Interventions in the Enhancement or Preservation of Motor Skill Learning in Those with Mild Dementia

Dinah Hudson
Interventions in the Enhancement or Preservation of Motor Skill Learning in Those with Mild Dementia

Abstract
The aim of this research is to provide a resource on current available data regarding methods used for enhancing or preserving motor learning in those with Alzheimer's dementia (AD). A decline in motor skill learning is associated with increased morbidity in the AD population. The implementation of interventions such as multisensory environments (MSE), physiotherapy, and physical activity may prove beneficial in stalling the inevitable degeneration of motor skills in this population. These interventions then may indirectly increase levels of activities of daily living, autonomy, and the quality of life of AD patients. The importance of familiarizing individuals with this knowledge relies on the possibility that many people could benefit from awareness of approaches that aid and preserve the learning process in those with AD and other types of dementia.

Degree Type
Open Access Senior Honors Thesis

Department
Psychology
INTERVENTIONS IN THE ENHANCEMENT OR PRESERVATION OF MOTOR SKILL LEARNING IN THOSE WITH MILD DEMENTIA

By

Dinah Hudson

A Senior Thesis Submitted to the

Eastern Michigan University

Honors College

In Partial Fulfillment of the Requirements for Graduation

with Honors in Psychology

Approved at Ypsilanti, Michigan, on this date 2015
Abstract

The aim of this research is to provide a resource on current available data regarding methods used for enhancing or preserving motor learning in those with Alzheimer’s dementia (AD). A decline in motor skill learning is associated with increased morbidity in the AD population. The implementation of interventions such as multisensory environments (MSE), physiotherapy, and physical activity may prove beneficial in stalling the inevitable degeneration of motor skills in this population. These interventions then may indirectly increase levels of activities of daily living, autonomy, and the quality of life of AD patients. The importance of familiarizing individuals with this knowledge relies on the possibility that many people could benefit from awareness of approaches that aid and preserve the learning process in those with AD and other types of dementia.
Table of Contents

Abstract ................................................................................................................. 2
Introduction ............................................................................................................ 4
Definition of Dementia ............................................................................................ 4
Prevalence of Dementia ......................................................................................... 5
Diseases Related to Dementia ................................................................................ 6
Main Symptoms of Dementia ................................................................................ 7
  Cognitive Declines .............................................................................................. 8
  Motor Declines .................................................................................................. 9
Definition of Motor Learning .................................................................................. 10
Main Assessments in Dementia ............................................................................ 16
  Cognitive Assessments ......................................................................................... 16
  Motor Assessments ............................................................................................... 18
Main Intervention Approaches for Motor Impairments ........................................... 21
  Sensory Processing Enhancement ....................................................................... 22
  Physiotherapy ..................................................................................................... 26
  Physical Activity .................................................................................................. 27
  Pharmacological Approach .................................................................................. 28
Discussion ............................................................................................................... 29
Limitations .............................................................................................................. 30
Aims for Future Research ...................................................................................... 32
References .............................................................................................................. 33
Introduction

Cognitive decline is expected in typical neurocognitive aging in the elderly. Conditions expected are of a wide range of causes producing a wider range of effects including anything from changes in cognition to a decrease in motor ability. In this population, however, these effects should not severely hinder everyday functioning. Indications of otherwise abnormal daily functioning may be indicative of a larger issue. But, unlike what is characteristic of normal cognitive aging, global cognitive decline is a distinguishing factor of the disease known as dementia. Dementia is an umbrella term for diseases such as Alzheimer’s Dementia (AD), Dementia with Lewy Bodies (DLB), and Parkinson’s disease where severe motor deficits are a significant feature. This review was put together to investigate methods of intervention that may contribute to the increase in the quality of life and independence of dementia patients.

Computerized searches for peer-reviewed scholarly articles and books within the databases of PsychInfo and PubMed were conducted. Only reports published in English were considered.

Definition of Dementia

Dementia is a progressive neurocognitive disorder that deteriorates mental abilities such as thinking, comprehension, learning capacity, language, emotion, behavior, recognition, judgment, motor control, and daily living activities. Assessing the extent to which a person has become affected is important for diagnosing the severity wrought on the individual. It is imperative to gauge the affect dementia has and to arrange suitable care for the patient. Cognitive decline is measured using assessments that
reliably and validly detect possible deficits in affect, behavior, and cognition. Instruments such as the Mini Mental State Examination (MMSE) (Folstein et al., 1975), Dementia Rating Scale (DRS) (Mattis et al., 2001), Test for Severe Cognitive Impairments (TSI) (Albert & Cohen, 1992), and Block Design Test (Kohs, 1920) are designed with that in mind (Eramudugolla, 2012; Burns et al., 2006). These tests assess memory, attention, language, and executive functioning—components which are first to be affected by cognitive decline.

Other components of mental processing affected by dementia are motor control and motor skill learning. Declines in motor processing and functioning are assessed using measures such as the Assessment of Motor and Process Skills (AMPS) (Chard et al., 2000) and the Maze Test (Kuzis et al., 1999). After a diagnosis of dementia, steps must be taken to enhance the quality of life of the patient as much as possible.

Discussed here will be solutions to questions like: do motor skill interventions significantly enhance the quality of life of someone with dementia? And, if so, which are they?

**Prevalence of Dementia**

As recently as the 20th century in the United States, there has been an increase in the human life expectancy. As a result, a rise in the number of reported cases of dementia and dementia like symptoms associated with old age has become evident.

