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PHYSICAL THERAPY AND REHABILITATION (O. ADDISON, SECTION EDITOR)

Rehabilitation for Individuals with Dementia: Facilitating Success

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Abstract

Purpose of Review Individuals with dementia (IwD) have unique characteristics related to movement quality, motor learning strategies, and interpersonal needs. Without an understanding of these issues, physical therapists (PTs) treat these patients as they would cognitively intact older adults and become frustrated or disheartened when patients do not respond to therapy as expected. The purpose of this article is to facilitate the success of therapeutic interventions with IwD by suggesting therapeutic strategies that play to the strengths of this population.

Recent Findings Classic and recent literature related to motor control and motor learning in IwD is reviewed, and relevant clinical applications are highlighted. Key components related to successful interventions in existing evidence are presented.

Summary Armed with an understanding of the unique qualities related to movement disorders and motor learning, PTs will be better equipped to exploit the strengths of IwD for optimal rehab outcomes.

Keywords Dementia · Rehabilitation · Motor learning · Movement disorder

Introduction

One in ten Americans over age 65 is living with Alzheimer's disease (AD), the most common of the dementias [5]. As baby boomers age, rehab professionals are more and more likely to treat clients with dementia. A substantial proportion of patients receiving care in orthopedic outpatient, acute care, and sub-acute patient settings are older adults, so an appreciation of the intricacies of individuals with dementia (IwD) is important not only for those physical therapists (PTs) who work exclusively in long-term care or geriatrics but in almost all practice settings.

Physical therapy and exercise can be of great benefit to IwD, but PTs must recognize that the needs of these patients are different than those in whom cognition is intact. When PTs treat IwD as they would their cognitively intact age-matched peers, they are unlikely to get the results they anticipate. PTs often become frustrated and a sense of therapeutic nihilism may overshadow future efforts at rehab with this population. This is evident when patients who do not follow commands become "low priority" on the therapy list! Even therapists who work routinely with IwD feel as though they could benefit from further education related to optimizing interventions with this group [16, 82].

The purpose of this article is to facilitate the understanding of the unique needs of IwD within a rehabilitation context. If PTs design their therapeutic interactions to exploit the strengths of IwD, they will have greater rehabilitation success. To do this, therapists must acknowledge and understand [1] the movement disorders often seen in dementia, [2] the intricacies of motor learning in this population, and [3•] the importance of the therapeutic relationship. When rehabilitation efforts are put in a context that respects these issues, as well as the basic physiological principles behind effective rehabilitation (e.g., appropriate level of challenge and intensity), therapeutic success is much more likely. Given the potential impact of maintaining functional independence and decreasing burden of care, IwD should be among our *highest* priorities.

Brief Overview of Types of Dementia

Dementias are a group of chronic, progressive, irreversible conditions that result in the death of CNS neurons. There is no effective treatment and no cure for any of the dementias.

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Alzheimer's disease (AD) is by far the most common of the dementias. It generally has a slow steady trajectory with memory complaints routinely being the initial symptom associated with the predictable initial pathology in the hippocampus and medial temporal lobe. Vascular dementia (VaD), the second most common type of dementia, can display more of a step-wise progression, with onset of new symptoms linked to new vascular insults. While memory complaints may be the initial symptom, individuals with vascular dementia will demonstrate difficulty based upon the brain regions impacted by vascular pathology, so initial complaints may include cognitive or language issues. Lewy body dementia (LBD) is the third most common dementia and clinically contrasts AD and VaD in its fluctuations in signs and symptoms over time. Individuals with Parkinsons disease dementia (PDD) share the same dementia pathology as LBD and often, individuals with LBD have some of the movement disorders familiar to PD. Mixed pathology dementias, commonly AD or LBD combined with VaD, are likely a common occurrence in dementia in older adults. Fronto-temporal dementia (FTD) is the most common of the young-onset dementias (diagnosed under age 60), and the hallmark symptoms of FTD are personality and behavior changes or language issues, with sparing of memory.

Movement Disorders

While dementia is considered a cognitive disorder, the definition of dementia includes a component of functional decline. The functional deterioration is certainly related to cognition, but there are also movement disorders that are observed in IwD that impact function. These come in the form of gait changes, diminished postural control, apraxia, bradykinesia, and paratonia.

