Effectiveness of Environment-Based Interventions for People With Alzheimer’s Disease and Related Dementias

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KEY WORDS
- Alzheimer disease
- behavior
- environment
- environment design
- evidence-based practice

A systematic review of evidence for the efficacy of environment-based interventions on the affect, behavior, and performance of people with Alzheimer’s disease and related dementias was conducted as part of the American Occupational Therapy Association’s Evidence-Based Literature Review Project. Thirty-three reports met inclusion criteria. Results suggest that ambient music, aromatherapy, and Snoezelen® are modestly effective in reducing agitation but do not consistently have long-term effects. Visually complex environments that give the illusion of barriers deter people from wandering to unsafe places but do not reduce the urge to wander. Evidence that bright light therapy can aid in regulating mood and the sleep–wake cycle and thus help people remain awake during the day is preliminary. Montessori-based programming can be useful in matching activities to the person's remaining skills. Further research is needed to evaluate the long-term effect, contraindications, and best dosages of these interventions.


Neuropsychiatric symptoms (NPS), such as depression, anxiety, agitation, apathy, hallucinations, and delusions, affect about 80% of nursing home patients and ≥50% of community-dwelling patients with dementia (Monastero, Mangialasche, Camarda, Ercolani, & Camarda, 2009). NPS are associated with greater dependence in functional tasks and nursing home placement and may be related to the characteristics of the psychosocial or physical environment, such as crowded housing conditions leading to sensory overstimulation (Zuidema, de Jonghe, Verhey, & Koopmans, 2010). NPS are also associated with staff attitudes toward challenging behaviors, the size of the units in which patients reside throughout the day, or both (Somboontanont et al., 2004). NPS are associated with caregiver burnout (Ballard, Day, Sharp, Wing, & Koopmans, 2008), increased health care costs (Murman, Von Eye, Sherwood, Liang, & Coleda, 2007), and increased institutionalization of patients with dementia (Steinberg & Lyketsos, 2009). Antipsychotic drugs are often the first choice in managing NPS (Schellhorn, Barnhill, Raiteri, Faso, & Ferrando, 2009), which is alarming in light of reports that such drugs are associated with increased risk of death of older people with Alzheimer’s disease (AD; Schneider, Dagerman, & Insel, 2005). Therefore, finding alternative and effective methods for managing NPS is an important public health and fiscal priority (Borson & Doane, 1997).

Nonpharmacological interventions fall into three broad categories. On the one hand, unmet-needs interventions assume NPS to be an expression of an underlying need, such as the need for stimulation, pain reduction, or socialization. For example, the repetitive vocalizations of a patient with dementia may have the purpose of providing his or her own auditory stimulation (Scholzel-Dorenbos, Meeuwsen, & Olde Rikkert, 2010). Learning and behavioral interventions, on the other hand, assume NPS are the result of inadvertently
reinforced behaviors, such as patients learning to get attention by screaming (Bourgeois & Hickey, 2009). Finally, environmental vulnerability and reduced stress-threshold interventions assume a mismatch between a person’s environment and his or her ability to cope with the situation. For example, too much noise in the environment may cause patients to overreact and become agitated (Cohen-Mansfield, 2001). These approaches describe many of the interventions occupational therapy practitioners can provide while enabling participation in occupation (American Occupational Therapy Association [AOTA], 2008). The purpose of this review was to identify the evidence related to the effectiveness of environment-based interventions on performance, affect, and behavior of people with AD or related dementia.

Background Literature

Environment-based interventions refer to strategies that use the “external physical and social environments that surround the client and in which the client’s daily occupations occur” (AOTA, 2008, p. 645). Proponents of these approaches have theorized that learning is dependent on the ability to take in, process, and integrate sensory information to plan and organize behavior. Deficits in processing and integrating sensory input therefore result in a deficit in planning and producing behaviors. Opportunities for increased and enhanced sensory experiences are thought to enhance the ability of the central nervous system to process and integrate sensory information and satisfy the inner drive to develop sensory integration, a prerequisite for higher cognitive processes (Calvert, Spence, & Stein, 2004). Multisensory interventions (MSIs) can be classified into four broad categories related to sensory experiences: auditory (music therapy and natural sound environments), olfactory (aromatherapy), visual (bright light therapy [BLT]), and multisensory (Snoezelen®, Montessori).

