It is estimated that there are about 100 billion neurons in the human brain, with a potential 100 trillion connections. Those are very, very large numbers... almost too big to comprehend. To put numbers like this into perspective, consider your spending habits. If you decided to really splurge and spend one million dollars per day, even if you had started at the time of Jesus you still would not have spent a trillion dollars! However, these incredible numbers do not even come close to describing the amazing stuff housed inside those skulls of ours.

Back in 2004, the title of the April issue of Scientific American read, “Has Science Missed Half the Brain?” Who knew that before ’04 we were only running on half power?! In reality, those bits were always there but the title may have been somewhat inaccurate. The “half” of the brain that was missed may be as much as 80% or 90% of the brain. These overlooked morsels our minds are not neurons, in fact they were judged to be mere supportive material since we first began to peer into the mysteries of the brain. If you haven’t guessed yet, the parts of the brain being referred to are collectively known as glia (Greek: γλοια “glue”). However these glia are a far cry from your basic biologic glue, much more like the latest hi-tech superglue.

Although it is likely that glial density varies throughout different parts of the brain, reported figures have varied from about 1:1 up to 10:1 (glia:neurons). A single glial cell (astrocyte) can interact with as many as 140,000 synapses. Glia come in many different flavors (see Table 1), and are now recognized as playing leading roles (vs just the supporting cast) in brain function including the ever popular notion of neuroplasticity. Glia do provide support to neurons including construction and repair of myelin, transport of nutrients and support immune responses in fighting off CNS invaders. However, in the past 2 decades a large body of literature has shown they also are responsible for formation (synaptogenesis), maintenance and pruning of synapses, mediation of immune responses within the
Big Numbers and Pain
continued from page 1

nervous systems and can communicate to both neurons as well as other glia. Douglas Fields, actually referred to neurons as the architectural substrate for glia in his book The Other Brain.

HOW DO GLIA MATTER IN THE CLINIC?
The scientific and medical communities are becoming more aware of the extensive roles which glia play in normal function of the nervous system, neuroplasticity, pain amplification and induction of persistent pain. Glia mobilization can be initiated by injury, but enhanced through opioid exposure and contributes to opioid-induced hyperalgesia, dependence and withdrawal. Preclinical research has demonstrated that glia are responsible for many of the processes which further activate immune and inflammatory responses following injury as well as induction of neuropathic processes and central sensitivity. In animal models of spared-nerve injury, peripheral glial cells become activated and proliferate within hours of injury. Microglia in the spinal cord ramp up their endeavors in a few days, and astrocyte expression may not peak for several months post injury. Features like these have prompted some researchers to hypothesize that chronic pain might actually be a gliopathy!

To date, clinical trials using pharmaceutical agents to modulate glial activity have had mixed results. However, a favorite intervention and potent immune-function modulator has already shown great promise in preclinical studies... exercise! In a rodent model of spared-nerve injury, rats were trained using a graded progression of aerobic swimming. Starting with only 10 minutes of aerobic exercise, and slowly increasing to 50 minutes per day over a 5 weeks training period, a substantial reduction of neuropathic pain was noted. In fact, the authors reported that the exercise program actually reversed the mechanical hypersensitivity generated from the nerve injury, with improvements continuing for more than a month post-intervention. The mechanism behind this intervention was normalization of nerve growth factor (NGF) levels, brain-derived neurotrophic factor (BDNF) expression and a dramatic reduction in astrocyte and microglia hyperactivity in the dorsal horn. So it seems while glia may be fantastic future targets for pharmacotherapy, there is already useful, available and powerful tool for amelioration of persistent pain...appropriate, graded aerobic exercise.

Armed with this new understanding of the amazing capabilities of this CNS superglue, clinicians should not underestimate the potential for skillfully applied exercise to significantly alter clinical outcomes. And the key message for your patients... Keep moving! Exercise might be the next “disease-modifying therapy”!