Gait Changes

There is substantial evidence that cognition and gait are intricately related [7•, 8, 9, 93, 105], and several longitudinal studies have demonstrated that gait changes are predictive of cognitive decline in older adults [7•, 46•, 50, 98, 104]. The changes in gait parameters that are seen in typical aging are magnified in IwD. As compared to older adults with cognition intact, IwD display decreased gait speed; decreased step and stride length; increased single limb stance time and double limb support time; and increased variability of stride length, width, and time [6, 7•, 8, 62, 101, 109]. There is some evidence that etiology of dementia may impact the severity of gait and balance issues. This is an area under continuous study, but gait disturbances may be more predictive of and pronounced in individuals with non-AD dementias, such as LBD and FTD [7•, 30, 72]). Although, some researchers have found that gait speed is related to executive function irrespective of dementia type [42, 90].

Anticipating and recognizing decline in gait function is a staple of geriatric PT. Gait speed is considered a "vital sign" of the older adult [31], and the implications of slowing gait, given the relationship of gait speed with functionality and mortality, are a key component of the assessment and treatment of all older adults, with or without cognitive impairment. Encouraging targeted bouts of fast walking in the context of PT or exercise interventions provides practice and confidence in this skill. Educating caregivers about the importance of walking at speeds greater than "mosey" or "stroll" can make a difference in everyday activity of IwD and help them to maintain gait speed over time. Gait speed has been shown to be responsive to training in this population [3•, 12•, 54].

Diminished Postural Control (Balance and Falls)

It is conservatively estimated that IwD fall at least two to three times more than older adults without dementia, regardless of setting [4, 24, 27]. Decreased gait speed and increased gait variability have been associated with falls [2, 61], and there is some evidence of balance deficit preceding dementia diagnosis [51, 53]. Executive function has been repeatedly associated with gait slowing and with falls [11, 44•, 65] and has been identified as a reasonable predictor of falls in community-dwelling older adults [64]. In a study demonstrating the deterioration of balance control with cognitive decline in individuals with AD, executive function was determined to be the most relevant of cognitive measures to all aspects of balance control [88]. PTs do not routinely assess executive function as a part of falls screening. In fact, a recent study identified that fewer than 33% of PTs surveyed included cognitive screening as a component of falls risk assessment, and when they did screen cognition, most commonly, it was in the form of assessing orientation or administering the Mini Mental State Exam, neither of which is a strong indicator of executive function [10]. Perhaps the easy addition of the Mini-Cog [13] as a cognitive screen for older adults without any diagnosis of cognitive deficit would be appropriate. Mini-Cog is a 3-min assessment tool that assesses three-word registration (i.e., can the individual repeat the words?), clock drawing test (i.e., provided with a blank circle, can the individual create a clock face and register the time as 11:10?), followed by remembering the three words (i.e., can the individual recall the three words after being distracted by the clock drawing test?). A simple algorithm for scoring identifies whether an individual requires further work up for cognitive deficit.

Postural control mechanisms are thought to be effected in many ways in dementia; most notably individuals with dementia experience visual perceptual changes that can impact their balance control systems, but they are also slower to process sensory data and less agile in their motor responses [59].

IwDs demonstrate poorer postural stability and more rapid decline than do their age-matched peers as evidenced by computerized posturography and clinical static and dynamic balance measures [85–87]. Efforts at systematic review of the literature on the topic of postural stability in dementia have been complicated by the variability in methodology of studies [17]. A recent review of postural control in AD suggests that individuals with mild to moderate dementia display impaired static and functional (in task context) postural stability as compared to healthy peers, and the most influential factors contributing to this postural instability are increased attentional demand (dual tasking) and decreased visual input [63]. There are obvious implications here for training.

Fall determinants in dementia overlap with the multitude of intrinsic and extrinsic risks identified for older adults without cognitive impairment. As with all older adults, a history of falls, polypharmacy, and balance and gait deficits increase the risk of future falls in IwD. Some unique risks for IwD include behavioral issues (e.g., disruptive, attention-seeking behaviors), visual perceptual problems, caregiver burden, and, specific to the long-term care environment, psychotropic drugs and restraints [26, 49]. Comprehensive falls screening and a dedicated multidisciplinary team approach is likely the best way to address fall risk. Rehabilitation professionals bring expertise in physical and functional training, but medical and nursing staff may be pivotal to troubleshooting polypharmacy and behavioral issues.