Therapeutic ambient music interventions involve “controlled use of music and its influence on the human being to aid in physiologic, psychologic and emotional integration of individuals during treatment of an illness or disability” (Munro & Mount, 1978, p. 1029). Ambient music and nature-related sensory stimuli have been shown to aid in pain control, relaxation, distraction, and reduction of anxiety in diverse populations (de Niet, Tiemens, Lendemeijer, & Hutschemaekers, 2009). Aromatherapy is the practice of using volatile and essential plant oils for psychological and physical well-being (Field, 2009). Its application has been varied, and research has provided preliminary evidence that aromatherapy has some effectiveness in reducing pain, anxiety, and depressive symptoms of surgical and cancer patients (Braden, Reichow, & Halm, 2009).

Sleep disorders and circadian rhythm disturbances are frequently seen as people age. Some indication exists that disruptions of the normal circadian rhythms can be reduced with BLT, making a normal daily sleep–wake cycle more likely (Wu & Swaab, 2007). BLT involves exposure to intense levels of light under controlled conditions, usually a system of fluorescent lights installed in a box with a diffusing screen, set up on a table or desk top at which one can sit comfortably for the treatment session. Special bulbs may also be placed overhead for group treatment. The broadest application has been in the treatment of shift work and other sleep disorders (Thorpy, 2010). Preliminary evidence has suggested that BLT may influence depression, primary sexual dysfunction, and nonmotor symptoms of Parkinson’s disease (Bossini et al., 2009; Freeman, 2009; Zesiewicz & Evatt, 2009). However, contraindications are not yet fully understood (Wu & Swaab, 2007).

MSIs stimulate several primary senses through the concurrent use of lighting effects, tactile surfaces, meditative music, and scented oils (Vidal, Lehmann, & Bulthoff, 2009). Such interventions have resulted in limited improvements in behavioral state organization of premature infants (White-Traut et al., 2004), academic-related skills of children with a variety of disabilities, and positive emotions of adults with developmental disabilities (Chan et al., 2010; Zwicker & Hadwin, 2009). Two MSI programs that have gained popularity are Snoezelen and Montessori. Snoezelen is delivered in a room outfitted with special equipment and supplies that provide gentle stimulation of the primary senses. The individual is free to explore, react, and respond with no declared aims or purposes. Sensory experiences can be strategically manipulated on the basis of the person’s needs and desires (Botts, Hershfeldt, & Christensen-Sandfort, 2008). Snoezelen appears to help reduce stereotypy and increase engagement of people with mental retardation or recovering from brain injury (Lindsay et al., 2007); reduce anxiety during psychosis; and induce relaxation and manage pain related to orthopedic trauma, cancer, and labor (Schofield, 2009). Unlike Snoezelen, therapeutic Montessori uses learning games and materials suggestive of a purpose and suited to a person’s abilities and interests. The environments are set up by a therapist–observer who intervenes only when individual help is needed (Lillard, 2008). The relative success of Montessori with children led to exploration of its therapeutic applications to enhance decision making and language development in adults with various disorders (Camp, 2007).
Method for Conducting the Evidence-Based Review

This systematic review addressed the focused question, “What is the evidence for the effect of environment-based interventions on performance, affect, and behavior in both the home and institutions for people with AD?” Detailed information about the methodology for the review can be found in Arbesman and Lieberman (2011; this issue).