Numerous reports indicate that by 2050, the elderly population aged 85 years or older in North America is estimated to reach approximately 19.5 million (Rocca et al., 2011). Of those 19.5 million, 13.2 million are anticipated to have a diagnosis of dementia within the same year (Rocca et al., 2011). Because one of the highest risk factors for
dementia is age, the expansion of the aging population is likely to see a significant portion of its population diagnosed with dementia. The increased number of those with dementia will place a significant strain on appropriate health care options.

Brookmeyer and colleagues (2011) point out the importance that prevalence plays when considering the burdens of care, services, and resources that the disease places on the AD and U.S. population (Brookmeyer et al., 2011). Tremendous economic strains will be placed on the public for the costly responsibilities of in-home nursing care and the like for this population. One possible solution to deter those economic costs of care would be to create a system of care for the elderly where remaining autonomous for as long as possible is encouraged. Van Halteren-van Tilborg and colleagues (2007) suggest this can be accomplished if the elderly never stop learning, and recommend interventions aimed at preservation of the learning process.

**Diseases Related to Dementia**

Alzheimer’s dementia, which is the focus of this research, has a main feature of impaired recall. Also characteristic of AD is a symptom known as gegenhalten. This term describes a form of hypertonia, or muscle spasticity, associated with involuntary resistance to passive movement and impaired fine motor movements resulting from apraxia. Usually a result of upper motor neuron lesions, hypertonia describes the spasticity, rigidity, and tension of the voluntary muscles, leaving AD patients with the diminished ability to control most voluntary movements. Other diseases related to dementia include Parkinson’s disease and dementia with Lewy Bodies.

Parkinson’s disease is a type of neurodegenerative disorder highly associated with dysfunction in the basal ganglia, a structure located deep within the brain (Burn, 2006).
The dysfunction occurs in association with a lack of sufficient dopamine within the areas that comprise the basal ganglia. The basal ganglia is an important brain structure that contributes to voluntary movement and inhibition of involuntary movement (Hamilton et al., 2008). Patients with Parkinson’s often exhibit the inability to control voluntary or automatic movements and often experience tremors, bradykinesia (slow movement), muscle rigidity, impaired balance and posture, speech and writing changes (Hamilton et al., 2008).

Dementia with Lewy Bodies (DLB) is recognized as the second most common origin of dementia in older adults. Lewy bodies are protein deposits that develop within nerve cells. Those nerve cells impaired by the Lewy bodies are primarily found in areas of the cortex coupled with thinking, memory, and motor control. DLB imprisons sufferers of the disease with visual hallucinations, impaired visual perception, and fluctuating attention. According to McKeith and colleagues (2006), up to 50% of patients with DLB have extrapyramidal motor symptoms (not being able to eat properly, use the bathroom independently, and get up from a chair without help) at diagnosis and 75% of people afflicted encounter this feature of the disease at various stages throughout the illness (McKeith et al., 2006).

Main Symptoms of Dementia

Dementia can result from abnormal cognitive aging, disease, or trauma to the brain. This can range anywhere from medical conditions that attack brain cells or disrupt oxygen flow to the brain, illness that effects the central nervous system, or even abuse of drugs or alcohol. What categorizes abnormal cognitive aging apart from normal cognitive
Running Head: Interventions in Motor Skill Learning

Aging is the ability to maintain independence, daily living, and relationships. Unlike typically aging individuals, sufferers of dementia severely and rapidly lose these abilities.

In normal aging of the brain, global cognitive decline is not typical. In an individual afflicted with dementia, however, thinking, decision-making, planning, and communicating capabilities are severely slowed down. Cognitive components such as memory loss, impaired judgment, difficulties with abstract thinking, faulty reasoning, inappropriate behavior, loss of communication skills, disorientation of time and place, neglect of personal care and safety, hallucinations, paranoia, agitation, and gait, motor, and balance problems are severely affected (Alzheimer’s Disease and Dementia). Because of these properties, dementia qualifies as a mild to severe cognitive disruptor, which progressively worsens cognition over time.

Similar to its effect on progressively worsening mental processing, dementia also detrimentally contributes to an affected individual’s life in virtually every aspect. AD patients experience deficits in affective, behavioral, and biological processes that are crucial to neurotypical aging in affected persons (Christofoletti et al., 2008). Evident in the manifestations of deficits in cognition, mood, behavior, a decline in overall functional ability can severely affect quality of life.

**Cognitive Declines**

Severe dementia is defined and diagnosed through the use of several rating scales. Many take into account the patient’s remaining abilities, or lack thereof, often indicated by the patient’s caregiver. A score of 10 or less on the MMSE is indicative of severe cognitive dysfunction, which is representative of severe dementia. While all cognitive domains are affected, not all are affected to the same extent. Implicit memory is one such
function somewhat spared even into the late, severe stages of dementia. Overlearned skills like the repetitive motion involved in riding a bike, and routines like eating breakfast at the same time every morning, employ implicit expressions of memory. (Burns et al., 2006).

The TSI or Test for Severe Cognitive Impairment (Albert & Cohen, 1992), is one such performance based test that assesses immediate and delayed memory, general knowledge, conceptualization, language production, and motor skill learning. More specifically, the TSI targets measurement of overlearned motor skills, which includes aspects of implicit memory where semantic processing is not involved (Burns et al., 2006; Albert & Cohen, 1992).

Tests such as the TSI allow for the closer inspection of preserved and impaired cognitive abilities in individuals with dementia. Measuring changes in cognitive functioning can be useful in assessing the progression of dementia (Burns et al., 2006).

