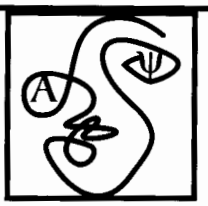

Cognitive Skills: Training, Maintenance, and Daily Usage

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GLOSSARY

divided attention The ability to split a person's attentional focus or to maintain vigilance with respect to two or more objects or activities.

executive function A set of higher order cognitive abilities primarily associated with frontal and prefrontal structures of the brain; it involves planning, organizes information, inhibits responses, and orchestrates mental resources.

hippocampus A subcortical structure of the brain that is key for memory function and is specifically involved in encoding new information, a vital first step for subsequent recall.

mild cognitive impairment (MCI) A term used to describe individuals with focal memory impairments but no evidence of frank impairment in other cognitive domains and no evidence of impaired daily functioning; MCI is often thought of as a preclinical stage of dementia.

transfer of training The capacity for training-induced improvements in cognitive skills to translate into improved performance of cognitively demanding activities.

Cognitive skills are basic and higher order mental abilities, such as attention, information processing, memory, executive functioning, and reasoning, that interact with sensory and perceptual systems to determine success in performing daily activities. Older adults are at risk for cognitive decline but may benefit from strategies to maintain cognitive skills and from training programs to enhance certain skills.

1. COGNITIVE SKILLS AND THEIR IMPORTANCE FOR DAILY FUNCTIONING

The ability to think, remember, and reason allows people to negotiate the world in which they live, whether it be planning the steps in cooking a meal, remembering to take their medications on time, deciding how to spend their money, or reacting quickly to avoid hitting a dog in the road. People's cognitive abilities provide them with the flexibility to engage in a number of unique and demanding situations. Declines in any of these abilities can subsequently diminish the ability to function in day-to-day life. Cognitive abilities that tend to decline with age, with potential impact on the ability to perform everyday tasks, include attention, speed of processing, memory, executive functioning, and reasoning. These abilities interact with sensory and

perceptual systems to determine performance in daily life.

1.1. Sensation and Perception

Information processing must begin with acquiring the information in the first place. Thus, age-related changes in sensory–perceptual abilities (e.g., poorer vision, hearing) can influence older adults' ability to perform measures of cognitive ability as well as everyday activities. For the most part, older adults can compensate for age-related sensory decline through corrective lenses and /or hearing aids. Older adults also compensate for degraded sensory information through cognitive strategies in which they use the context of a situation (e.g., conversation, other words in a sentence, situational cues) to understand what is being presented. However, impairments in sensory processing can lead not only to poorer performance on cognitive tests, and perhaps a false impression of cognitive impairment, but also to restrictions in everyday activities such as driving. Such restrictions may, in turn, lead to increased depression and/or the need for formal care.

1.2. Attention

Attention encompasses a rather broad range of abilities, from simply orienting (e.g., turning attention toward a sudden noise), to sustained attention or vigilance (e.g., maintaining focus over an extended period of time). Divided attention is quite commonly used in everyday contexts and occurs when people try to do two things at the same time. This ability may or may not decline with age, depending on the individual and the difficulty of the two tasks being performed at the same time. The use of cell phones while driving is an example of a divided attention task that can be fairly difficult. There is mounting evidence that crash risk is elevated for drivers of all ages while using cell phones, and this risk may increase with age. In general, research indicates that older drivers are susceptible to decrements in driving performance when increased demands are placed on attention, whether it be cell phones or multiple events occurring at a congested intersection. Selective attention, or the ability to pay attention to relevant information while ignoring irrelevant information, is also germane in this context. It has generally been found that the detrimental effect of irrelevant information, or distraction, is higher for older adults.

1.3. Speed of Processing

Speed of processing, or the ability to perceive and process information quickly, is one of the first cognitive abilities to decline with age. Over the past decade or so, many studies have demonstrated relationships between cognitive processing speed and everyday function in older adults. Various indexes of mobility have been linked to processing speed impairments in older adults with and without dementia. For example, reductions in life space, or the extent of a person's travel in his or her environment inside and outside the home, have been associated with impairments in processing speed. Furthermore, multiple studies have demonstrated that processing speed impairment is an excellent predictor of increased crash involvement in older drivers and is an even stronger predictor of injurious crashes. Reduced processing speed also is related to slower performance of instrumental activities of daily living (IADLs) such as looking up a telephone number, finding items on a crowded shelf, and reading medication labels.