Balance has been demonstrated to be responsive to training in this population [3•, 12•, 57, 71]. Across the spectrum of mild to severe dementia, combined with any level from mild to significant balance impairment, PTs must introduce the appropriate level of therapeutic balance challenge. If patients do not experience loss of balance in the context of therapy, the training is too easy.

Apraxia

Normal motor planning, resulting in skilled movement, may be framed within the conceptual-production systems model, the components of which are the sensory-perceptual system which processes sensory input (auditory, visual, tactile), the conceptual system which stores knowledge of motor actions and tools, and the production system which retrieves appropriate motor responses based upon the first two components [56, 81]. These functions are thought to be housed in discrete anatomical brain regions. Apraxia, or difficulty with motor planning, was historically considered one of the defining features of AD, and it is seen with increased prevalence as severity of AD increases [81]. Apraxia is evident in 32–35% of individuals with AD [68, 80] and is found in other dementias as well, particularly FTD (which includes the disorder of primary progressive aphasia). Limb apraxia is more common in AD whereas buccofacial apraxia is more common in FTD [1, 43]. Limb apraxia is often evident in self-care skills when patients struggle to use a shoe horn or a toothbrush or some other implement they have been using effectively for decades. There is some indication that providing verbal cuing to an apraxic patient may be counterproductive and may overload an already engaged left hemisphere (i.e., dominant hemisphere for right-handed movement and language comprehension) [81]. Apraxia impacts an individual's ability to pantomime or imitate gestures as well, so PTs may have greater success with guidance and tactile cuing over demonstration.

Bradykinesia

Bradykinesia, an extrapyramidal motor sign, is an anticipated finding in Parkinson's disease dementia (PDD) and Lewy body dementia (LBD) [30], but it also may be present in AD, especially with advanced disease and/or individuals experiencing neuropsychiatric symptoms (e.g., hallucinations) [95, 96]. Bradykinesia in the context of dementia likely has a large component of bradyphrenia (slowness of thought and processing). Integrating fast and/or large amplitude motions in the context of rehab for this population seems justifiable, but has not been studied.

Paratonia

Paratonia is a unique presentation of hypertonia characterized by involuntary resistance to passive movement or pressure that increases with the progression of dementia [39, 97]. Paratonia, sometimes referred to as Gegenhalten tone, may be present in any of the dementias, although individuals with dementia of vascular etiology or diabetes mellitus appear to be at higher risk [40]. It is distinctly different than rigidity or spasticity, and characteristics of paratonia include involuntary variable resistance during passive movement (may be in any direction), degree of resistance correlates to speed of movement, resistance felt in two movement directions of one limb or two separate limbs, and absence of clasp-knife phenomenon [38]. As it progresses, paratonia can complicate the ability to assist functional movements and can ultimately lead to immobility and contractures. Mobilizing individuals with advanced dementia and paratonia can be difficult; however, it is possible to exploit this unique tone to facilitate movement. For example, in assisting an IwD to move forward in a chair in preparation for standing, the PT may intuitively pull the individual forward with hands placed on the posterior aspect of the shoulders. An individual with paratonia will respond by pushing backward into the cue of the hands so he or she is pushing back into the chair rather than moving the upper body forward; the PT and IwD are effectively fighting each other (Fig. 1a). If the therapist modifies hand placement to be on the anterior aspect of the individual's shoulders, the IwD will respond by pushing into the pressure of the hands, facilitating movement in the proper direction to achieve the forward weight shift in preparation for mobility (Fig. 1b). This tactic may work for supine to sit transitions—counterintuitively, the PT will give the cue of pushing the person back into the bed they are trying to get them to rise from. In transitioning sit to stand, this manual technique can work if the PT strategically starts with posteriorly directed pressure, causing the patient to lean anterior, and transitions to inferiorly directed pressure, to facilitate the motion to stand (Fig. 1c). While these techniques work on only a select group of patients with significant paratonia, when they *do* work, they can substantially reduce the burden of care for caregivers responsible for mobilizing them.

