuries and with mild to moderate dementia, in order to compensate for verbal and episodic memory deficits [23–25]. Similarly, several nursing homes use environmental/spatial cues to increase functional independence in room finding for the elderly. Spatial cues can be considered as salient reference points (landmarks) which can help the patient to

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Table I. Summary of intervention strategies for reducing spatial orientation disorders in patients with dementia.

Study	Participants	Dementia severity	Method	Intervention	Intervention strategy	Outcome
Namazi et al. [12]	10 patients (eight women) with AD ($M = 79.3$, range 67–88 years)	From mild to severe (CDR scores from 1 to 3)	Multiple single-case design	Significant (familiar, beloved) vs. non-significant (unfamiliar and neutral) objects displayed outside each participant's room	Compensatory	The overall ability to locate one's room appeared to have some relationships to the level of dementia. Four residents were more successful in locating their rooms with significant memorabilia items than with non-significant ones irrespective of CDR scores
Nolan et al. [13]	Three women with AD (range 84–90 years)	Extremely severe (MMSE scores from 4 to 7)	Multiple baseline design across patients	Portrait-type photograph of each participant from early childhood *plus* a large print sign with the resident's name both placed outside each participant's room	Compensatory	Significant improvement in participant's ability to accurately locate their own room, following the intervention
Lancioni et al. [14]	Three patients (one women) with AD (range 73–83 years)	From mild to moderate (MMSE scores from 12 to 21)	For two participants: AB multiple baseline design across patients For the third participant: an AB^1BAB design was used, where the B^1 was a special intervention phase serving to establish responding to the system cues	An AT-based program provided brief verbal messages (cues) from the room to reach	Compensatory	The orientation system was effective in helping the three participants reach the target destinations within their day center successfully
Lancioni et al. [15]	Five patients (four women) with AD ($M = 77$, range 72–80 years)	Moderate stage (MMSE scores below 15)	Alternating treatments design	Auditory cues vs. light cues AT programs	Compensatory	Both orientation systems with auditory and light cues proved to be highly effective in helping the five participants reach the target destinations successfully
Hanley [16]		From moderate to extremely severe	Experiment 1: ABABA multiple single-case	Experiment 1: active ward orientation	Restorative	Experiment 1: significant improvement

(*continued*)

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	Eight women with senile dementia (range 69–79 years)		design Experiment 2: ABC multiple single-case design	training procedure Experiment 2: comparison between three types of intervention; (a) introduction of large ward signposts, (b) signs with a preceding training two weeks prior to signs introduction, and (c) signs with a training for two weeks after to signs introduction		for four out of five participants to locate the target destinations, following the intervention Experiment 2: significant improvement for participants in the conditions (b) and (c). Improvements were fully maintained at three month follow-up for participants in the condition (c)
McEvoy and Patterson [18]	15 patients (10 women) with dementia ($M = 70.3$), 15 patients (11 women) with depression, schizophrenia or anxiety reaction ($M = 68.5$)	Not specified	Control group study with pre, post and follow-up assessment of spatial orientation skills	Backward chaining program	Restorative	Non-demented patients found more locations than demented ones, but patients with dementia were able to find more locations at post and follow-up intervention assessment with respect to the pre-intervention assessment
McGilton et al. [19]	17 patients (16 women) with AD ($M = 86.2$) in the treatment group, 15 patients (10 women) with AD ($M = 89.2$) in the control group	From mild to severe (GDS Mean score for both groups = 5.1)	Randomized controlled trials, with pre, post-test 1 and post-test 2 after one week and after three months following the intervention, respectively	Backward chaining program	Restorative	For the experimental group, increased ability to find the way to the dining room at post-test 1, but not at post-test 2. No increased ability to find the way to the bedroom at post-test 1 or 2
Provencher et al. [17]	1 women (77 year) with AD	Mild cognitive decline (MMSE score = 24), severe episodic memory and attentional component of executive functions deficit	ABA multiple baselines across the routes	Errorless-based technique	Restorative	Significant improvement in participant's ability to travel along the two routes, following the intervention. Significant reduction of time needed to travel and increase of the speed

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discriminate among similar places and recognize specific areas, such as corridors, stairs, room entrances, that are relevant for her/his orientation and for reaching a target destination [12, 13, 26].