1.4. Memory

Memory is one of people's most obvious cognitive abilities. Of all the mental abilities, people report complaints about this ability more often than about any other ability, probably because it is fundamental to most everyday tasks. Also, memory decline can be obvious when a person is attempting to recall necessary information such as telling a doctor what medications he or she is taking or trying to remember a phone number. Although activation of both cortical and subcortical areas of the brain is necessary for good memory functioning, the hippocampus, a subcortical structure, has the primary responsibility of encoding new information, a vital first step for subsequent recall of the information. As seen with Alzheimer's disease, when the hippocampus is severely damaged, profound memory loss is experienced. Although some normal age-related decline in memory does occur with age, such changes generally do not severely affect daily functioning to the same degree as found in a dementia such as Alzheimer's disease. Regardless, age-related memory declines have been found to influence activities of daily living (ADLs), whether they be forgetting to adhere to medical appointments or not remembering to pay bills. Research has linked memory declines to self-reported impairment with daily shopping, preparing a hot meal, housecleaning, managing finances, and completing forms.

1.5. Executive Function

One of the most complex cognitive abilities is executive function, which includes people's ability to plan, organize information, inhibit responses, think abstractly, and reallocate mental resources. This ability is primarily associated with the frontal lobes of the brain and is known to decline with age. Executive functioning is necessary to complete tasks that require complex behavior or have multiple steps. For instance, executive functioning is useful in paying bills because this task requires planning (e.g., determining how much money to transfer from a savings account to a checking account), calculating how much money remains in the checking account after paying the bills, and (in many cases) deciding what is the least amount that can be paid to prioritize money to other uses. Thus, financial capacity can be impaired in individuals with executive dysfunction, as is seen in adults with Alzheimer's disease. However, dysfunction in executive abilities can also affect less cognitively demanding activities. For example, scientists have found that lower levels of executive functioning are related to impairment in the ability to perform other IADLs such as medication management, even among noninstitutionalized retirees.

1.6. Reasoning

Reasoning is another complex cognitive ability affected by aging. This ability is similar to executive functioning; in fact, damage to the fontal lobes also impairs the ability to reason. Unlike executive functioning, reasoning focuses on using logical constructs, knowledge, and principles to extrapolate a solution to a problem. Reasoning is a sophisticated problem-solving skill that requires both memory and executive functioning. Reasoning is used in a variety of real-world tasks, ranging from medical decisions to driving behavior. Thus, declines in reasoning ability can impair decision making in a variety of real-world scenarios. As with other cognitive skills, reasoning ability has been found to predict IADL performance. Scientists have found that inductive reasoning is important for figuring out problems associated with everyday tasks such as shopping and managing money. In fact, researchers have found that as inductive reasoning is enhanced, everyday problem solving also improves.

1.7. Cognitive Impairment

Whereas age-related declines in cognition and function may be relatively subtle and selective in normal aging, the declines experienced by individuals with mild cognitive impairment (MCI) or dementia are more pronounced and become pervasive over time.

MCI is a term used to describe individuals with focal memory impairments but no evidence of frank impairment in other cognitive domains and no evidence of impaired daily functioning. MCI is often thought of as a preclinical stage of dementia. Approximately 5 to 15% of adults age 65 years or over may be affected by MCI. Individuals with MCI, by virtue of their memory impairments and their risk of progression to dementia, are at high risk for declines in the abilities needed to function effectively and independently in society. These individuals are likely to experience a gradual loss of functional skills of a magnitude that lies somewhere between the subtle decrements associated with normal aging and the much more obvious deficits associated with dementia. Little has been done to directly evaluate the impact of cognitive changes in MCI on the performance of everyday tasks. A critical question is how changes in memory and other cognitive abilities influence the performance of everyday tasks over the period of time that, for many individuals, will mark the transition from MCI to dementia. To date, no one has mapped cognitively demanding everyday activities to component cognitive abilities in MCI. Thus, it is difficult to determine whether some tasks of daily life are dependent on specific abilities or how levels of ability influence functional performance. A clearer understanding of this relationship within the MCI population is needed.

Dementia includes a category of diseases, such as Alzheimer's disease, characterized by more severe cognitive impairments that hamper a person's ability to perform everyday tasks. The incidence of dementia rises with age. For example, only approximately 5% of adults over 65 years of age have Alzheimer's disease, whereas 10 to 20% of adults over 80 years of age are affected, and estimates have indicated that as many as 40% of adults age 85 years or over suffer from the disease. Research in the field of cognitive aging has demonstrated that the deterioration of cognitive function that occurs with dementia contributes to a decline in the performance of everyday activities. Research has also shown a clear link between declining everyday function (e.g., managing finances, grocery shopping, driving) and subsequent hospitalizations, need for care, and death.

2. HOW COGNITIVE SKILLS MAY BE MAINTAINED

Cognitive decline in numerous areas can result in difficulty in performing tasks important for everyday life and

for maintaining independence throughout old age. Thus, an important question to consider is, "How can individuals maintain cognitive abilities and avoid cognitive decline?" Several factors have been related to sustained cognitive function with age, including education level, physical activity level, pulmonary health, and feelings of self-efficacy. By and large, healthy and active lifestyles that include proper diet and exercise, prevention of disease, and the avoidance of trauma all are important for sustaining cognitive capacity with advancing age.