**Motor Declines**

If no preservative measures are taken to reverse or slow down the degradation of motor ability, immobility can result. Immobility has been identified with increased morbidity in elderly people and people with MCI. Often times in cases of cognitive impairment in the elderly, once the person becomes bedridden, the expectation for recovering lost functional abilities becomes very low.

In typical-aging individuals who show no sign of motor skill deficit, voluntary movements are planned out, without conscious knowledge, in three stages. These stages do not necessarily act independently, but work in a fashion to produce a desired voluntary movement.
The preparatory phase is what is known as the first stage of this voluntary movement planning, and is thought to process information and prepare a motor program. This is the planning of a movement, which takes place prior to the start of a movement. The second phase, known as the ballistic phase, is associated with the follow through with a movement where the movement proceeds as planned. In the third phase, final adjustments are made before acquisition of the target. The later two stages occur throughout the voluntary movement (Bellgrove et al., 1996).

Main motor impairments in dementia patients, such as the declining ability to control voluntary movements, likely result from not being able to execute the programming phase. This means, they may not be able to program their movement during that first phase, and instead make up for it during the execution of the motor task, by reprogramming or shifting their movement during execution. This compensation may manifest as a noticeable reduction in motor speed as well, indicating impairment in preparation and execution of movement (Bellgrove et al., 1996).

**Definition of Motor Learning**

Part of the solution to enhancing preparation and execution phases of movement in this population relies on retraining motor skills. Implicit motor learning capacities remain intact in this population, so it would be logical to target those pathways. Motor learning is defined as the relatively permanent behavioral adjustment connected with practice or experience of a motor task. There are two main types of motor learning: implicit motor learning, which is defined as learning that automatically occurs without conscious awareness, and explicit motor learning where awareness of the sequence and goal of learning are present (Bo & Lee, 2013).
These learning capabilities can be enhanced when the individual is offered the ability to practice and to receive some type of motor feedback upon execution of a task. In addition to that, the ability to relearn practical motor skills may enhance one’s sense of independence as training programs are adjusted and tailored to the individual with dementia and their degree of impairment (Van Halteren- van Tilborg et al., 2007).

The degree of impairment of the motor function is related to the severity of cognitive impairment (Scherder et al., 2008). Although the center of the brain associated with decision making and motor skill learning is impaired in AD patients, literature has shown that mildly demented individuals are, to a degree, able to learn new motor skills (Rouleau et al., 2002). Take finger dexterity for example. Often, individuals with mild dementia have difficulty signing their name or successfully completing a task as simple as reaching for money out of their wallet. This example of hindrance due to declining motor skill lends to the thought that hand motor function is a part of explicit cognitive functioning. This means, the explicit learning pathways are more severely affected than implicit learning pathways in AD patients. In order to preserve what motor skill is left, it is imperative to determine which learning method, implicit or explicit, is more distressed so as to develop a learning model tailored to the individual (Scherder et al., 2008).

Of the two learning pathways discussed here, explicit learning requires the passage of 3 stages in the procurement of motor skills. The first stage, also called the cognitive stage, focuses on understanding of the task and developing strategies to approach it. This requires attention and executive functions. The second stage is known as the associative stage, which requires the learner to select the best strategy and to refine the skill. In this phase, cognitive aspects are less important. And lastly, the third stage is
what is known as the autonomous stage where the skill becomes automatic. Compared to the other stages, this requires the lowest degree of attention. Targeting a learning method Additionally, variables like practice and feedback can be altered at each stage to enhance learning. It would be least effective to employ a training technique derived from understanding of the explicit learning pathway. These stages involve some degree of attention and executive functioning, which happen to be cognitive properties diminished in AD patients. In short, an explicit learning model would not be most appropriate for motor skill acquisition.

On the other hand, implicit learning methods, otherwise known as procedural learning techniques, are hypothesized to be effective for teaching new skills in individuals with MCI as seen in individuals with dementia. In implicit learning, skills are mastered subconsciously, or without awareness. Often, learning occurs through repeated exposure, and can later on be retrieved from implicit memory (Van-Halteren- van Tilborg et al., 2007). Additionally, practice and feedback can enhance motor skill acquisition in an implicit learning model.

Since fatigue plays an unwanted factor in any learning, it would be neglectful not to address the question of how to approach alternating practice with rest in order to maximize learning potential in patients. Schmidt and Wrisberg (2000) differentiate two types of practice: in massed practice “the greater the proportion of the session is dedicated to training”, and in distributed practice, “the duration of rest is equal to or greater than the duration of practice” (Van Halteren- van Tilborg et al., 2007). The latter technique of balancing out rest with practice is found to be more effective in acquisition
of motor learning, because it helps to reduce the instance of fatigue (Van Halteren-van Tilborg et al., 2007).

Another aspect to consider surrounding training techniques is whether or not to approach training the task as a whole, or to divide training into components. Van Halteren-van Tilborg and colleagues (2007) propose training components of a task before combining them into the whole task, while still being careful to maintain the goal of the task. A great example illustrating this point is in the task of driving a car: learning to drive a car can be easily split into the components of ‘learning to shift gear’ and ‘learning to steer,’ etc., which can be trained individually. Learning to reach and grasp an item, on the other hand, does not lend itself well for phased training since reaching and grasping are integral components of a single, continuous movement (Schmidt & Wrisberg, 2000).

