CSM Tuesday, January 22, 2013

The Anne Shumway-Cook Lectureship—The Brain Is Plastic: A Pathway for Guiding the Future of Physical Therapy

Time: 8:00 am–10:00 am (See Program for Room)

Speakers:

Nancy Byl, PT, PhD, MPH, FAPTA, Professor Emeritus, UCSF, School of Medicine, Department of Physical Therapy and Rehabilitation Science

Michael Merzenich, PhD, Professor Emeritus, UCSF, School of Medicine, Department of Physiology and Head and Neck Surgery, Director of Research, PositScience Corporation

Level: Multiple Level

This lecture will capture the excitement, opportunity and timeliness created for the physical therapy profession to make a paradigm shift in leadership in health care delivery based on changes in population demographics, the physiology of aging, the importance of exercise and the exciting evidence supporting neuroplasticity for positive health and recovery post injury/disease.

Objectives

Upon completion of this lecture, the attendee will be able to:

- Briefly describe the history of the development of the profession of physical therapy
- Summarize the characteristics of a professional
- Outline the changes in demographics relative to the population
- Summarize the physiology and neuropathology of aging
- Highlight the history and evidence supporting the plasticity of the nervous system
- Provide ideas about how basic neuroscience can be integrated into clinical practice to improve outcomes
- Briefly summarize the potential for physical therapists to improve access and outcomes of health care
- State the key points supporting neuroplasticity as the foundation for growing the profession of physical therapy.

LECTURE

I. Introduction (Byl and Merzenich) 45 minutes

A. The Development of the Physical Therapy Profession and New Opportunities for Physical Therapists (Byl)

B. New Opportunities for the Profession of Physical Therapy

1. The population of elderly is increasing with increasing health care demands due to the natural physiological effects of aging
2. Exercise is the best conservative medical treatment for physiological, psychological and cognitive benefits
ii. “Exercise is Medicine” Program (AMA) – MDs should/must discuss importance of integrating regular exercise for all of their patients (AMA, 2008)

iii. Healthy People 2010- It is the responsibility of society and the individual to keep the brain and the body fit (Dept. HHS, 2009)

3. The brain revolution of brain plasticity; the healthy and damaged brains can change with training

II. Taking Action to Advance the Profession: Integrating exercise and neural adaptation principles into clinical practice (Byl and Merzenich) 45 minutes

A. What should the new health care system look like? (Byl and Merzenich)

B. What Barriers Need Attention to Enable the Growth of the Physical therapy Profession (Byl and Merzenich)

C. Integrating science into practice is still a necessity: Examples Merzenich

III. How will we know if we are Successful? (Merzenich) 10 minutes

IV. Summarize the keypoints of growing the physical therapy profession today: Physical therapist and neuroscientist perspective- 5 minutes

V. Questions, answers and discussion 15 minutes

LECTURE CONTENT

I. Introduction (Byl and Merzenich) 45 minutes

A. The Development of the Physical Therapy Profession and New Opportunities for Physical Therapists (Byl) 10 minutes

This marks my 50th year as a physical therapist. Like many of you, I have participated in the growth of knowledge, the application of science to clinical practice and ultimately the steady growth of physical therapy as a profession. Historically, our profession has developed by “seeing a need” and “filling it”. During the first World War, nurses and physical education individuals were called to duty to treat injured soldiers. This led to the development of the first physical therapy educational programs (1921). More educational programs developed in the 40’s to supply physical therapists to rehabilitate patients from World War II as well as rehabilitate patients with polio. As medical care has increased, there has been an increase in the survival of patients with once fatal birth defects, traumatic birth deliveries, stroke, brain trauma, spinal cord injuries, degenerative disease and cancer. Not only has the demand for physical therapists increased, but with increasing complexity of impairments across multiple body systems, there has been an increased need for more indepth and breadth of knowledge and scientific inquiry. Catherine Worthingham, PhD, PT not only provided leadership as the President of the American Physical Therapy Association, but she provided the research evidence to expand the number of educational programs in physical therapy as well as elevate the level of education from a baccalaureate to a master’s degree. Today a doctoral degree is required to obtain licensure to practice. In the process, the Allied Health Professions Training Act was passed. Then, with continued investment of time and effort, the Commission on Post Secondary Education recognized the Commission of Education of the APTA as the accrediting body for physical therapists and physical therapist assistants instead of the early accreditation process with the American Medical Association.