Results

A total of 1,720 titles and abstracts were reviewed and 189 reports were read in full. Thirty-four studies (25 Level I, 7 Level II, 1 Level III, and 1 Level IV) were relevant to the focused question. Articles were abstracted using an evidence table format and later summarized and appraised in a Critically Appraised Topic. Supplemental Table 1, available online at www.ajot.ajotpress.net (navigate to this article, and click on “supplemental materials”), contains information about the objectives, design, procedures, outcomes, findings, and limitations of the studies. Findings are summarized in the following sections according to the main categories of intervention, including environmental interventions; MSIs; and other strategies, such as ambient music, natural sounds, aromatherapy, and BLT.

Environmental Interventions

Two studies involved occupational therapy in the provision of environmental strategies. Dooley and Hinojosa (2004; Level I, N = 80) examined whether adherence to occupational therapy recommendations increased the quality of life of people with AD living in the community and decreased caregiver burden. Among other things, the intervention program included recommendations for environmental modifications (such as posting of visual cues and emergency telephone numbers, labeling of drawers and cabinets, bells on doors). Later, Graff et al. (2006; Level I, N = 135) included educational sessions on similar compensatory and environmental strategies in their study of the effectiveness of community-based occupational therapy on daily functioning of people with AD. Graff et al. concluded that such interventions were effective when combined with caregiver approaches and community resources as part of individualized programs.

Several studies focused on the effectiveness of interventions that may be described as environmentally based. Opie, Rosewarne, and O’Connor (1999; Level I, N = 43); Price, Hermans, and Grimley Evans (2001; Level I, N = 0); and Livingston, Johnston, Katona, Paton, and Lyketsos (2005; Level I, N = 162) included studies on environmental changes in their systematic reviews of psychosocial approaches to behavior disorders in dementia. Studies were based on the premise that the physical environment can exacerbate the confusion and disorientation experienced by people with dementia. Although most studies showed beneficial effects, few had moderate validity. Studies concluded that placing strips of tape on the floor to give the illusion of a barrier was ineffective and may actually increase unwanted exiting by drawing attention to the doors. The only intervention that reduced exiting was the complete occlusion of doorknobs or doors using curtains or blinds. Full-length mirrors over doorways led to a significant decrease in exiting behavior, but also increased agitation in some participants. The studies’ small sample sizes limited their generalizability. Because the possibility of psychological distress could not be excluded from these interventions, their use should be preceded by research on their subjective impact.

Nolan, Mathews, and Harrison (2001; Level IV, N = 3) tested the impact of placing two external memory aids outside participants’ bedrooms in a nursing home. A laminated card with a statement indicating who lived in the room was taped to the participant’s door. A photograph of the participant was attached to the back of the memory card. Participants all improved in their ability to locate their bedrooms during the intervention phase, and their ability to accurately locate their room showed a >50% mean increase after the intervention. In contrast, Livingston et al. (2005) concluded that signposting was effective only in combination with reality orientation therapy.

Heyn (2003; Level III, N = 13) tested a program that consisted of a focused attention and warm-up session that included storytelling and imagery, flexibility and aerobic exercise, a strength-training session, and a closing session focusing on relaxation and breathing techniques. Results showed an improvement in overall mood and in engagement in physical activity, although such change did not reach statistical significance. The small convenience sample, lack of comparison group or follow-up, and limited impact on active engagement in functional activities make it difficult to draw conclusions about the intervention’s effectiveness.

Multisensory Approaches

Evidence demonstrating the detrimental effects of sensory deprivation on normal people has led to hypotheses that behavioral problems of people with dementia may be related to progressive neuronal losses that result in impaired processing of sensory stimuli, making normal stimuli confusing (Thomas et al., 2008). Several forms of intervention available for people with dementia involve concurrent
application of multiple sensory stimuli. Research has mostly focused on two particular types of programs, Snoezelen (Botts et al., 2008) and Montessori (Camp, 2007).

Snoezelen rooms for sensory stimulation in dementia units have gained ground as an enhancement to patient care in recent years. These environments stimulate the primary senses by permitting the person free exploration of a variety of objects and materials (such as a fan blowing scraps of paper, ink mixed with water and projected onto a screen, musical instruments, tactile objects, scent bottles, soaps, and flavorful foods).