Schmidt & Wrisberg (2000) also recommend that random practice as opposed to scheduled practice might be most effective for the attainment and generalizability of a motor skill. They also advise that specific motor skill acquisition, like that which involves the context-specific demands of the task, benefits from blocked practice (Schmidt & Wrisberg, 2000).

Several studies indicate that AD patients learn best under constant practice conditions. According to Dick and colleagues (1996), people use their episodic memory from training trials to correctly achieve a task while learning a skill. Current literature suggests that because AD patients experience problems with episodic memory, or autobiographical memory, constant practice is more effective for learning a skill because “repeated running of the same motor program does not require an intact episodic
memory” (van Halteren-van Tilborg), and instead relies on more implicit approach to skill learning like that which feedback provides (Dick et al., 1996).

Feedback is another crucial component of motor learning. There are two types discussed here, and they consist of intrinsic and extrinsic feedback. Intrinsic feedback comprises sensory information as a result of a motion. Extrinsic feedback encompasses information from an external source such as correctional or verbal feedback provided from an occupational therapist.

Additionally, feedback can be provided in the following ways: during the movement, directly after movement completion, or delayed, and either verbally or non-verbally. Moreover, the information that feedback can present could be on the average performance of the test taker, which is known as summary feedback, or it can reflect each movement or performance in what is known as constant feedback. As suggested by van Halteren-van Tilborg and colleagues (2007), the idea of constant feedback lends itself to the fact that it only enhances motor performance and not so much the level of learning. Extrinsic feedback can be furthermore be divided into “knowledge of results”, where the movement outcome is given in terms of whether or not the goal was accomplished. Knowledge of performance is the other divided component of extrinsic feedback, and deals with the movement itself. For example, within a tossing task, the knowledge of performance may look something like increasing the swing of your arm to reach the target.

In a separate assessment known as the Maze Task (Kuzis et al., 1999), participants are blindfolded and required to trace a complex pathway. No visual feedback exists during the duration of trials. Results of the trials, however, lend to the idea that
visual feedback is important to the learning motor skills in AD patients; from this, AD patients are able to complete the task quicker with repeated trials. This is telling, and suggests that implicit learning occurs. For this, it is hypothesized that constant visual feedback is important in the learning of motor skills that will enhance activities of daily living; however, more research is needed to support such a claim (Van Halteren-van Tilborg et al., 2008).

Hand motor function is another aspect intimately linked with activities of daily life (ADL). Hand motor functions can be described as fine, complex, and gross. Fine hand motor function are assessed by tasks that require hand and finger dexterity of one hand, and hand-eye coordination. Complex hand motor movements include the alternation of movements involving both hands, and usually incorporate a visuospatial element (precision grip). Gross hand motor functions are exercised in tasks that require speed (velocity) and grip strength (grip force, pinch). A gradual decline in hand motor function is consistent with a weakened ability to complete functional daily activities such as eating, moving objects, writing, and getting dressed. The quality of life can be severely hindered if hand motor functioning becomes unstable.

According to Scherder & colleagues, poor hand motor function is related to a higher level of functional dependence, which possibly explains why people with low hand motor function are more likely to live in caring facilities. Additionally, low grip strength has also been a predictor of mortality, as individuals with lower handgrip strength have a greater risk (Scherder, et al., 2008).

A meaningfully close relationship exists between fine, complex, and gross hand motor function. Scherder and colleagues (2008) propose that elderly people have a less
apt precision grip compared to younger people. All these changes are attributed to typical gradual decline that is a result of normal aging. Elderly individuals may try to compensate for loss of precision grip by applying grip patterns, which produce more strength. This is evident through preferred use of the index finger, and less use of the middle finger during activities which require greater pinch force. This lends to the idea that typical aging already decreases the amount of control or amount of force for successful completion of the task. Up until the approximate age of 65, everyday fine motor functional tasks like pouring milk and removing money from a wallet become increasingly difficult; and a greater decline becomes present after the age of 75 (Scherder et al., 2008).

**Main Assessments in Dementia**

Assessments commonly used in diagnosing dementia involve the estimation of behavior, cognition, daily functional ability, balance, and motor skills. While there are numerous cognitive assessments for dementia, this review focuses on those which highlight measurement of motor skill decline. Here, assessments are divided into cognitive and motor categories. The evaluation of these aspects is necessary to gauge if the individual exhibits symptoms of dementia, and how severely those symptoms have hindered ADL and autonomy.

**Cognitive Assessments**

While there are numerous cognitive assessments for dementia, this review focuses on those which incorporate measurement of motor skill decline. The Mini-Mental State Examination (MMSE) (Folstein et al., 1975) measures global cognitive function. An MMSE score is more frequently used in research and clinical settings compared to other
measures of cognitive impairments. The MMSE is also used to define study groups or to
determine if antidementia drugs are indicated. More so in clinical practice, level of daily
functioning and neuropsychiatric functioning are of special relevance. Daily functional
ability of AD patients is directly observed as they perform activities significant to their
daily lives. The MMSE assesses items like orientation in place and time, attention,
concentration, memory, visuospatial skills, and praxis, or successful motor planning and
execution of voluntary movements (Baum et al., 1988). The highest score one can attain
is 30, and is reflective of a better global cognitive state.

Assessments recording ADL can sometimes involve the patient’s caregiver. The
Bristol Activities of Daily Living Scale (BADLS) (Bucks et al., 1996) is a caregiver
related tool which assesses functional impairment in people with dementia. The scale
contains 20 subcomponents, and each subcomponent consists of four meaningful
constructs of daily living. Those aspects involve instrumental activities of daily living,
self-care, orientation, and mobility.