There is a saying that technicians work to earn and professionals earn to work. A professional is an expert with a special area of knowledge and expertise who produces high quality work (e.g. products, services, creations, presentations, consultancy, scientific inquiry, research, administrative leadership, or art). A professional typically develops to meet a need in society or fill a niche relative to an individual or a community. A professional is expected to have high standards of ethics, morals, behaviors and work activities that protect individual privacy and confidentiality. A professional is also expected to provide sincere and long term commitment to clients. A professional must also be positively motivated to do a good job and maintain creativity in problem solving to best serve the client, the community and the profession. Further, a professional must ideally establish appropriate team relationships with the similar expertise as well as with those representing complementary expertise.
Physical therapists are professionals who bring an expertise in education, diagnosis, problem solving, intervention and scientific inquiry regarding physical activities, therapeutic exercise, learning based training paradigms and assistive technology to the health care team. Physical therapists are prepared to evaluate, analyze, problem solve and treat problems of movement dysfunction consequent to acute and chronic conditions in patients across the lifespan. Uniquely, physical therapists are particularly skilled to address impairments in movement secondary to genetic differences, trauma, disease and aging across the life span. The professionals in physical therapy are committed to work as part of a team to educate the individual and the community about positive health as well as increase client accessibility to high quality, sensitive services designed to decrease risks of disease, reduce impairments and disabilities and improve independence and quality of life across the life span. The physical therapist is also prepared to assist patients recover from impairments associated with disease and trauma.

With health care reform, scientific discoveries about exercise and the brain revolution, physical therapists have an exciting and unique opportunity to grow the profession and improve the health of our nation. Physical therapists will need to assume a prospective and aggressive a new role as primary health care practitioners. In this role they will need to have early access to patients to facilitate prevention, wellness and maintenance of function despite aging or disease related impairments.

B. New Opportunities for the Profession of Physical Therapy

Physical therapists have the opportunity to create a paradigm shift in health care delivery. With an emphasis on therapeutic, moderate, aerobic and task oriented exercises early to prevent illness, counter the physiological effects of aging and maximize function, physical therapists should be expected to see individuals within primary care resiliency exercise clinics. At least three major evidence based changes are creating the opportunity for physical therapists to take the lead in creating a new health care model to increase availability of services, reduce health care costs and improve outcomes.

The first important change is that the population is aging and aging alone can be associated with physiological challenges that can compromise independent function. The second change is that the American Academy of Sport Medicine, the American Heart Association, the AMA and the Department of Health and Human Services now agree that regular exercise is important to positive health and disease management and that individuals must be given the responsibility to keep their brain and body fit. Third, the brain revolution of brain plasticity provides evidence that the healthy, the aging and the damaged brain can change with training.

1. Increasing Numbers of Elderly

The dynamics of the aging population are affected by many variables but age is important. The first major increase in the elderly was in 2011 when the baby boomers reached 65 years of age. This older population is projected to double from the 36 million in 2003 to 72 million in 2030, this is an increase from 12% to 20% of the population. (US Census Bureau 65+ in the US: 2005. US Census Bureau, POPHQ-5H185, 4600 Silver Hill Road Washington, DC 20233) The needs of this population will vary by geography, economics, gender and race. However, without specific intervention and attention to physical activities and learning based exercises, there is evidence based documentation of physiological pathology with aging. This pathology of aging can lead to serious medical problems and expensive health care services.

The bad news is that with increased age, for most older individuals, there is a marked deterioration in physical and mental performance. Normally, one can expect some objective changes expressed in terms of: weakness, decreased flexibility, joint degeneration, decreased balance/slower reflexes, decreased safety in transitional movements, increased falls, osteoporosis, increased healing time and pain. With aging, there is also marked degradation in behavioral performance abilities, expressed in terms of: increased habitual behaviors, decreased variety and coordination of actions, forgetfulness, isolation, depression, and sleep problems. These behavioral changes are paralleled by a physically deteriorating brain differentially expressed in the ‘default networks’ of the cerebral cortex, marked by a variety of signs including: physical shrinkage manifesting as neuroripil reduction (synaptic reduction; dendrite and axonal dis-elaboration), neuron loss, emergent pathology (amyloid plaques, neurofibrillary tangles, associated local damage), increased numbers and activation of astrocytes, alteration in selective growth factors (BDNF; BGNF) and modulatory neurotransmitters (dopamine, norepinephrine, acetylcholine, serotonin, et alia).