Six studies that reported on the effects of Snoezelen for people with dementia were located. Baillon et al. (2004; Level I, \( N = 20 \)) randomized dementia day care patients into either a Snoezelen or a reminiscence group. They measured agitation behaviors and mood and concluded that Snoezelen was not any more effective than reminiscence. Both interventions resulted in only short-term changes in mood and agitation. The systematic reviews reached similar conclusions in relation to the effectiveness of Snoezelen compared with ambient music, usual daily routines, or standard activity sessions (Lancioni, Cuvo, & O’Reilly, 2002; Level I, \( N = 21 \); Livingston et al., 2005; Level I, \( N = 162 \)). Verkaik, vanWeert, and Francke (2005; Level I, \( N = 19 \)) concluded that although Snoezelen showed some evidence of effectiveness with depressed, aggressive, and apathetic behaviors of people with dementia, the evidence was quite modest and further research is needed. Chung and Lai (2002; Level I, \( N = 5 \)), however, found no evidence of the efficacy of Snoezelen on the mood or behavior of people with dementia in the studies they reviewed. Robinson et al. (2007; Level I, \( N = 11 \)) also concluded that the evidence to recommend Snoezelen as an intervention to reduce wandering in dementia was not robust. Although these reviews reported some positive within-session effects related to communication, engagement, and self-injury measures, long-term effects were inconclusive because they were either not directly measured or relied largely on qualitative or unstructured (not always unequivocal) data. Selection, performance, attrition, and detection biases rendered results of the studies unreliable.

Therapeutic Montessori programs also use environments rich in manipulative materials. Unlike Snoezelen, however, these materials consist of learning games suited to a person’s abilities and interests. Montessori materials, such as games, household utensils, and so on, are suggestive of a purpose. Montessori-based activities have been claimed to engage people in learning through task breakdown, guided repetition, progression in difficulty from simple to complex, and careful matching of demands to levels of competence (Lillard, 2008). Because they can be easily adapted to the interests and skills of people with AD, Montessori activities have been applied for the purpose of socialization, meaningful activity, and diversion. Activities are designed to tap procedural memory, which is better preserved than verbal memory, while minimizing language demands and providing external cues to compensate for cognitive deficits. Familiar objects provide cues to their own use (e.g., playing cards suggest sorting them in a sequence; mixing bowls and cooking ingredients suggest combining them and mixing them), and the presence of objects in the person’s environment is thought to prompt participants to follow suit and use them (Camp, 2007).

Four studies (Lee, Camp, & Malone, 2007; Level I, \( N = 29 \); Jarrott, Gozali, & Gigliotti, 2008; Level II, \( N = 10 \); Orsulic-Jeras, Judge, & Camp; 2000, Level II, \( N = 16 \); Vance & Johns, 2002; Level II, \( N = 15 \)) reported that the average amount of time people spent constructively engaged in Montessori activities was significantly higher than that spent engaged in negative occupations. Pleasure scores were significantly higher and anxiety scores lower during Montessori programming in contrast with regular unit activities, but these gains declined after participants became familiar with the activities. Gains were made in attention, object permanence, and memory. No apparent benefit in vocabulary, spatial attention, spatial reasoning, or abstract reasoning or in activities of daily living (ADL) measures were observed. These researchers concluded that because of the small sample size and multiple subjective outcome measures, results should be considered with caution. Lin et al. (2009; Level I, \( N = 133 \)) randomized institutionalized residents with dementia into three treatment sequences that included Montessori, acupressure, and presence (attention on intrapersonal processes) in varying order. The acupressure and Montessori-based-activities groups, but not the presence group, saw a significant decrease in agitated, aggressive, and physically nonaggressive behaviors. Sample size, nonheterogeneous control participants, and extraneous factors presented significant limitations for this study, and negative effects were not investigated.