The Instrumental Activities of Daily Living (IADL) (Katz, 1983) is an informant
questionnaire. This assessment is used to measure daily performance tasks, such as
preparing food, housekeeping, laundering, using the telephone, shopping, and managing
personal finances independently. Higher scores on this item are indicative of greater
independence in performing activities.

Bouwens et al. (2008) describe the NPI (Cummings et al., 1994), or
Neuropsychiatric Inventory, as a one month retrospective informant-based rating scale
established to assess psychopathology in patients with neurodegenerative diseases such as
dementia. An assessment such as the NPI would be crucial to identifying
neuropsychiatric symptoms commonly observed in dementia: delusions, hallucinations, depression, anxiety, agitation, euphoria, disinhibition, irritability, apathy, abhorrent motor behavior, night-time behavior disturbances, and appetite and or eating abnormalities. The severity and rate of all symptoms are scored using semi-structured questions first administered to the patient’s caregiver. Scoring is exemplified as follows: “the continuous score for each symptom is obtained by multiplying severity (1-3) by frequency (1-4). The higher the score, the more issues the patient has” (Bouwens et al., 2008). The summed symptom score yields the total NPI score.

The Block Design Test (Kohs, 1920), a modified form of the Weschler Intelligence Test for Children-Revised (WAIS-R) (Weschler, 1981), is a test administered to gauge visuospatial abilities (Hamilton et al., 2008). Low performance of this test is indicative of the rate of subsequent global cognitive decline in patients with DLB (Hamilton et al., 2008). Block design tests are employed to measure visuospatial construction, or the ability of an individual to mentally rearrange objects. Poor initial construction ability on Block Design Tests may be indicative of a precipitous decline in cognition, associating lower scores with likelihood of dementia (Hamilton et al., 2008).

GDS or the Global Deterioration Scale (Reisberg et al., 1983) and the CDR or Clinical Dementia Rating scale (Morris, 1993) measure global decline taking into account a multitude of aspects. The GDS rates global level of deterioration.

**Motor Assessments**

The AMPS, or the Assessment of Motor and Process Skills (Chard et al., 2000), is one instrument of many used in occupational therapy settings to identify a baseline of functional performance. Assessment usually occurs through direct observation by clinical
staff in a structured manner (Bouwens et al., 2008). Assessment is of individuals with mild to moderate dementia. What remains important to consider is the finding that these measures have been shown to correlate with the degree of neuropathology in AD patients. Therefore, these assessments are moderately predictive for daily life functioning (Bouwens et al., 2008). The AMPS consists of a motor ability score, which measures impairments in motor behavior and process ability score altogether to grade functional skills. For motor ability, a score of +2.00 on a scale of -3.00 to 4.00 is considered typical. For process ability a typical functioning score is cut off at +1.00 ranging from -4.00 to 3.00. On the AMPS measurement higher scores reflect higher functionality.

The Berg Balance Scale (Berg et al., 1989) is an assessment of balance, and evaluates such impairment in older adults. The items on the Berg Balance Scale gauge functional tasks such as reaching, bending, transferring, standing, and rising. Difficulty achieving these tasks is indicative of a motor skill deficit.

The timed Get-Up-and-Go test (Podsiadlo & Richardson, 1991) is a measurement of the time and number of steps a person takes to raise up from a standard armchair, walk three meters, turn, walk back to the chair, and sit down. A high number of steps taken and a longer walking time are indicative of an increased risk of falls.

Scherder and colleagues (2008) used assessments that revealed noticeable differences between elderly persons through utilizing the following hand motor tasks: the Finger-to-Thumb test (Franssen et al., 1999), Purdue Pegboard (Tiffin et al., 1948) and a pointing/touching task (Camarda et al., 2007). Complex hand motor functions such as alternating movements of both hands and Luria’s three different movements with one hand (the fist-edge-palm test) were tested by the assembly test of Purdue Pegboard.
Patients with mild dementia completed the aforementioned tasks of gross hand motor function (i.e. finger tapping) at a slower rate compared to elderly participants without mild dementia. Dementia patients took longer to prepare movements, performed more slowly, change velocity more variably, and needed more time to reach peak velocity compared with people without dementia. In healthy aging people, training for an increase in pinch force, hand steadiness and moving small objects appears to be effective. This finding is important, because many of ADL tasks require the cohesiveness of fine, complex, and gross hand movement manipulations. The improvement of these movements hindered by dementia may enhance the quality of life.

Occasionally in healthy aging elderly patients, not all aspects of hand motor function are trained with ease. In elderly individuals, however, more have issue with releasing grip force. This is just one example of hand movement exercises that are not so simple to exercise. In individuals with Alzheimer's dementia, patients are able to learn implicit hand motor functions, usually of the fine (rotary pursuit) and gross type (tossing), but it is also important to discover whether or not implicit learning of fine, complex, and gross hand motor function are possible in other subtypes of dementia.

A decline in hand movement coordination and as seen in signing one’s name is characteristic of fine hand motor activity is correlated with a decline in cognitive functioning. Scherder and colleagues’ (2008) findings maintain that disturbances in higher-level hand motor function are suggestive of cognitive impairment. Training for increased strength of hand motor functioning should be done at a stage where impairment may still be redressed and has potential to be improved upon.
The Maze Test (Kuzis et al., 1999) is an assessment in which participants are blindfolded and required to trace a complex pathway. Results show that AD patients are able to learn new motor skills implicitly (Van Halteren-van Tilborg et al., 2007).