Higher education levels are associated with better cognitive performance during older adulthood. Education level affects cognitive function both directly, through enhancing brain function, and indirectly, through individuals with more education being more likely to participate in intellectually stimulating activities that, in turn, preserve cognitive abilities.

Physical activity has various benefits for older adults and positively affects cognitive function in a variety of ways. For example, physical activity has been shown to decrease depression (which can cause cognitive deficits, particularly for older adults) and to increase overall physical health and improve quality of life. Strenuous exercise directly benefits brain and central nervous system functioning, which are vital to maintaining cognitive abilities. Accordingly, aerobically active individuals perform better on measures of working memory, reasoning, and speed of processing than do those who exhibit more sedentary behavior.

In addition to exercise, many facets of physical health have been related to cognitive function. For example, a specific physiological measure, pulmonary peak expiratory flow rate, has been found to be predictive of sustained cognitive ability with age. This physiological index is related to cardiovascular health and physical activity level. Studies have noted in particular that preserved vascular and cardiovascular health is vital for cognitive function. For example, decreased cerebral blood flow is associated with poor cognitive performance. Furthermore, poor cardiovascular health is associated with increased incidence of stroke, a leading cause of cognitive impairment. In the Seattle Longitudinal Study (SLS), absence of cardiovascular disease was linked to better reasoning ability and speed of processing performance for older adults. A number of other diseases, such as diabetes, emphysema, and Parkinson's disease, can also result in cognitive deficits. In general, the fewer chronic diseases a person has, the better his or her chances of maintaining cognitive abilities with advancing age.

Overall, a healthy lifestyle is important not only for physical health but also for mental health. Obesity has been related to higher incidence of many chronic diseases, which in turn are related to cognitive decline. Cigarette smoking and excessive alcohol consumption both have been linked to higher incidence of stroke, a leading cause of cognitive impairment, as well as to many other poor health outcomes, thereby negatively affecting cognition. Furthermore, alcoholism can be directly detrimental to cognitive function. Most obviously, traumatic head injury results in cognitive impairment and is associated with increased incidence of dementia later in life. Therefore, simple preventive behavior, such as using seat belts combined with air bags while in automobiles and using helmets while riding on motorcycles, bicycles, or scooters, is advised.

In addition to physical health and healthy lifestyles, psychological well-being is important for preserving cognitive function. An individual's attitude can affect his or her cognitive performance with age. For example, self-efficacy, a positive evaluation of one's own cognitive capabilities, is related to better cognitive performance. Individuals in the SLS who rated their personalities as "flexible" during midlife were found to be at reduced risk for cognitive decline in later life. Furthermore, individuals who indicated satisfaction with their life accomplishments during middle age performed better on cognitive measures in later life.

Sustained social activity also is associated with better cognitive performance. For example, researchers have found that those who engage in social, domestic, and leisure pursuits are less likely to have cognitive impairment. Similarly, the SLS indicated that older adults who had high socioeconomic status and were socially active experienced the least cognitive decline over a 7- to 14-year period. Risk of cognitive decline was lessened for individuals who read extensively, traveled, attended cultural events, were involved in clubs and professional associations, and pursued continuing education opportunities. Extensive social networks and support systems, including intact families, have also been related to better cognitive functioning with age. Conversely, depression has been identified as a psychological/biological cause of decreased cognitive function. Particularly for older adults, depression can manifest itself as cognitive impairment.

3. HOW COGNITIVE SKILLS CAN BE TRAINED AND THE IMPACT OF TRAINING

3.1. Cognitive Training

Given that cognitive abilities can and do decline with age, often resulting in difficulty in performing everyday

tasks, the possibility of cognitive training to prevent, slow, or reverse age-related cognitive decline has been investigated. A growing number of studies now support the protective effects of intellectual stimulation on cognitive abilities for older adults without dementia. Early studies in the area of cognitive training were conducted within the Adult Development and Enrichment Project (ADEPT) and the SLS. Both of these studies provided 5 hours of strategy training, preceded and followed by cognitive assessment. Significant cognitive training gains were observed in both studies for the specific abilities that were trained.

A large randomized clinical trial, Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE), recently evaluated the impact of three promising cognitive interventions—speed of processing training, memory training, and reasoning training—on the maintenance of both cognitive and day-to-day abilities in community-living older adults. The study showed that for all three interventions, there were significant and specific improvements in cognitive ability as well as an increased benefit of additional booster training. The amount of training gain for cognitive abilities was equal to or greater than the amount of decline that would be expected in older adults without dementia over 4 to 14 years of aging in the absence of any training.