2. Exercise is the Best Conservative Medicine for Healthy Aging

The evidence can no longer be ignored. Both the American Heart Association and the American Academy of Sports Medicine report that exercise improves health in older individuals (Nelson et al, 2007). The AMA has established a program referred to as Exercise is Medicine. This effort states that MD’s must discuss the importance of integrating regular exercise for all of their
patients (AMA 2008). Healthy People 2010 states that it is the responsibility of society and the individual to keep the brain and the body fit (Dept HHS 2009).

In terms of exercise, the evidence clearly supports that exercise, physical activities and learning based task specific training can preserve memory, flexibility, strength, posture, balance, sensory accuracy and coordination. Further, the evidence supports that aerobic exercise and forced intense rigorous can stimulate brain growth factors, norepinephrine, neurotransmitters, insulin growth factors, dopamine as well as increase oxygen delivery to neural tissues. Even moderate exercise can maintain the length of telomeres (DNA measurement of aging) as well as enhance endorphins for natural management of pain and depression. Aerobic exercise also maintains cardiopulmonary capacity, decreases cardiopulmonary disease, digestive problems, renal disease, diabetes and cancer. Why wouldn't individuals want to execute this type of "medication" that is inexpensive and does not require a physician prescription???

3. The Good News: We Live in the Early Days of The Brain Revolution (Merzenich) 25 minutes

We now know that there are many positive things we CAN do to manage and improve our adaptation to aging. Dr. Michael Merzenich has been a leader in the scientific development of brain plasticity. He will review the history of the discovery of brain plasticity, and outline our new understanding of how neuroplasticity processes underlie skill acquisition in the child and adult brain. He will summarize how this growing neuroscience subdiscipline provides a new understanding of the origins of the neurological abilities that define our Personhoods, and shall explain how plasticity science provides us with a new and more complete understanding of the neurological origins of the expressions of chronic neurological and psychiatric impairments and illness. Dr. Merzenich shall also explain how he and his scientific colleagues have worked to "harness the Genie" by developing learning-based activities as medicine to help neurologically limited or disabled populations. He will then specifically document evidence supporting the effectiveness of learning based therapies to grow resilience against end-of-life catastrophes represented by Alzheimer's and Parkinson's Disease, as well as facilitate healthy aging, mental alertness and refined and elaborate physical abilities all across the lifespan.

Dr. Merzenich will also explain how new learning-based tools can be delivered with high effectiveness and impact in a professionally monitored setting on the 'front-lines' of medical treatment by neurologically-directed physical therapists. He shall specifically focus on strategies designed to first identify, then increase neurological resilience, in individuals at risk for more serious neurological and psychiatric problems, explaining how the physical therapy community and related professional colleagues could play a central role in delivering these new forms of help to the many millions of individuals in need -- and thereby potentially revolutionize medical care for the neurological patients that you now serve.

II. Taking Action to Advance the Profession: integrating exercise and neural adaptation principles into clinical practice (Byl and Merzenich) 10 minutes

At CSM 2012, the Anne Shumway Cook lecturer, Carolee Winstein, PhD, PT, FAPTA and her panel focused on the challenges of integrating basic science findings into the clinical practice of physical therapy. This lecture reviewed the basic principles of research and limitations of applying basic science findings relative to many variables such as Type I and Type II errors, statistical versus clinical significance, effect size, expense of randomized clinical trials and other concepts. We have spent millions of dollars on small randomized clinical trials. Albeit we have found statistically significant findings that have changed practice, but the effect sizes are small (maybe making 25% gains above what would have occurred without intervention).

These challenges cannot be ignored and should be considered as an integral part of this current presentation. The success of the physical therapy profession in making a paradigm shift will take initiative, enthusiasm, creativity, problem solving, commitment and drive by each physical therapist. Each practicing therapist will need to be familiar with the evidence principles of exercise, neural plasticity and learning based training. Further, each therapist will need to creatively learn to integrate these principles across the life span (pediatrics to geriatrics), cultures, genders and type of dysfunction (cardiopulmonary, metabolic, musculoskeletal, neurological injury, neurological degenerative conditions). Therapists will also have to integrate the science of exercise and plasticity across body segments (upper limb, lower limb, trunk, face), types of exercise (e.g. gait, balance, aerobic, forced intense exercise, strengthening, flexibility, balance training, sensory training) and strategy of training (e.g. forced use, task practice, mental imagery, mental practice, guided imagery, virtual game playing, magnetic stimulation, neuromuscular stimulation paradigms, biofeedback, robotic technology). Therapists will also need to determine how to become primary care providers within different settings, from home to rural gathering places, from outpatient health care settings to inpatient settings, and from progressive living to skilled nursing.
Physical therapists should be the professionals of choice to integrate the evidence on aging, exercise and brain plasticity into health care to facilitate positive health, healthy aging, mental well being, functional independence and quality of life. Although the cardiopulmonary system, the genitourinary system and the digestive system are critical to life and the musculoskeletal system is essential for independent movement over ground. The brain and its central and peripheral connections are critical to cognition, emotions, balance and mobility. Thus, the plasticity of the nervous system must be considered a primary driver for the forward movement of the profession of physical therapy.