Excess Disability

Excess disability is a construct that suggests that individuals with dementia often appear more functionally disabled than they should, given their physical impairments [15, 92]. Likely, this is a function of both the patient and the caregiver. It takes longer and is more tenuous to allow an IwD independence in performing tasks; thus, caregivers often step in, with the noble intent of enhancing safety and efficiency and perhaps avoiding frustration for all. The unintended result is that individuals lose the opportunity to practice tasks and over time lose the ability to perform the tasks altogether. Caregivers are often quick to provide assistance with tasks such as walking to and getting into the car (e.g., offering a hand while walking, opening the car door) or walking while carrying things (e.g., a bag of groceries from the car to the house, a plate of food from the counter to the table). Without the opportunity to practice these tasks, skill proficiency suffers. Fortunately, with mindful strategies, excess disability is an avoidable or reversible phenomenon [77]. PTs should provide pointed education to caregivers related to allowing opportunities to carry out functional tasks as independently as possible, while being sensitive to the reality that life is busy and oftentimes caregivers are forced to assist, given time constraints. Excess disability may help explain the potential for great success with exercise and rehabilitation interventions in IwD. If IwDs are provided with physical and functional challenges and are given the opportunity to work to their potential, they may regain lost abilities.

Motor Learning

Motor learning in dementia is not well-studied, but there are some relevant and important considerations of which therapists should be aware to provide the most promising

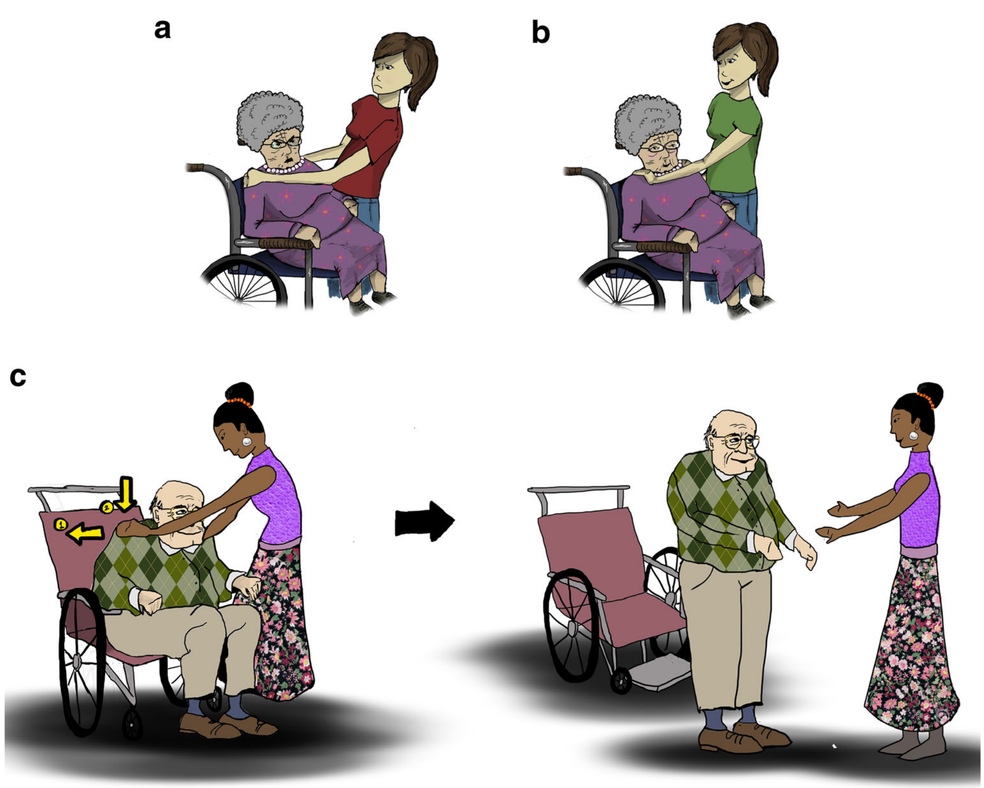

Fig. 1 **a** If the PT tries to "pull" the patient with paratonia forward in the chair, the patient will push backward. **b** If the PT places hands anteriorly to gently "push" the patient with paratonia back, the patient will lean forward. **c** Strategic use of force first posteriorly and then downward can facilitate standing in a patient with paratonia. This illustrations was from Scout Ries and they are used with her permission

interventions to IwD. A summary of memory and learning systems and strategies to enhance practice sessions are presented below with a summary and examples presented in Table 1.