In the Rotor-Pursuit Task, participants must maintain contact between a stylus and a rotating spot. Dick and colleagues (2001) proposed the existence of preserved learning abilities in their dementia samples from research conducted with this assessment (van Halteren-van Tilborg et al., 2007; Dick et al., 2001).

The Mirror-Tracing Task gauges the visual and motor skill of the participant. Within the task, participants are asked to trace an image using a mirror. Drawing the image is heavily reliant upon procedural memory, which incorporates muscle memory. Both memory classifications are a part of implicit memory involvement, which remains somewhat intact in dementia patients (Rouleau et al., 2002).

Serial Reaction Time Task (SRTT) (Willingham et al., 1989) reports that SRTT implicit learning was most successfully enhanced in the mildly demented population. This instrument involves two learning processes. They require the mastery of spatial and motor skills, which are possibly compromised in patients (Willingham et al., 1997).

These studies (Bouwens et al., 2008; Dick et al., 2001; Rouleau et al., 2002; Scherder et al., 2008; van Halteren-van Tilborg et al., 2007) all demonstrated preserved implicit motor-skill learning in AD patients regardless of the task used. However, level of learning differed depending on the task. Measures that incorporate visual feedback appear to have a progressive effect on the learning pace of individuals with dementia. Though, in implicit learning, there appears to be no clear-cut distinction between the
three stages. Researchers propose that in implicit learning the stages may overlap or are ordered differently.

**Main Intervention Approaches for Motor Impairments**

Much of the literature on interventions reports the benefits of sensory processing enhancement, physiotherapy, physical activity, and pharmacological approaches as fundamental interventions for balance maintenance and fall prevention, as well as promotion of health and quality of life in the elderly with dementia. Physiotherapy, occupational therapy, and physical education are important interventions for the maintenance of balance and contribute to the preservation of motor skill functioning (Christofoletti et al., 2008).

**Sensory Processing Enhancement**

Sensory processing largely has to do with our perceptions of sensations in our surrounding environments. Sensorimotor mechanisms allow for the adjustment of movement in response to sensory information through our senses of sight, hearing, taste, touch, and smell. Instances where sensorimotor mechanisms are in play involve executing complex tasks such as driving a car or playing a videogame (Willingham, 1998).

Christofoletti et al. (2007) suggest that stimulus enhancement assists sensory processing. Research lends to the idea that a poorly enriching environment, or environments with nonspecific stimuli might be partly responsible for the confusion experienced by some AD patients. In other words, environments that engage the sense and are rich with specific stimuli may not contribute to the state of confusion in this population. These effects of these poorly engaging environments may be correlated with
an increase in cognitive and behavioral impairments.

A therapeutic solution to a lacking stimuli rich environment is an intervention employing multisensory environments (MSE). These environments can incorporate different sight engaging stimuli, fragrances, sounds, tastes, and tactile stimulations. MSE can be adapted to regulate the amount of competing stimuli and stimulus intensity by matching sensory preferences and individual need. Because the sensory signals received from the environment is enhanced, the amount of work the brain and spinal cord have to expend is reduced, which may allow room for performance to be enhanced (Collier et al., 2010). A performance increase through heightened stimulation is believed to be beneficial when matched by the information processing capability of the individual (Collier et al., 2010).

Use of multisensory environments (MSE) is one such effective treatment for more than just visual feedback. As Collier and colleagues (2010) explain, MSE addresses "imbalances in sensory stimulation by pacing sensory-stimulating activity with sensory-calming activity." This sensory modification may help AD patients cope with confusion and behavioral changes that result from their degenerative illness (Collier et al., 2010).

When administering MSE, it is important to modify the intervention to the sensory needs of the participant in order to increase the chance of successful engagement. Additionally, the standardization of the participant is needed to ensure successful cooperation. In their study, Collier and colleagues (2010) standardized intervention along with protocols identified by assessments known as the PAL Instrument for Occupational Profile (PAL) and the Adult Sensory Profile (ASP). "The PAL uses a framework with differing levels of activity based care for people with dementia." Relatedly, the ASP
measure categorizes the stable and enduring sensory processing preferences of an individual (Collier et al., 2010).

Delivery of the intervention can include the use of bubble tube, optic fibers, music of choice, scents, citrus fruits, and sherbert. MSE usually takes place in a quiet environment. Collier and colleagues (2010) found a significant improvement in the motor and process scores participants. The benefits of improved motor and processing scores are anticipated to aid in the improved performance in activities of daily living indicated by assessments such as the AMPS. This type of treatment would target that dwindling sensory acuity that occurs with old age. This decline in sensory acuity can be exacerbated by a decline in subsequent perception, attention, and information processing. Still noted in people with AD though, are the implicit motor control pathways. This suggests that “neural structures that integrate sensory and kinesthetic information” are still intact (Collier et al, 2010). This means that the loss of motor performance characteristic in dementia is likely to be the result of cognitive deficits that interfere with the sensory processing and motor response in the central nervous system (brain and spinal cord) (Collier et al, 2010).

In hopes of reducing cognitive noise, it may be advantageous to modify the level of sensory stimulation presented in the MSE intervention as administered in tandem with the PAL and ASP assessments. This way, resolving issues with perception, attention, and information processing abilities may be improved by reducing sensory overload. Results of the Collier et al (2010) study report support for the use of MSE with moderate and severe dementia and difficulty partaking in ADL. The use of PAL and ASP in conjunction with the MSE is also recommended for modifying activity in the MSE to
support individual sensory needs and information-processing ability.