Namazi et al. [12] investigated whether familiar objects of long-term significance to each resident could serve as spatial orientation cues to help him or her identify his or her bedroom. Ten persons suffering from mild to severe AD were involved in the study, which compared the effectiveness of significant (familiar and beloved) and non-significant (unfamiliar and neutral) objects displayed outside the participants' bedroom. A multiple single-case design [27] was conducted for 10 trials under each of the two conditions. Results indicated that the ability to locate one's room appeared to have some relationships to the level of dementia. Patients in the early stage of the disease performed equally well under both conditions. Those in the moderate stage of the disease showed a mixed performance; some of them relied more frequently and successfully on significant cues, and some others were less successful and performed at comparable levels in the two conditions. The patient with an advanced stage of the disease failed drastically to use any type of orientation cues.

Nolan et al. [13] evaluated the impact of placing two external memory aids outside the bedrooms of three persons with AD. A portrait-type photograph of each participant from early childhood and a large print sign with the resident's name were both placed outside each participant's room, and a multiple baseline design across patients was conducted for two months, five times per week. Results showed that there was over a 50% mean increase in participants' ability to accurately locate their own room following the intervention.

AT programs

The term AT describes devices and programs used to restore, maintain, or improve the ability to carry out functional activities by persons with physical and/or intellectual disabilities [28–33]. The ultimate goal is to give the highest possible degree of independence and autonomy to the person for any task targeted within the intervention program. AT programs for reducing spatial orientation disorders have been profitably employed with persons with intellectual and visual disabilities: for example, auditory cues repeated at regular intervals to call the person toward a specific target destination were used with persons with visual impairments [34–39]. Similarly, a visual orientation system based on a portable device to be worn by the participant and on light sources that marked the routes to the various destinations was employed for promoting independent indoor traveling in persons with profound developmental disabilities [40].

Recently, an AT orientation program based on verbal messages (cues) has been successfully implemented by Lancioni et al. [14] with three persons with AD. The orientation system (a) included a sound source at each of the destinations and a portable control system to activate and deactivate each of those sources and (b) provided brief verbal messages (cues) from the destinations the person was expected to reach. The verbal messages (cues) consisted of short sentences encouraging the patient to walk and find the destination. A multiple baseline design across patients was conducted for over three months, six days per week. Results showed that the three participants involved in the study learned to use effectively the orientation technology to reach different room destinations. They improved their percentage of travel accuracy within the day center that they attended above the 90% level, with potentially important implications for their overall travel perspectives [26, 39, 41, 42].

In a more recent effort, Lancioni et al. [15] compared the effectiveness of two AT orientation systems, one involving auditory cues (i.e. verbal messages automatically presented from the destinations, as in Lancioni et al. [14]) and the other employing light cues (i.e. strobe lights replacing the verbal messages). Five persons with AD were involved in an alternating treatments design, with intervention sessions carried out on a daily basis, for over five months. Results showed that there was over a 65–70% mean increase in patients' ability to travel and locate the target rooms, irrespective of the system used for the intervention. Both orientations systems proved to be highly effective in helping the five patients reach the target destinations successfully. A social validation assessment suggested that social raters found the system based on visual cues preferable.

Restorative strategies

RO training

RO training is a widely employed technique to improve the ability to deal with reality (and most probably the quality of life) of confused elderly people and people with dementia [43]. Such technique has been used in the rehabilitation of persons with memory deficits, episodes of confused behavior, and time–place–person disorientation [44]. There are two main forms of RO: (a) class RO, in which information about time, place and significant life events of the patients are presented and actively rehearsed every day for about half an hour under the supervision of a therapist, and (b) 24 h RO, which

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involves the whole staff every time they interact with the patients during the activities of daily living and at other times [45].

Hanley [16] investigated the usefulness of 24 h RO in reducing ward disorientation in eight women with senile dementia. In experiment 1, an ABABA multiple single-case design [27] was used to test the effectiveness of active ward orientation training in five patients. The training consisted in showing the patient each incorrectly identified area in the baseline and giving a verbal description of it, and then coaching the patient to repeat the name of the area. Results showed a significant treatment effect for four out of five patients. In experiment 2, an ABC multiple single-case design [27] was employed to compare three types of intervention: (a) the use of large three-dimensional ward signposts, (b) use of signposts preceded by two weeks of ward orientation training, and (c) use of signposts followed by two weeks of ward orientation training. Results showed that signposts alone were not effective in improving ward orientation. On the other hand, the association of the trainings to the signposts produced a moderate improvement, which persisted in two patients at a three months follow-up.