Table 1 Characteristics of successful motor learning and relearning intervention strategies in older adults with dementia

Strategies	Examples
Capitalize on procedural (implicit) learning strategies [34, 69, 100, 106] • Use activities that promote "learning by doing" • Design treatment environments and tasks to elicit desired response from learner • Put exercises in the context of functional tasks when possible	Instead of abstract exercise, use sit to stand for LE strengthening; move cans from table or counter to high shelf for UE strengthening and ROM Create obstacle course that elicits desired responses (over and around obstacles, rugged terrain) and direct patients toward a target at the end of the course.
Integrate errorless learning strategies; eliminate (or minimize impact of) mistakes made by learner [19, 45, 107] • Strategies, might include: • Feed-forward instruction, mnemonics • Modeling of the task, physical guidance • Immediate correction, discouraging guessing • Spaced retrieval training (increasing intervals between instruction/cueing with correct performance and decreasing intervals with incorrect performance), tapered guidance, vanishing cues	Anticipate errors and intervene before they happen… If training to use a new assistive device and trying to encourage patient to push up from the chair prior to grabbing the walker, be attentive every time (train staff and families), and do not let the patient make the mistake of misplacing hands on walker prior to standing. By avoiding the error while learning, there is a better chance that the patient will more efficiently and effectively learn the optimal strategy.
Do not entirely discount declarative (explicit) strategies (e.g., trial and error learning), particularly with individuals with mild dementia [14, 102, 103, 107].	In mild dementia, it may be reasonable to encourage patients to talk through an ADL strategy or a kitchen prep strategy in advance and/or during activity.
Use constant (vs. variable) and blocked (vs. random) practice conditions [21, 22, 23, 69, 100]	In training sit to stand: [1] practice the specific needs for the functional living environment, [2] use repetitive and consistent practice of the specific environmental demands, and [3•] complete transfer training in a session before moving to gait training.
Consider part to whole practice and forward chaining (add next component part when learner masters previous part); put component parts back into context of whole task within training session [110].	Deconstructing an ADL task for the purposes of training is a reasonable strategy: In training use of single cup coffee maker, break task into parts (choose coffee from selection storage, place in coffee maker, close lid, push proper button, etc.). Restructure component parts into the context of the entire task within the training session.
Specificity of training is important; expect limited to no transfer of training [21, 69, 100]	Create a therapy environment that mimics the specific needs of the living environment; treatment in the living environment (home care, SNF) is ideal for specificity of training.
Provide sufficient visual feedback opportunities; assure vision is corrected; provide external motivation [20, 100]	Be sure patient has appropriate prescription eyewear for therapy.
Integrate perceptual and sensory priming and/or music as appropriate [34, 74]	In retraining an ADL activity, strive to create an environment that will be meaningful to the patient. In retraining shaving, recreate the experience of their many years of shaving: morning news on the radio, the smell of familiar after shave, the familiar feel of their shaving cream, etc.
Practice with appropriate level of challenge and intensity [18, 71, 91, 94•] • Activities should provide a reasonable level of challenge • Do not offer rest periods unless the patient looks (from a physiological perspective) as though they need a rest.	Patient should be challenged at the highest level possible. If training balance, patient must experience loss of balance in the context of training sessions so that they can perceive their own limits of stability.