Another sensory processing enhancement essential to training and performance is the element of visual feedback, which people with dementia rely heavily upon for adequate performance on motor tasks. Literature defines the importance of visual feedback as the ability allowing for the connection between visual cues and the correction or alteration of movements (Willingham, 1998).

Of course, there is the question of the reliance of visual feedback with individuals who are visually impaired. Would visual feedback still prove effective? One way this issue could be tackled is through "screening and subsequent correction of visual problems" or through the use of visual aids in increasing effectiveness of training in this group where vision problems are very common (Collier et al., 2010).

Equilibrium, or balance, is also another important sensory focus in this population, and is an equally important focus of some interventions. Balance is a necessary aspect of functionality. It is also important for static, dynamic, and recovered stability of the body (Christofoletti et al., 2008). A lack of balance can result in falls, which can be from an internal or external source relative to the AD patient. The involvement of intrinsic factors, or internal aspects related to falls, likely result from what Collier and colleagues (2010) define as "sensorimotor alterations inherent in the ageing process."

These intrinsic aspects involve changes in vision, abnormal sensations known as paraesthesias, weakness, and decreased flexibility and mobility; whereas extrinsic factors like hassles found in the environment like holes in the ground, stairs, and uneven terrain demand attention, recognition, and decision making on the part of the individual. These
aspects of movement and cognition are strongly affected by dementia (Collier et al., 2010). For this, Collier and colleagues advocate for a multidisciplinary intervention that incorporates physiotherapy to improve both intrinsic and extrinsic factors hindered in AD patients.

**Physiotherapy**

Christofoletti and colleagues (2007) explored interventions that involve non-pharmacological strategies, interventions based on physiotherapy, or kinesiotherapeutic sessions, occupational therapy, which focused on exercises of daily living activities, and functional capacities training or physical education. These interventions are important in supporting health and boosting quality of life (Christofoletti et al., 2007).

The Christofoletti and colleagues (2007) study investigated the effects of two motor interventions focused on the balance of elderly people with mixed dementia who were institutionalized. Discussed in their research is the claim that AD patients with disturbed balance are often placed in caring facilities. The participants in this study were diagnosed with dementia based on the classification of mental and behavioral disorder, whose findings were confirmed by the MMSE and the Katz Activities Daily Living Scale (Katz et al., 1963) that measures their general rate of independence in bathing, dressing, using the toilet, and eating and moving around.

Participants had no prescriptions for antidepressant medications with central anticholinergic or sedation actions, which would affect their motor capabilities. An intervention of physiotherapy, occupational therapy, and physical education took place five times a week for duration of 2 hours per day. Kinesiotherapeutic exercises were tailored to concentrate on strength, balance, and cognition, such as immediate and
working memory, concentrated attention, balance, and praxis. These elements were included in activities such as gardening, drawing pictures, painting, and embroidering and were selected for therapy given their therapeutic properties.

The physiotherapeutic interventions mentioned yielded significantly beneficial effects on the maintenance of balance and prevention of falls in AD patients. Additionally, Christofoletti and colleagues (2007) note that although global cognition did not improve, they observed a slight decrease in mental decline presented as verbal fluency and executive functioning. However, to enhance more than just balance in this population, perhaps a multidisciplinary intervention incorporating more than just physiotherapy alone may prove positive in enhancement and preservation of motor skills.

**Physical Activity**

The physical activities mentioned earlier are used in particular because the motor coordination required is heavily intertwined with cognition. Physical activity is defined as “the movement of skeletal muscles, resulting in energy expenditure exceeding the resting state” (Blondell et al., 2014) and is heavily involved with motor skill acquisition.

The facilitation of physical activity is another useful approach that engages the motor skills of the AD patient population. Physical activity might consist of walking sessions frequently associated with upper and lower limb exercises for the purposes of stimulating “strength, balance, motor coordination, agility, flexibility, and aerobic endurance” (Christofoletti et al, 2007).

Training individuals to complete a task or activity requiring motor skill is very often used to maximize patient motor ability. The amount of training a patient receives is dependent upon the task, and the patient. AD patients who are physically active have a
better chance of acquiring motor skills without awareness simply by repeated exposure. Because of this, there is a better chance of facilitating the enhancement of motor functioning through repetition training (Van Halteren-van Tilborg et al., 2007).

**Pharmacological Approach**

While there is much evidence supporting the use of physical activity, this does not mean that pharmacological approaches should be rendered unnecessary. Pharmacological approaches are important, and often involve the use of cholinesterase inhibitors. A cholinesterase inhibitor is a chemical enzyme that inhibits the enzyme acetylcholinesterase, which functions to breaks down acetylcholine, a neurotransmitter that increases the activation of muscles in the peripheral nervous system (nerves and ganglia outside the spinal cord) (Van Halteren-van Tilborg, 2007). These drugs used alone may have some benefit in maintaining autonomy of elderly AD patients, as indicated by delayed nursing home placement (Becker et al., 2006). Additionally, literature on pharmacological research is promising. Benefits of pharmacological interventions involving cholinesterase inhibitors also include improvements in ADL. The effects of non-pharmacological and pharmacological interventions yield a similar effect in the fact that the autonomy of the patient improves to some degree (Van Halteren-van Tilborg et al., 2007; Luijpen et al., 2003).