Dr. Merzenich and I created a paradigm shift back in 1991, suggesting that the etiology of focal dystonia was not psychological but behavioral. We created a model of focal dystonia that was not based on genetics but driving abnormal learning. This perspective led to even the most scholarly clinicians to try to prove our hypothesis was wrong. Rather, the evidence has only continued to elaborate on our findings.

Thus, physical therapist individually, together as a profession and with the support of our professional association (APTA) are capable of creating a paradigm shift where physical therapy professionals are entry level primary providers. Physical therapists can no longer be thought of a “last ditch effort” to restore function post injury or disease, or prevent hospitalization, surgery or joint or organ replacement. If services and products included in the health care agenda do not include physical therapy as part of primary care as well as recovery, the agenda should not be approved by the FDA, Medicare, Medicaid or private insurance. Physical therapists must be primary care providers introducing “resiliency training” to maintain healthy function and integrating group appointments, wireless technology and assistive orthotics to improve health at reduced costs.

A. A Perspective : What should the new health care system look like? (Byl and Merzenich)

Byl 10 minutes

New primary care resiliency exercise clinics should be set up in rural and urban areas to screen patients (regardless of age) who lack medical care services. The screening and the patient evaluations would be done by physical therapists. It would be ideal in this setting, if there were also evaluations by dental hygienists, audiologists and social workers. Ideally, by phone, physicians should be available for consultation if needed and medical clinics should be available that would be willing to see patients as needed. Exercise programs should be in printed form, on CDs or online, pre fabricated assistive devices should be available, instructions on nutrition should be ready to hand out and hearing amplifiers should be tried. Supervised sessions of aerobic exercise and learning based activities might be available for a limited number of sessions.

In outpatient clinics, health maintenance organizations, progressive living facilities, senior citizen centers, primary care resiliency exercise clinics should be established by physical therapists. Direct access issues would not be a problem because the access would be for wellness, not illness. Even if a patient had a known chronic disease, this intervention would be for positive health. These clinics could begin by targeting the population over the age of 55 years. All individuals over 55 years of age would be referred to a primary care resiliency clinic. The physical therapist would have a physical examination to determine the appropriate program for exercise, learning based activities, nutrition, hydration, stress management and sleep. A similar clinic could be available for all individuals with chronic disease (regardless of age). Similarly, resiliency exercise clinics should be available for children to identify early developmental delay, impaired learning or difficulties with head control, sitting balance, transitional movements and/or gait. During adolescence, it is also important to decrease obesity and metabolic disease like diabetes with exercise to complement needed medications.

The physical examination and the recommended exercise programs would be tailored to the patient’s condition. Evidence based guidelines of physical therapy practice would be implemented. If patients were found to have medical “red flags”, they would be referred to a physician, preferably an onsite physician who could provide additional medical and laboratory testing. In the rural community, it may be necessary to set up an acute drop in clinic to handle those with “red flag” signs and symptoms.

In addition to teaching patients what type of exercises are needed, how to do the exercises, and how to integrate these exercises at home or in a community setting, some individuals, particularly, those at risk for falling, those with acute conditions requiring manual intervention strategies complemented with exercise, and those with cognitive impairments might be better served by attending supervised individual or group exercise programs to provide time to individualize the intervention, enhance compliance and assure safety. All participants with cognitive impairments and those over 55 years
of age would be encouraged to maintain an active lifestyle with regular learning. Some may benefit from participating in established memory training programs available online from PositScience, Lumocity.com, iphone applications (Fruit Ninja, Bubble Ball, Four in a Row, Mouse Maze etc) and others. For those recovering from acute trauma or insults such as a stroke, perhaps an *Olympic Learning Based Village* could be created where the patient and the family could live together to learn how to most effectively integrate learning based exercises for recovery of independence and quality of life.