**Other Interventions**

Ambient music and nature sound therapy aim to create a secure, stimulating environment that helps to meet the social and emotional needs and reduce the problem behavior displayed by people with AD and related dementias (Cohen-Mansfield, 2001). Generally, the desired outcome is the modulation of agitation. Evidence from 6 systematic reviews and 1 nonrandomized controlled study suggest that ambient music may indeed help decrease
agitation and, therefore, indirectly contribute to improved attention, but its effect is modest. Methodological problems (small sample size, nonequivalent control groups, lack of blinding, lack of control of extraneous variables, reliance on observational and self-report outcome measures) contribute to the limited evidence of effectiveness. Kong, Evans, and Guevara (2009; Level I, N = 14) and Kverno, Black, Nolan, and Rabins (2009; Level I, N = 21) concluded that only sensory interventions, including calming ambient music, had efficacy in comparison with other types of interventions but noted that such outcomes should be interpreted cautiously because music was paired with hand massage, no effort was made to control the social environment in which the intervention took place, and benefits were short lived. They concluded that ambient music is more helpful in calming situational anxiety than in significantly changing reactions to internal or external triggers. Livingston et al. (2005; Level I, N = 162) and Robinson et al. (2007; Level I, N = 11) reviewed small trials that showed improvements in disruptive behavior during or immediately after a session, but no evidence was found that benefit carried over in the longer term. Sherratt, Thornton, and Hatton (2004; Level I, N = 21) found active and receptive (ambient) music interventions to be effective in a variety of ways.

Although active music intervention appeared to improve engagement and reality orientation, passive or ambient interventions reduced wandering, repetitive vocalizations, and irritability. Ambient music was applied unevenly across the reviewed studies, however. Sometimes participants were instructed to directly attend to the music, and at other times the music was playing in the background while participants engaged in a manual task. Studies in which participants were permitted to select their preferred music were more likely to report positive effects. Opie et al. (1999; Level I, N = 43) reviewed studies that tested the effect of music in residential facilities and also concluded that aggression (yelling, abusive language, and verbal and physical resistance) was likely to be reduced when residents’ preferred music was played during various activities. Beyond the calming effect during a session, however, Opie et al. found no long-term effect.

Swanson, Maas, and Buckwalter (1994; Level II, N = 22) compared the effects of a special care unit (SCU) and of a traditional (integrated) nursing home on residents with AD. The SCU included open spaces, a secured courtyard to permit free wandering, locked storage spaces, reduced ambient noise, quiet but pleasant decor, and soothing ambient music. Swanson et al. found no significant differences in cognitive or functional abilities scores for the groups over time. However, the SCU participants’ socially accessible behaviors (catastrophic reactions and social interactions) were better than those of participants in traditional units. The SCU sample size was small and the control group nonequivalent, making the results tentative.

Aromatherapy is reported to be one of the most widely applied complementary therapies used for people with dementia (Cohen-Mansfield, 2001). Several clinical trials have compared inactive treatment with aromatherapy, principally using either lavender (Lavandula angustifolia or Lavandula officinalis) or lemon balm (Melissa officinalis) in diffusers or lotions applied topically. Seven systematic reviews were located (Holt et al., 2003; Kong et al., 2009; Kverno et al., 2009; Nguyen & Paton, 2008; Opie et al., 1999; Robinson et al., 2007; Thorgrimsen, Spector, Wiles, & Orrell, 2003; all Level I). As with ambient music, results were inconclusive because of small samples, lack of control of intervening variables, unevenly applied interventions, and inconsistent effects. However, as an aggregate, these studies suggest that aromatherapy may be useful in inducing relaxation and reducing agitation and other NPS. Some studies reported negative consequences (skin rash, anxiety), suggesting caution in the use of these interventions until the side effect profile of commonly used oils is better understood.