Procedural Vs. Declarative Memory and Learning

In training/retraining motor skills in individuals with cognition intact, we often use both procedural (implicit) and declarative (explicit) memory and learning systems. Though simplified, it is helpful to consider that procedural learning is "learning by doing" and develops through repetition or skill practice *without* the need for deliberate cognitive oversight (e.g., attention, awareness, reflection), whereas declarative learning requires more conscious knowledge and awareness (e.g., articulation of processes, reflection on performance, intentional comparison to previous skill performance) [76, 106]. When cognition is intact, learners can "learn by doing" and enhance their learning by intentionally articulating their strategies and/or evaluating and reflecting upon their performance, thus employing both systems. It has been well documented that procedural and declarative memory are functions of different neuroanatomical brain regions. The medial temporal lobe (i.e., hippocampus and related structures) is vital to declarative memory and learning. This region is implicated early and progressively in AD particularly, rendering declarative memory impaired and ultimately unavailable to most IwD. By default, the use of procedural (implicit) memory and learning is pivotal to success in skill acquisition/reacquisition in this population [69, 100, 106]. The burden is on the PT to design treatment tasks that will elicit desired motor activities without the need for substantial cognitive oversight. For example, in training walking on altered terrain, a PT may create a walkway using yoga mats with towels underneath creating irregularly shaped and spaced bumps. In a patient with cognition intact, the PT may direct the patient to attend to the mat while walking and to think about the feel of the mat and how it is different than level ground. After a couple trials, the PT may ask the patient to articulate what went well and what they might do differently on future attempts. These strategies require cognitive oversight. For training the same activity in an IwD, the PT may set up the same walkway but give no instruction about the walkway itself but give the patient a target on the far end of the walkway (e.g., "Touch the red flag"); thus, the environment demands practice of the task, but there is no added cognitive demand in the context of training. With repetition of the task, the IwD uses procedural memory and learning to master the skill.

Errorless Learning

Because IwDs do not typically monitor and learn from their mistakes like their cognitively intact peers, errorless learning strategies may benefit learning/relearning of skills. There is some discrepancy in the literature as to whether errorless learning strategies are, by nature, involved in implicit or explicit learning, or can be applied to both [45, 58, 102, 103], but perhaps that matter is academic. These strategies are designed to stop the learner from practicing the task incorrectly, because if the learner performs the task incorrectly, then that most recent incorrect performance is likely to be their default performance upon the next attempt. A systematic review of errorless learning strategies applied to functional/ADL tasks in dementia demonstrated errorless learning to be superior to errorful learning [19]; however, these findings are not undisputed. A recent well-designed multi-site randomized controlled trial (with some shared authors of the review study) compared structured relearning of ADLs with errorless vs. trial-and-error learning in IwD and determined that both strategies were equally effective and sustaining [107]. Another recent but smaller study comparing trial-and-error learning and errorless learning strategies with mild to moderately severe AD found the interventions to be equally effective in retraining instrumental ADLs [14]. Not surprisingly, these authors demonstrated the learning effects were greater for implicit understanding of the task (i.e., being able to perform the trained task) than explicit knowledge of the task (i.e., ability to organize pictures or written description of steps of task).

The errorless learning principle is rather new to the literature and as more therapists become aware of the concept, there is the risk of misapplication to broad rehab training. While avoiding errors may be important in the context of ADL and IADL retraining, or practicing the steps to a functional training task (e.g., components of safe transfer, remembering to use assistive device for gait), there are some situations where allowing the patient to experience some "error" is appropriate and necessary. For example, in the context of balance training, patients must experience their limits of stability in the protected environment of rehab in order to improve their balance—giving the patient the opportunity to experience "near falls" (some of which are saved by the PT and some of which are saved by the patient) is an invaluable component to balance training.

Part-Whole Practice

Deconstructing a task into its component parts has recently been used within an errorless learning paradigm for ADL/IADL activities and for sit-to-stand transfers with some success in individuals with mild to moderate dementia [14, 110]. Forward chaining is a useful strategy in part-whole practice in which the therapist adds the next component part of a task when the learner masters the previous part. Retention of learned tasks is promising in delayed posttests; however, the more important and as-yet unstudied variable would be the ability to integrate these learned activities into the context of daily life. Whenever utilizing part-whole practice, it is essential that the practice session finishes by putting the parts back into the context of the entirety of the task. Spaced retrieval training (an errorless learning strategy) might be used to do this; the therapist strategically increases or decreases guidance and cues based upon patient performance (large intervals between cues when the patient is performing well, brief intervals when the patient needs more instruction). The goal, over time, is to taper guidance and cues.