Errorless-teaching techniques

Errorless learning (EL) is one of the most successful techniques used in the rehabilitation of people with memory disorders, especially those with severe forms of impairment [46–50]. The EL technique requires learning or encoding new information without error. In order to achieve this result, prompting cues are given to the person before he/she could commit an error. This process is repeated over multiple trials, until the individual can complete the whole task without the help of those cues that are faded out.

Provencher et al. [17] investigated the effectiveness of an errorless-based technique in facilitating the learning and the retention of procedural components of three new routes with a woman with mild AD. An ABA design with multiple baselines across the routes was employed [27], with the intervention given for two routes and no intervention for the third one. For both routes with intervention, the participant watched the research assistant performing the route correctly and was then instructed how to travel the route herself. She was, therefore, corrected as soon as she began to take a wrong turning; by this way, her performance of the route was always correct. Moreover, in order to allow the participant to learn the routes in a gradually increasing succession of stages, a vanishing cues procedure was also adopted. This procedure ensured that the help provided to cover the entire route was progressively faded out [51]. Results showed that there was over a 50% mean increase in participant's ability to travel along the two routes, following the intervention. The ability to travel correctly was maintained for a 10-week follow-up for the first route and at a 1-, 2-, and 6-week follow-up for the second route. There was also a significant reduction in the time needed to travel, due to decreasing hesitations in choosing the way at critical turning points.

Backward chaining programs

Backward chaining can be formally defined as the strategy of learning tasks in the reverse order in which they are usually performed. The learning begins with the last element in a chain of steps and proceeds to the first element, until the whole task can be performed without any assistance. Backward chaining has been used since long time in teaching a broad range of skills. For example, it has been used to teach basic skills in reading and writing in primary and secondary schools, complex emergency response procedures to military personnel, and daily life activities to people with dementia and acquired brain injury [24, 52, 53].

Two studies investigated the effects of a backward chaining procedure to reduce spatial orientation disorders in people with AD. The first one [18] evaluated the effectiveness of a behavioral program designed to retrain various skills needed for non-institutional living in two groups of elderly patients, 15 diagnosed with dementia and 15 with various psychiatric problems but no dementia. Spatial orientation intervention was based on a backward chaining procedure. The intervention began with the last portion of each route to be learned and then proceeded with further steps involving the last part together with intermediate parts, and eventually covered the entire travel route. When independence was achieved in the last part of the trip, prompting was then moved to the second part, and assistance was given for the remaining part. The program went on with more additional steps to enable the patients to manage the entire distance they had to cover for reaching the target destination. Three assessments of spatial orientation skill were recorded: an initial one during the first week of training, a second one after one month of training, and a final assessment at the end of the intervention program. Results showed that (a) performance of patients with dementia was generally poorer with respect to performance of patients with psychiatric diseases and (b) patients with dementia were able to find more locations at the second and third intervention assessments with respect to the initial one.

The second study [19] used a randomized controlled trials design to evaluate the effects of a way-finding intervention for reaching two different

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destinations (i.e. dining room and bedroom) within a geriatric center. A sample of 32 patients with AD was split into two groups; 17 patients received the intervention and 15 did not. A backward chaining procedure was employed, similar to that used in McEvoy and Patterson [18]. Three evaluations of spatial orientation skills were recorded: the first one prior to start the intervention sessions, the second and third after one week and after three months following the intervention, respectively. Patients who received the way-finding intervention demonstrated an increased ability to find their way to the dining room only at post-test 1, but this effect was not sustained at post-test 2. Again, they did not show an increased ability to find their way to the bedroom, neither at post-test 1 nor at 2. No differences were found between the three assessments for the control group.