3.2. Durability of Training

In the ACTIVE study, among those individuals who experienced immediate cognitive improvements, training gains were found to persist for at least a 2-year follow-up period for all three interventions. Prior cognitive training studies have also pointed to the durability of training effects, with maintenance of reasoning training demonstrated at even 7 years after original training. Those older adults in the SLS who received reasoning booster training were found to substantially outperform their initial baseline levels 7 years later. Although studies of memory training have consistently shown that memory improvement can be maintained 1 week to 6 months, results on the durability of training beyond 6 months are less consistent. Some investigators have reported a significant decrease in memory performance and a substantial decrease in mnemonic strategy use over a 3-year interval in a memory training group. Multifactorial memory training programs, such as those incorporating psychomotor training in addition to memory training, have resulted in maintenance of memory improvement extending to 3½ years.

Maintenance of speed of processing training effects has not been evaluated extensively beyond the ACTIVE study, which demonstrated maintenance for at least 2 years. In an early training study, speed training effects were found to persist over a 6-month period. Furthermore, participants in the older age group (>60 years) performed at the same level following training as the middle age group (40–59 years) had performed at baseline. In a subsequent study among older adults, training effects were found to persist over 18 months and remained significantly better than baseline. Thus, in general, cognitive training studies have supported the durability of training effects.

3.3. Transfer of Training

Given that cognitive training can result in improvements of targeted cognitive skills, can these cognitive improvements transfer to improvements in performance of everyday activities? Older adults are constantly faced with learning new things such as skills for using computers, home medical devices, automated teller machines, videocassette recorders, and job-related skills. In addition, older adults would benefit from preservation of functional abilities that were most likely acquired at a younger age (e.g., driving, other IADLs). Although the onset of decline occurs for many cognitive abilities during a person's 60s, the onset of decline for everyday abilities typically occurs during the 70s or later. Obviously, functional competence is multidimensional, relying on multiple cognitive abilities. Consequently, assessment of functional competence/everyday abilities has included multiple methods, including global measures, performance-based measures, and self-report measures.

An example of a cognitively demanding task of daily living is the Everyday Problems Test (EPT), which assesses a person's ability to interact with 14 everyday situations (e.g., doubling a recipe, interpreting transportation schedules, understanding a Medicare benefit chart). Similarly, the Observed Tasks of Daily Living (OTDL) assessment presents tasks in three domains: medication use, financial management, and telephone use. Participants are asked to perform actions required to solve everyday tasks (e.g., searching medication label for side effects, making change). Performance on these measures has been related to multiple basic cognitive abilities; therefore, it may improve with cognitive training.

Other measures of everyday ability emphasize the speed of responding to real-world stimuli. For

example, slower processing abilities can present a risk with respect to safe driving. The speed of processing research has examined age differences in the Useful Field of View (a collection of speeded tasks evaluated in the ACTIVE clinical trial) as well as the benefits of speed of processing training to both cognitive abilities and everyday tasks. Prior training research found that improved speed of processing resulted in improved braking times in a driving simulator in addition to significantly reducing the number of dangerous maneuvers made by drivers during an open-road driving evaluation and maintaining the extent of people's driving over an 18-month period. Self-reported difficulty in driving, driving avoidance, and reducing the extent of people's driving all have been found to be associated with slower processing speed. Despite the fact that individuals with impairments appear to self-regulate their driving performance by reducing their exposure to challenging driving situations, studies have shown that these modifications have not been sufficient to eliminate their increased risk of crash involvement. Another measure, the Timed IADL (TIADL) test, provides an index of the time needed to successfully complete five tasks (e.g., finding a number in a telephone book, finding specific items of food on a grocery shelf). The time needed to complete the TIADL tasks is similarly reduced following speed of processing training among older individuals with impaired processing speed. Thus, speed of processing training has been found to generalize to important everyday abilities in addition to boosting cognitive ability.

4. CONCLUSION

Clearly, there are many aspects of cognition that can potentially decline as a part of the aging process, and some of these declines can affect performance of everyday tasks. There is a growing body of literature demonstrating that these declines can be prevented or slowed through changes in lifestyle. Progress also has been made in the area of cognitive training, indicating that cognitive decline is not necessarily irreversible during older age and that interventions may allow longer maintenance of cognitive function into older age. Furthermore, the fact that many cognitive declines are amenable to moderating effects implies that the independence and mobility of individuals can be extended into later life. In short, the outlook for preventing, delaying, or reversing the onset of age-related cognitive decline is bright.

See Also the Following Articles

Cognition and Culture ■ Cognitive Aging ■ Cognitive and Behavioral Interventions for Persons with Dementia ■ Dementia in Older Adults

Further Reading

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