Practice Schedules (Variable Vs. Constant, Random Vs. Blocked)

Cognitively intact older adults benefit from variable (vs. constant) and random (vs. blocked) practice, as these serve to broaden their motor program creating flexibility and adaptability which bodes well for real-world success where task conditions can be unpredictable. With a goal of independent sit-to-stand transfers in a patient with intact cognition, a sound intervention would be to practice sit-to-stand in variable (e.g., integrating transfer surfaces of different heights, compliancy, and stability) and random practice conditions (e.g., interspersed among other therapeutic activities). In contrast, this would *not* be the best treatment session design for an IwD. Classic studies by Dick and colleagues and summary studies from the early to mid 2000s lay a foundation for our understanding of creating optimal practice sessions for individuals with dementia [21–23, 69, 100]. In looking at both gross motor (tossing) and fine motor (rotary pursuit) skills, Dick demonstrated that individuals with AD learn better with constant practice as they are unable to engage in the relational processing required with variable practice—they are unable to compare and contrast their efforts and outcomes and encode and store the information for later retrieval and use [22]. Consistency of training becomes an important parameter in IwD. Whereas broadening a motor program for real-world adaptability is a realistic goal in patients with intact cognition, this is effective because of these patients' ability to transfer training to related tasks. Transfer of training is much more limited in IwD [21, 22, 69, 100]; specificity of training becomes necessary in this population with intentional narrowing or focusing of the motor program. If sit-to-stand training is a goal of therapy, it would be important to know the specific sit-to-stand needs of the patient's living environment and to re-create the task as close to the real-life demands as possible for therapeutic practice. Repetitive and deliberate practice is instrumental in motor learning in both normal and pathological conditions, but consistency of the training is key to IwD.

Feedback

The use of feedback during motor learning is not well studied in IwD. There is some evidence that older adults with AD rely more heavily than do their cognitively intact peers on constant visual feedback while learning new motor tasks [20, 100]. Assuring proper eyewear for corrected vision is therefore important. In terms of feedback schedules, cognitively intact adults benefit from strategic extrinsic feedback (summary or interval feedback) that fades over time to encourage intrinsic reliance on the learner. The cognitive abilities of IwD may not support the ability to internalize feedback; however, a small study comparing learning of a visuomotor computer task in participants with mild to moderate AD compared feedback of 100% knowledge of results (KR) vs. 33% KR during acquisition phase, and those participants who had the reduced frequency of feedback had better retention and transfer of the task than did those who received feedback after every trial [70]. PTs should be careful not to bombard patients with feedback yet to provide relevant information that patients may need for optimal safety and function. Additionally, it is important to remember that PT comments on performance can be motivating and encouraging and IwDs may thrive on this attention.

Priming

Motor priming in neurorehabilitation is a relatively new area of study. By providing a stimulus prior to, or in conjunction with, therapy, PTs may be able to "prime" patients for motor learning and enhance outcomes. Avenues of administration include stimulation-based priming (e.g., transcranial magnetic stimulation), motor imagery and action observation, sensory priming, movement-based priming, and pharmacological priming [84]. While this adjuvant to treatment has not been studied in IwD, the rationale makes great sense for this population, as all strategies, with the exception of motor imagery, have low cognitive demands. Perceptual and sensory priming has been suggested in the context of a model for relearning ADL skills in IwD [34]. The model suggests that therapeutic interventions and environments should integrate familiar and relevant sensory and perceptual experiences during training (e.g., auditory, visual, olfactory, tactile) to enhance motor relearning of tasks. Whether this serves to prime the nervous system for learning or it simply provides a sense of comfort in the therapeutic environment, it can be a powerful tool. Integrating relevant music in the therapeutic environment may provide this comfort as well. The use of music can have a positive effect on mood and arousal which may be useful in supporting cognitive performance (attention and memory) in motor learning in IwD [74].

Dual Tasking (Real-World Preparation)

Dual tasking, or superimposing a cognitive or motor task on a base motor task, can be evidence of mature motor learning. Even cognitively intact individuals have their limits, as evidenced by movement and/or cognitive decompensation when they hit their attentional threshold. In cognitive impairment, attentional reserve is depleted, so those limits are hit earlier and the implications are often more apparent. High dual-task gait cost (i.e., substantial slowing of gait with added cognitive demand) was recently associated with progression from mild cognitive impairment to dementia [66]. In community-dwelling cognitively impaired older adults, both motor and cognitive dual-task conditions negatively impact speed and variability of gait [72, 89]. Recently, specific dual-task tests were found to have sound psychometric properties for persons with mild to moderate dementia, specifically walking while counting by 2s and walking while reciting the alphabet are suitable tests to use with this population [55].