Sleep fragmentation, common in AD, is associated with excessive daytime napping and sleepiness and with other behavioral symptoms such as sundowning syndrome and nocturnal agitation (Wu & Swaab, 2007). Evidence is mixed as to whether BLT is an effective treatment in restoring the wake–sleep pattern and thus supporting more active engagement in life during the day. Skjerve, Bjorvatn, and Holsten (2004; Level I, N = 21) and Forbes, Morgan, Bangma, Peacock, and Adamson (2004; Level I, N = 3) deduced that no conclusions could be drawn about BLT’s efficacy or about its safety and practicability in clinical settings. Opie et al. (1999; Level I, N = 43); Ayalon, McGum, Feliciano, and Arean (2006; Level I, N = 9); Kong et al. (2009; Level I, N = 14); and Kverno et al. (2009; Level I, N = 21) reviewed BLT studies that tested various light boxes, evening and morning overhead lights, and light provided through adapted headgear. Statistically significant positive results were reported only in studies using light boxes, but methodological problems (nonequivalent experimental and control groups, high attrition, unequal application of intervention, etc.) with these studies led these researchers to conclude that although BLT showed promise, more research was needed.

Dowling, Graf, Hubbard, and Luxenburg (2007; Level I, N = 70); Dowling, Mastik, Hubbard, Luxenberg, and Burr (2005; Level I, N = 70); Hickman et al. (2007; Level
II, \( N = 66 \)); and Sloane et al. (2007; Level II, \( N = 66 \)) compared bright light exposure to usual room light with residents with AD in nursing homes. Overall, BLT did not improve residents’ performance on most measures of sleep–wake (circadian) or rest–activity (time spent engaged in purposeful tasks in comparison with dozing or staring) disruptions compared with control participants. However, experimental groups, as a whole, did appear to receive sufficient light to prevent their rest–activity rhythm from deteriorating, unlike the control groups. Dowling et al. (2008; Level I, \( N = 50 \)) tested whether the addition of melatonin would enhance the efficacy of BLT in treating rest–activity disruption in institutionalized patients with AD. The group that received melatonin showed significant decreases in daytime somnolence, increases in daytime activity, and an improvement in day–night sleep ratio. Because the researchers did not test melatonin alone, ascertaining the degree to which BLT contributed to the changes is not possible.

**Discussion and Implications for Occupational Therapy Practice**

Occupational therapy has long recognized the influence of the environment on people’s behavior and therefore used environmental strategies to support participation in occupation (AOTA, 2008). Evidence of the effectiveness of environment-based interventions on affect, behavior, and performance of people with AD and related dementias is mixed. Tolerance for interventions should be tested beforehand; strategies should be individualized to meet patients’ needs and applied in enclosed spaces in which the effects can be limited to one patient at a time. MSIs that combine manipulative and tactile tasks appear to be the most effective. Reduction in agitation and improvements in affect in turn improve participation in ADLs. The use of a purely olfactory form of aromatherapy to decrease agitation has little support. Incorporation of calming music and aromas into ADL routines or other occupations normally associated with smells may reduce agitated behaviors and thus increase the likelihood of the person’s participation in activities. No evidence has been found that changes in the environment that cause the person to perceive obstructions that are not present (subjective barriers) reduce wandering. However, they do keep patients safe and are more ethically acceptable than restraints or psychotropic medications. BLT alone is not powerful enough to produce statistically significant changes, but in some cases it does help people remain awake for longer periods during the day when more opportunities for occupational participation are available.

External memory aids in the form of signs with the person’s name and portraitlike photographs can help people with AD navigate their environment. Snoezelen has within-session positive effects on mood and behavior, but materials are expensive. The Montessori philosophy is consistent with occupation-based, client-centered practice that emphasizes naturalistic treatment that can be graded for complexity. It engages older people to be active and can provide a rich social and caring environment.

Most of the studies that have investigated these interventions are limited by small sample size; lack of randomization and follow-up; lack of control of intervening variables; and overuse of subjective, self-report outcome measures. Most research has been conducted in long-term care or assisted living facilities. However, some evidence has been found for the value of inclusion of environmental modification strategies in community-based occupational therapy programs for people with mild to moderate dementia. Brief occupational therapy interventions can be effective when directed at improving the quality of life of people with dementia. Interventions that combine sensory strategies, environmental modifications, caregiving approaches, and community-based assistance can help improve the client’s affect, as well as independence in ADLs. ▲

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**References**


