Assistive Technology for Senior Adults Facing Cognitive Impairments:

Neuroscience Considerations

Roger P. Carrillo

Senior Advisor

Camanio Care, Inc.

Assistive Technology for Senior Adults Facing Cognitive Impairments: Neuroscience Considerations

Roger P. Carrillo

Senior Advisor

Camanio Care, Inc.

The United States population of senior adults, age 65 and over, is currently estimated at 48 million. This group of senior adults continues to increase at a record rate of 0.3 % per year. By the year 2050, the number of senior adults over age 65 and older is projected to grow to 88.5 million. Currently, it is estimated the U.S. population of senior adults comprises about 14.9 % of the country's population. By 2040, this segment of the population is expected to grow to about 20% of the total U.S. population. (U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau (2014). The anticipated U.S. senior population growth in the coming years and expected increase of seniors with age-related brain health conditions related to cognitive dysfunction will have a major impact on the country's geriatric health and long-term care system. Ongoing research is needed to develop appropriate and comprehensive clinical treatment of brain-related conditions resulting in cognitive dysfunction resulting from brain trauma or disease. In addition, development of innovative care facilities is necessary to meet the expected growing population needs in the U.S.

Due to the aging process, the older we are we will inevitably encounter mild to severe loss of our physicality, cognitive, sensory processing skills, memory problems and social interactive skills. The loss of one or more functional areas listed above may be related to brain trauma, pathological onset, or other factors occurring naturally due to aging (Kane, et al., 2005). Loss of these functions may have mild effects at early stages, however a combination of several

functions may result in major impairments to aging adults' abilities to live an active and independent life consequently resulting in long-term institutional care.

Brain Functional Areas Affected After Injury or Disease:

- Perception: Recognition and interpretation of sensory.
- Attention: Ability to sustain concentration, action or thought.
- Memory: Problems with short-term and long-term memory impairments.
- Motor Skills: Ability to mobilize our muscles and bodies and manipulate objects.
- Language: Skills allowing us to translate sounds into words and generate verbal output.
- Visual and Spatial Processing: Ability to incoming visual stimuli, to understand spatial relation, to determine relationship between objects and visualizing images and scenarios.
- Executive Functions: Abilities that enable goal-oriented behavior, such as the ability to plan and execute a goal including: flexibility, theory of mind, anticipation, problem solving, decision making, working memory, emotional self-regulation and inhibition (Michelon, 2006).

Early onset of memory problems may be minor and encompass forgetfulness or mild progressive loss of short-term memory. Of concern for persons experiencing increasing progressive memory problems is early onset of one or several of the Dementia conditions. Dementia is a broad category of brain diseases that may cause gradual decrease in the ability to think and remember, resulting in loss of functional skills and development of complex health-

related issues affecting abilities to live independently. It is estimated that five percent of the senior population will be affected by dementia and unfortunately it is usually a precursor to diagnosis of Alzheimer's disease. Alzheimer, a chronic neurodegenerative disease, starts slow and worsens over time or resulting in other neurodegenerative disorders that eventually result in death. The growing senior population and the presence of significant aging-related brain-related dysfunctional risks make it essential for the country's geriatric health and long-term care system to understand and consider neuroscience principles and their implications in evaluating and selecting tools and interventions necessary to effectively manage brain health and wellness strategies required in the person's home, senior living community, and long-term care facility.

Functional Assistive Technology for Active Life Activation: Neuroscience Considerations

Use of functional assistive technology in health and long-term care settings has been around for some time. Assistive tools and devices have evolved from simple tools for persons losing functional skills were initially used to compensate for impaired physical functional capacities or to compensate for loss of abilities for completing activities of daily living. We now see high-tech robotic equipment to assist persons with paraplegia for assisted mobility without a using a wheelchair. Functional assistive technologies also encompass a broad range of tools, devices, computer/digital technology or mechanical/robotic equipment that provide alternative functions creating opportunities for compensatory functional skills needed to interact with the person's environment. The use of computer-based "brain exercises" game-like applications using digitally-based puzzles and repetitive game exercises have gained use recently as ways to "exercise" the brain to maintain cognitive and other brain functions at highest levels. Virtual Reality (VR) devices have recently been introduced, both in the U.S. and internationally, for

research clinical trials designed to stimulate memory functions for elderly subjects using memory enhancement virtual reality programs.

Recently innovation and utilization of functional technology has introduced interactive and gamification strategies to increase activation of physical activity, cognitive processing, and social and interpersonal activities while using interactive functional technology may have positive outcomes for some persons experiencing progressive memory deterioration due to some dementia conditions, trauma, or other neurological disorders affecting brain function. Gamification is the application of game-design elements and game principles in non-game contexts and employs game design elements to improve user engagement and learning and enhance activation.

Activation is broadly defined by use of these action synonyms: stimulate, invigorate, refresh and energize. Encouraging a person with brain functional dysfunction who is experiencing little or no physical exercise, is lethargic or apathetic or is socially isolated to perform physical, cognitive, and socially-related activities that are stimulating, invigorating, refreshing and energizing may result in brain health benefits resulting in enhancement of brain neuroplasticity. A review of neuroscience research on neuroplasticity provides evidence of the brain's ability to change throughout a person's life due to the brain's ability to change neural pathways and synapses caused by factors such as the environment, behavior, and disease affecting neural processes.