Some authors suggest dual-task training should be avoided with IwD [100], but recognizing that there are cognitive demands to walking in anything but the most protected environments, including walking with the use of assistive device [67], it is important to prepare IwDs for real-world functioning. Additionally, given the well-documented inter-relatedness of gait and cognition, it makes sense to incorporate both cognitive and motor components in rehab efforts. In fact, recent systematic reviews demonstrate promise in using combined interventions (either dual-task training or multi-component interventions) in older adults with cognitive impairment in outcomes including cognition, functional status, and falls risk [12•, 29, 52, 108]. PTs must identify appropriate levels of dual-task challenge and create therapeutic activities that are sufficiently motivating in the context of each patient's abilities. Therapeutic tasks should be related to real-world challenges. Technologies integrating gaming and virtual reality in rehabilitation are becoming more abundant and will likely be the subject of dual-task study with IwD. Currently, case reports describing use of computer/video gaming (Wii bowling) or virtual reality (green screen) strategies have demonstrated feasibility with IwD [25, 60].

Appropriate Challenge and Intensity

PTs working with IwD must honor basic principles of exercise and experience-driven neural plasticity, including considerable repetition, appropriate intensity of practice, and level of challenge of tasks, salience of tasks which motivates participation [47, 111]. In geriatrics, PTs often underestimate the abilities of patients—they may fail to provide an appropriate challenge or offer rest breaks too liberally. Low rehab expectations are the enemy of IwDs. It is the skill of the PT to identify the appropriate threshold for patient performance of a task and create therapeutic interventions that meet or exceed that threshold. The importance of intensity of interventions in IwD has recently been acknowledged, as evidenced by multiple publications with reference to intervention intensity in the titles [18, 41, 75, 91, 94].

Therapeutic Relationship

Creating the optimal therapeutic relationship is pivotal when working with IwD, and while detailed discussion is beyond the scope of this paper, Table 2 provides a summary of characteristics and tips for successful interpersonal interactions in rehabilitation. It is important that the rehab environment feels safe, calm, and predictable to IwDs. When there is consistency and familiarity in the setting, the people, and the time of day for exercise or rehab activities, IwDs may feel a sense of "routine" even when they have no memory of participating from day to day or week to week. Group activities are often an effective strategy for delivering exercise interventions, although tailoring an exercise or rehab program to the needs of each individual is vital to program success [99].

Table 2 Creating a successful therapeutic relationship

Characteristic (references)	Strategies
Prioritize relationship over task [18, 32, 35–37, 48, 73]	• Establish an excellent rapport • Invest time in understanding personal and family history • Use names of family members, pets, and friends in conversation • Talk through a "reminiscence" • Build on the patient's interests and cognitive strengths • Attend to emotional needs with reassurance, respect, and empathy • Reward successes
Communication should be simple and direct [32, 36, 78, 79, 83]	• Intentionally simplify interactions (e.g., yes/no questions, choice of two activities) • One-step commands (unless capable of more) • Direct, friendly eye contact • Smile • Avoid asking "Do you remember…?" • Sit at eye level to talk • Speak with pleasant but firm voice commands to elicit response • Instruct toward meaningful/functional goals vs. abstract/non-functional actions • Provide clear, objective, repetitive instructions as necessary • Utilize gestures, demonstrations, tactile cues, reassuring touch

Conclusions

Qualitative studies with therapists working with IwD [28, 33] share the need to "be on your toes" or "think outside the box" and acknowledge some of the frustrations that come with treating this population, not the least of which are productivity requirements that are not forgiving to the needs of this group. IwDs might easily be labeled as "low priority" on a busy therapist's schedule, and when behavioral issues or pain complaints complicate rehab efforts, it is that much more likely that therapists may feel overwhelmed. PTs who are equipped with the knowledge of the intricacies of movement and motor learning in IwD paired with strategies to foster an excellent therapeutic relationship are poised for the best possible rehab outcome.

Compliance with Ethical Standards

Conflict of Interest Julie Ries declares no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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