Discussion

Efficacy of the intervention strategies

The aforementioned studies argued that it is possible to reduce spatial orientation disorders in AD. In terms of training efficacy, it might be interesting to note that all the studies reported positive/mixed results on spatial orientation abilities after the interventions. Both compensatory and restorative strategies seemed to be valuable in enhancing correct way-finding behavior, with various degrees of effectiveness. The use of spatial cues [12, 13] and of AT programs [14, 15] produced an increase of 50–70% in participants' ability to accurately locate the target destinations. The use of RO training plus spatial cues (large signposts, in Hanley [16]) gave mixed results. Some participants benefited from the combination of the two techniques, some others responded only to one technique, and some others failed to respond to both. Two studies with backward chaining programs were conducted; the first one [18] showed a significant improvement in participants' ability to find target locations at two post-tests, the second one [19] showed mixed results. Participants in the treatment group were able to find the way to the first target room at post-test 1, but not at post-test 2, and no increased ability to find the way to the second target room was registered, neither at post-test 1 nor at post-test 2. An errorless-based technique was employed in Provencher et al. [17], and results showed a significant improvement in participants' ability to travel correctly along the two treatment routes, both during the treatment and at a post-test measurement.

The best results were obtained with compensatory strategies, in particular with AT programs. This kind of intervention was highly effective in reducing spatial orientation disorders in AD, probably because it was aimed at supporting and recovering functional daily life ability without requiring effective learning skills. Restorative strategies, by contrast, showed partial results, especially at follow-up measurements. Studies using these strategies suggested that cognitive training programs may have only a modest impact on way-finding skills, slightly improving spatial and topographical memory functions in the short-term period.

In spite of the aforementioned differences between approaches, a definite conclusion about their relative efficacy cannot be drawn due to issues related to participants' characteristics and experimental designs. Two major sources of variability were identified: (a) participants included in the training programs had different levels of cognitive functioning, ranging from mild to extremely severe or unspecified [18], and (b) both multiple single-case and case-control designs were employed. An indirect comparison of treatment outcomes from studies with such large variability in methodological and participants' characteristics is hazardous and could lead to biased conclusions. Another limitation comes from the lack of information about the performance of the participants on a variety of cognitive/neuropsychological measures related to spatial abilities. An extensive assessment would be required to provide detailed information about residual learning skills in spatial memory domain and eventually determine the impact of the intervention strategies.

In light of the above, it seems still impossible to determine the most favorable intervention condition and whether a restorative rather than a compensatory intervention strategy should be pursued. From a rehabilitative point of view, one might prefer a restorative strategy as the one that could activate the residual learning potential and slow down the most negative outcomes of the neurodegeneration [54–56]. On the other hand, a compensatory strategy has a higher *a priori* probability to succeed and it requires less time to be acquired and could be maintained over time with the help of the technology [14, 15]

Practicality of the intervention strategies

Within rehabilitation contexts, restorative strategies might be best employed with less impaired patients more likely to be able to use residual learning skills. Preservation of such learning skills does not guarantee, however, that the beneficial effects of the intervention are felt over time. As a matter of fact, the studies discussed in the present review showed that the positive effect of the interventions decayed rather quickly after their conclusion, raising doubts about their rehabilitation worth and their potential in

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helping the patients avoid problems of agitation and wandering [57, 58]. Two other issues could be raised concerning the practicality of compensatory and restorative intervention strategies: environmental noises/disturbances and human/economic costs. Restorative trainings might be less intrusive and more compliant with the daily activities carried out in geriatric centers with respect to AT devices (visual and auditory systems) usually employed to carry out compensatory interventions. On the other hand, restorative strategies have higher human and economic costs than compensatory ones, requiring a *vis-à-vis* patient-operator relationship along the whole intervention period. On the contrary, the currently developed low-cost technological devices could facilitate daily activities, also promoting positive effect on mood [59–61].

Conclusion

To the best of our knowledge, no direct comparisons between restorative and compensatory procedures on the same patients suffering from AD have been conducted previously. A multiple single-case study with an alternating treatments design [27] seems to be the most appropriate methodology in order to approach this issue for the first time. It may allow a preliminary evaluation of different training techniques, avoiding sources of between-group variability. Afterwards, case-control or randomized controlled trials studies may be addressed on larger samples, providing a repeated and exhaustive neuropsychological evaluation (i.e. baseline, end of the intervention and follow-up) as a crucial requirement. Finally, the evaluation of spatial domain, also recurring to computer-aided assessment methodologies [62–65], could supplement the conventional neuropsychological assessment in order to fulfill the requirements of the evidence-based approach.

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