To support this program of exercise and learning based positive health, food stamps could be restricted for use only for healthy foods. Perhaps, leading edge or experimental treatments might have to be accessed by requesting the individual to agree to participate in a study or paying out of pocket to achieve this new treatment. Receiving surgical intervention (e.g. spine surgery, joint replacements) may need to be negotiated based on compliance with conservative strategies (e.g. consistent exercise, medication and diet compliance etc).

For those who are actively non-compliant with an exercise or learning based program and prefer to take prescription medications instead of investing in a healthy foundation for treatment, it may be necessary to increase the inconvenience of receiving these medications. These inconveniences may be a higher price, paying a higher co-pay, having to stand in long lines to fill the prescription, having to renew the prescription more often.

**The vision of a neuroscientists for the next health care delivery system Merzenich 10 minutes**

Dr. Merzenich will describe his positive perspective as a neuroscientist who has not only been an innovative scientist in neuroplasticity research, but a unique scientific leader who had applied his science to improve the community. Following his discoveries about auditory processing, he led the way to create a multi channel cochlear implant. Then he applied his findings on neuroplasticity findings in the auditory and sensory cortex to improve our understanding of dyslexia and schizophrenia. With this foundation of science, he worked with others to create one of the first educational programs for children with dyslexia (Scientific Learning). He went on to discover more about the aging brain, memory and cognition and helped create PositScience to maintain learning and cognition in aging individuals and those with Alzheimer's, Brain Trauma and Autism. He will talk about how the profession of physical therapy should think outside the box to maximize what we know about neural plasticity to change the delivery of health care to maximize function.

**B. What Barriers Need Attention to Enable the Growth of the Physical therapy Profession (Byl and Merzenich) 15 minutes**

(Byl) **7 minutes**

There are some practical limitations to integrating the principles of plasticity to clinical practice. Probably the biggest limitation is reimbursement for services. Second is getting administrators and physicians to accept physical therapists as part of the primary care team. Third is to create a primary care model of early intervention in a variety of settings. Fourth is achieving patient commitment and compliance (e.g. number of repetitions, progression of difficulty, duration of intervention, timing of intervention.) These limitations could be minimized through legislative initiatives to negotiate contracts, agreements and reasonable reimbursement from payers. For example, it might be possible to initiate a program within the continuing education center of an HMO like Kaiser Permanente. It might be possible to negotiate reimbursement for a limited number of early PT visits with other health care organizations (e.g. Sutter Health, Hill Physicians, Brown and Toland).

It is anticipated that health care costs would be reduced if exercise based interventions were expanded at the front end rather than at the tail end of the health care spectrum. The concepts of this resilience exercise training could also be incorporated into group health care visits for patients with known disease or injuries. This would involve creating an opportunity for the family and the patients with similar challenges (e.g. weight problems, diabetes, multiple sclerosis, Parkinson’s disease, stroke, neurodegenerative disease (e.g. ALS, PLS), psychological disorders and those with Alzheimer’s Disease) to see the physician, the psychologist, the physical therapist, the occupational therapist, the speech therapist and the nutritionist at the same visit.

Integrating existing technology about exercise performance could also be helpful. Patients could be asked to wear “fitbit” to monitor endurance. Creating more handouts for send home with patients, specific videos demonstrating the exercises to follow, camera feedback images to correct performance and making sure voice activated systems are
available to have patients call for help (e.g., robotic monitoring systems detecting a stray from usual activities (e.g., programming the Rhomba vacuum cleaner to follow patients in usual activities, take BP and HR) may also improve compliance and successful outcomes. The therapist may also arrange face to face meetings with individual patients as well as groups of patients to talk about problems and also about what has worked well for some (e.g., Skype).

Another priority would be to assure that evidence-based guidelines were integrated into common treatment paradigms. Intrusive procedures and life-saving, heroic interventions should be contingent on patient collaboration and cooperation with early conservative intervention strategies. Hospitals should include prevention and maintenance as part of their mission and not just be focused on providing acute crisis-oriented care. Thus, resiliency exercise clinics should be created within hospitals as well as community centers.

Emphasis on positive exercise-based resiliency clinics should improve health and reduce health care costs. Ideally, this positive attention to intervention would help prevent what is currently being proposed in England. Although England has been a leader in universal health care, today they too are having challenges. In order to save billions of dollars, administrators have decided it is okay for patients to wait for up to two years for joint replacements. In addition, with new technology, the policy makers have decided that primary care physical examinations can be self-administered using cameras and wireless-based testing devices with possibly camera-based interviews to minimize the expensive time required by physicians to see patients.