The possibility exists that the interactions between medication and non-pharmacological approaches may be most advantageous in preserving a patient’s autonomy. Van Halteren- van Tilborg and colleagues (2007) maintain that explicit, or declarative learning methods are the “starting points in most rehabilitation programs aimed at motor skill-learning in the cognitively unimpaired population.” However,
research aimed at improving learning in those in the dementia population report implicit, or procedural methods of learning were more efficient in helping people with dementia relearn practical motor skills.

Discussion

Individuals with dementia have the ability to enhance their motor skills, but in very specific conditions and with adequate instruction. Relearning motor skills must be somewhat frequent and consistent in order for results to be tangible and for progress to be shown. Moreover, an advantageous combination of balancing practice with rest is useful in implicit processing of motor skill acquisition, and also stalls fatigue.

Subsequently, the implicit route of learning relies less on executive functions and explicit learning pathways, which are hindered in AD patients. The research surrounding learning shows that individuals with dementia and some other forms of cognitive impairment are capable of implicit motor learning. The evidence presented in some studies suggests that there is consensus on a technique that teaches and trains implicit motor skills in individuals who lack such. It will likely prove beneficial to translate these intact abilities into an intervention that rehabilitation programs can model when training AD patients.

Dementia patients show preserved implicit motor learning and through these abilities, teaching motor skills can be utilized. Although to capitalize on the implicit motor learning, training tailored to the individual AD patient must be directed. When these plans are considered, and more knowledge of the explicit and implicit motor skill learning pathways becomes available, non-pharmacological interventions such as those aforementioned may have a momentous contribution toward not only the enhancement
and preservation of motor skill functioning, but to improve and maintain autonomy in those suffering with dementia.

There is an important note to make in that patients with dementia often have difficulty in being able to generalize motor skills learned during training sessions to their typical environment settings. Van Halteren-van Tilborg and colleagues (2007) advocate that, for instance, if a dementia patient is trained in the use of a coffee maker or kitchen timer, the device used during training must be available for use at the patient’s household. This recommendation supports the idea of tailoring intervention to the needs of the AD patient.

Overall, maintaining balance and some hand dexterity in the elderly is critical to ADL in this population. Without the ability to accurately and effectively plan and control hand movements, the likelihood of becoming bedridden as a result of a fall increases. To delay this for as long as possible, strategic interventions would prove valuable.

**Limitations**

In employing non-pharmacological interventions, it is noted that occasionally, users report difficulty in use. The failure of some non-pharmacological interventions to provide effective treatment is due to the effort that the caregiver or facilitator must provide, while simultaneous engagement of the patient is occurring. Administration for the MSE, for example, is largely unstructured, and that lack of structure can lead to frustrations experienced by the caregiver.

Furthermore, research into the efficacy of the treatment is limited. In the Van Halteren-van Tilborg and colleagues (2007) report, an important distinction is made. They suggest that when AD patients failed motor tasks, it may have not only been related
to learning problems. Such a phenomenon could be a result of other causes such as the complexity of instructions of the task or type of skill to be performed. Additionally, factors do differ across tasks. The ability to complete one task may not be generalizable to all other tasks administered to the AD patient. These variables may differ across tasks, which lends to the idea that the ability to complete one task is not indicative of the rate of improvement in another task. Willingham et al. (1997) conclude that AD patient trials in these cognitive and motor performance tasks may be a result of a performance inadequacy, and not a learning deficit.

Additionally, some motor interventions raise questions of validity. While targeting motor skill acquisition, in some cases interventions like MSE and physiotherapy may also relieve symptoms of depression that may be expressed comorbidly in AD patients. In other words, some interventions associated with preserving or enhancing motor skills are also effective in reducing depressive symptoms. The goal here would be to decide whether or not to screen out individuals with depression, and to take caution to exclude or include them in the sample. The confounding variables involved when including AD patients with depression in the sample raise the difficulty of proving whether or not the benefits of interventions are preserving cognitive functions, or lessening symptoms of depression. This highlights a major difficulty, because often dementia and depression occur comorbidly.

Lastly, not all cognitive and motor assessments are unbiased. Biases of instruments used to assess individuals from semi-literate populations. This should remind researchers to factor in scores for individuals being administered these tests that low
scores for semi-literate individuals may be due to lack of comprehension of assessment material before them, and may not be attributed to cognitive decline.

**Aims for Future Research**

Presently, the literature on interventions provides no consensus that motor interventions consistently improve cognitive functions of the elderly with dementia. The enhancement of motor skill learning and whether or not quality of life is significantly enhanced is an important consideration to the overall care, treatment, and welfare of AD patients.

Factors to consider for future research might incorporate a timeline of when interventions should be implemented to achieve optimal improvement in patient ADL. Currently, there appears to be no clear consensus about when such interventions would prove most effective in slowing down degeneration of motor skill functioning.

To date, obstacles still exist in quantifying cognitive functions. Those obstacles include limited knowledge of the cortical and subcortical pathways related to cognitive functions. As more knowledge of the neural motor mechanisms involved in learning becomes available, intervention strategies that incorporate both pharmacological and non-pharmacological techniques may enhance the efficacy treatments for motor skill decline as seen in the AD population.

Finally, because most of the literature presented here focused on AD, it would prove valuable to conduct research on the reliability and validity of the various interventions mentioned as treatments for other types of dementias and mild cognitive impairments where motor skill decline is present.
References


_Psychological Review, 105_(3), 558-584._