Neuroscience of the brain's role in memory involves a highly complex process of encoding information, storing information and retrieving information through various structures of the brain. Memory is crucial to our experiences and are related to the limbic system located on both sides of the thalamus beneath the cerebrum. The limbic system supports a variety of

functions including emotion, behavior, motivation, long-term memory and olfaction. Short-term memory, also known as working memory, allows recall for a period of several seconds to a minute without rehearsal and its capacity is very limited (Eysenck, 2012)

The role of neuron cells is to receive, process and transmit information through electrical and chemical signals via synapses. Critical to maintaining memory function is the ability to transmit electrical and chemical signals throughout multiple brain structures. Unfortunately, trauma, disease, aging or other unknown factors may affect the brain's memory function and lead-up to serious conditions such as Dementia related conditions and Alzheimer's Disease. Fortunately, the brain is resilient and with a complex process called neuroplasticity the brain has the capacity to change and adapt by forming and reorganizing certain synaptic connections, especially in response to learning and external experiences or following injury. During such connection changes, the brain engages in synaptic pruning and deleting of neural connections that are no longer necessary or useful and strengthening the necessary ones (Bennett, E.L., et al. 1964).

Neuroscience research has identified the following fundamentals necessary for maximizing brain health and neuroplasticity:

- Human genetics does not determine the fate of our brains, a healthy brain functions on physiological, chemical and electroconductivity fundamentals.
- Physical exercise and increased physical fitness promotes brain health and functioning.
- Cardiovascular exercise brings the greatest brain health benefits.
- Cognitive and mental stimulation strengthens the connections between neurons and improves neuron survival and cognitive functioning.
- A larger and more complex person's social network promotes neuroplasticity.

Based on review of neuroscience fundamentals discussed above, the introduction of interactive functional technology for use by persons experiencing cognitive skills and memory deterioration due to aging, may prove beneficial to promoting neuroplasticity. This certainly warrants introduction of devices or tools at early signs of memory problems to help curb progressive deterioration of the person's memory by improving neuroplasticity.

One such device is demonstrating promise. The BikeAround™, a functional assistive device developed in Sweden has been used by aging seniors in some European countries during the past five years. Camanio Care, Inc., a U.S. subsidiary of Camanio Care, AB, headquartered in Stockholm, Sweden, introduced the BikeAround™ early Spring, 2018 to the U.S. senior community living arena. The BikeAround™ is designed to promote activation of physical exercise; cognitive skills; and interactive social engagement. The device uses an interactive exercise bicycle linked to a virtual visual video experience using Google's Street View® connection that is projected on a virtual video screen or a flat video screen. While the person exercises by pedaling the bicycle and controlling its handle bars, the images are displayed on the JDome® virtual screen or a flat LED screen and guides the direction on the screen as driven by the user. A family member, friend, or a staff attendant may standby to assist the user and to engage in conversation about the locations being toured and viewed. In summary, activation activities prompted by the using the BikeAround™ results in multiple brain interactive functions controlling the person's physicality by requiring use motor skills while use of feet, legs, arms and hands as the user "pedals and drives" the BikeAround™. The user's cognitive processes are in full mode and the person's brain is multitasking using sensory feedback, problem solving, executive functions, working memory and prompting memories from experiences recalled from the scenes on the screen. Socialization is occurring when the user shares memories and is

reminiscing with the persons standing by and engaged in the user's experience. Users are motivated to return to the BikeAround experience and look forward to finding new places to visit or to explore new locations from around the world. Exercise time is increased by providing longer periods on the bike and more frequent use daily.

Conclusion

Camanio Care's BikeAround™ is designed to promote "active life" activation for persons reaching the early stages of aging or persons later in life entering senior care communities or other long-term care facilities. The BikeAround™ makes physical, cognitive, and socialization activation simple and fun. It creates an interactive experience that improves everyday life and provides opportunities to share memories and experience with friends, family and personnel providing assistance. The social experience is a major aspect of this person-centered activation. Combining physical activity to increase heart rate and endorphins resulting in greater enthusiasm and motivation. Reminiscing and sharing memories with others results in decrease of depression and provides for better sleep.

Ongoing assessment of clinical outcomes during pilot and clinical trials are promising and further research is needed and encouraged from facilities and university research projects using this devise. Feedback is favorable from user's family members and facility personnel and its utilization demonstrate increased engagement by users in operating the BikeAround™. There is notable increased exercise time using the BikeAround™. After using devise there are useful periods of reminiscing of locations visited by the user during and after BikeAround™ sessions. Clinical outcome studies are encouraged as more BikeAround™ studies are undertaken by researchers. In addition, neuroscience research efforts are needed to identify what

neuroplasticity changes are necessary and to determine if positive and consistent cognitive changes are noted within the brain and the degree of memory improvement is demonstrated during active life activation.

References

Bennett, E.L., Diamond, M.C., Krech, D., Rosenzweig, M.R., (1964). "Chemical and Anatomical Plasticity of the Brain". *Science*, 146: 610-619.

Eysenck, M.W. (2012) Fundamentals of Cognition. New York, NY. Psychology Press.

Kane R.L., Priestler, R, & Totten A. M. (2005). Meeting the Challenge of Chronic Illness. Baltimore, MD: Johns Hopkins University Press.

Michlon, Pascale, (2006). What are Cognitive Abilities and Skills, and How to Boost Them. *SharpBrains.Com.*

Pascual-Loeone, A, Amedi A., Fregni, F., Merabet, L.B. (2005). "The plastic human brain cortex". *Annual Review of Neuroscience. 28. 377-401.*