Others have suggested that the health care industry operate like the automobile industry. All interventions have a sticker price. This sticker price type system could be initiated in health care. In some ways this is how the values for reimbursement by CPT code have been determined. Unfortunately, the car industry went bankrupt in 2012 and had to be bailed out by the government. In addition, the CPT codes are determined behind closed doors.

Merzenich 8 minutes

Many of the other barriers to a paradigm shift in providing health care involve financial profit, personal motivation and psychosocial issues. Some of these issues impact providers, some impact patients others impact scientists. Still others are impact established administrative models. For example, sometimes, professionals focus on how to bill to bring in the most money. The frustration of billing has been so powerful for some professionals that they have lost their commitment to discovery. They have lost the excitement and pleasure about helping others. Many have lost their creativity for problem solving to address patient needs. If the provider cannot connect with the patient in this effort of positive health then it is unlikely the patient will climb on board to support this novel model of health care.

Poor patient commitment to positive health, lack of curiosity, negative expectations and poor interpersonal interactions can be major challenges to achieving positive health. Many patients, particularly those who are economically deprived may be discouraged and unwilling to take responsibility to be healthy. On the other hand, these resiliency clinics must be culturally sensitive.

Some of the barriers to maximizing health outcomes may also arise because of limited collaborations between basic scientists and clinicians, not only in integrating the outcomes of research but designing the next research studies. In other cases, shortcomings may occur because of the failure to integrate current technology to foster creativity, compliance, fun and surprise within each visit as well as to provide objective feedback about progress.

C. Integrating science into practice is still a necessity: Examples Merzenich 10 minutes

The success of the physical therapy profession will also be enabled by making sure physical therapists team with basic science researchers to advance the understanding of basic physiology. In addition, basic science researchers and clinical scholars need to clarify the principles of guidelines to practice such as timeliness of intervention, intensity of intervention, compliance of learning activities, surprise, fun and feedback of learning and integration of learning into daily activities. Electronic data bases need to be incorporated into practice to enable monitoring of outcomes and the development of clinically relevant studies needed to modify practice parameters and study outpatient costs.

Physical therapists will also need to collaborate with engineers to shape the development of new technology and study effective integration of technology as part of therapy and daily behaviors. Today we have exception
opportunities to use existing technology such as smart phones and wireless to enhance home compliance and patient and family commitments.

It is also important to remember that if this paradigm shift of positive health through resiliency training is successful, then the profession will need to address supply and demand issues. A lot more physical therapists, physical therapist assistants and physical therapist aids. The profession needs to be planning for this now, with the positive expectations for success.

III. How will we know if we are Successful? (Merzenich) 10 minutes

There are a variety of ways that success can be monitored. The emphasis must be on effectiveness and improved outcomes following the proposed paradigm shift of early integration of the principles of exercise and learning based training. The outcomes must be objectively measured. Some of the outcomes can be monitored by relatively inexpensive epidemiological and clinical tools. On the clinical side, there should be measured rewards for patients complying with learning based exercise paradigms:

- Decreased costs of health insurance
- Decreased utilization of health care services (physicians, inpatient admissions, number of allied health visits)
- Decreased costs of rehabilitation services
- Improved ability to manage independently at home
- Improved clinical performance parameters (gait speed, endurance, balance)
- Decreased number of falls
- Decreased severity of injury post fall
- Improved functional independence (CAFÉ 40, Stroke impact Scale, FIM)
- Increased age
- Decreased cases of Alzheimers Disease
- Decreased number of hospitalizations
- Decreased costs of automobile insurance and decreased accidents
- Decreased use of extended care facilities and skilled nursing homes
- Increased number of individuals working or volunteering

Laboratory measurements to monitor

- Neuromaging changes: maintained complexity of synapses and dendrites (connectivity)
- Mental status
- Depression
- Maintained telomere length
- Improved Mental status exams
- Increased norepinephrine, dopamine, BDNF
- Acetylcholine levels
- BDNF, EGF, NGF, et al
- Among many others.

IV. Summarize the keypoints of growing the physical therapy profession today - 5 minutes

The perspective of a neuroscientist (Merzenich)

The perspective of a scholarly physical therapy clinician (Byl)

V. Questions and Discussion (Merzenich and Byl) 10-15 minutes
References

36. Rapp PR and Gallagher M Preserved neuron number in the hippocampus of aged rats with spatial learning deficits Proceedings of the National Academy of Sciences of the USA 1996 93;9926=9930
38. Morrison JH and Hof PR Life and death of neurons in the aging brain Science 1997 278:412-419