TABLE 1. TYPES OF GLIA AND BASIC ROLES

<table>
<thead>
<tr>
<th>Glia Type</th>
<th>Basic Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microglia</td>
<td>These specialized immune cells are similar to macrophages and are capable of phagocytosis of CNS invaders. They also serve as part of the early warning system post nerve injury activating and proliferating within 2 days post nerve injury to further mobilize immune response, alter sensitivity in inflammatory pain and contributes to the development in neuropathic pain.</td>
</tr>
<tr>
<td>Astrocytes</td>
<td>These star-shaped cells are the most numerous cells in the CNS. Astrocytes (multiple different types) perform many functions in the CNS including: regulation of synapses, neuronal metabolic support, formation of blood-brain barrier, neural repair, activation of oligodendrocytes, modulation of neuronal blood flow and roles in neuroplasticity. They also have a close bond between CNS pre and post-synaptic terminals that has been referred to as a “tripartite synapse”. Considering latent expressions of symptoms in neuropathic pain, astrocytes become increasingly active 2 weeks to 5 months post nerve injury!</td>
</tr>
<tr>
<td>Oligodendrocytes</td>
<td>There are multiple sub-types of these cells, the myelinators of CNS axons, including oligodendrocyte precursor cells/progenitors which can migrate to re-myelinate areas of damaged nerve. Oligodendrocyte may be one of the more vulnerable of the glia, and are susceptible to glutamate toxicity (as they express NMDA and AMPA receptors) and immune modulators (including TNFα, IFNγ and others)</td>
</tr>
<tr>
<td>NG2 glia</td>
<td>NG2 chondroitin sulphate proteoglycan glia are almost as numerous as astrocytes, and may serve similar roles to astrocytes (see above). They express ion channels and receptors for CNS neurotransmitters but can also generate oligodendrocytes.</td>
</tr>
<tr>
<td>Schwann cells</td>
<td>Peripheral nervous system version of an oligodendrocyte, it is the myelin factory for peripheral nerves and removes axonal debris to allow neuronal regrowth</td>
</tr>
<tr>
<td>Satellite cells</td>
<td>Part of the peripheral nervous system early warning system, these glia become active within hours of nerve injury and contribute to alterations in sensitivity, inflammation and induction of neuropathic pain.</td>
</tr>
</tbody>
</table>
REFERENCES:


5. Fields RD. The Other Brain. New York: Simon and Schuster; 2009. (page 265)


Factors Associated With Work Ability in Patients Undergoing Surgery for Cervical Radiculopathy

OBJECTIVE. To investigate the factors associated with work ability in patients undergoing surgery for cervical radiculopathy.

SUMMARY OF BACKGROUND DATA. Surgery is a common treatment of cervical radiculopathy in people of working age. However, few studies have investigated the impact on the work ability of these patients.

METHODS. Patients undergoing surgery for cervical radiculopathy (n = 201) were recruited from spine centers in Sweden to complete a battery of questionnaires and physical measures the day before surgery. The associations between various individual, psychological, and work-related factors and self-reported work ability were investigated by Spearman rank correlation coefficient, multivariate linear regression, and forward stepwise regression analyses. Factors that were significant (P < 0.05) in each statistical analysis were entered into the successive analysis to reveal the factors most related to work ability. Work ability was assessed using the Work Ability Index.

RESULTS. The mean Work Ability Index score was 28 (SD, 9.0). The forward stepwise regression analysis revealed 6 factors significantly associated with work ability, which explained 62% of the variance in the Work Ability Index. Factors highly correlated with greater work ability included greater self-efficacy in performing self-cares, lower physical load on the neck at work, greater self-reported chance of being able to work in 6 months’ time, greater use of active coping strategies, lower frequency of hand weakness, and higher health-related quality of life.

CONCLUSION. Psychological, work-related and individual factors were significantly associated with work ability in patients undergoing surgery for cervical radiculopathy. High self-efficacy was most associated with greater work ability. Consideration of these factors by surgeons preoperatively may provide optimal return to work outcomes after surgery.

Role of Adult Hippocampal Neurogenesis in Persistent Pain.

The full role of adult hippocampal neurogenesis (AHN) remains to be determined, yet it is implicated in learning, emotional functions, and is disrupted in negative mood disorders. Recent evidence indicates that AHN is decreased in persistent pain consistent with the idea that chronic pain is a major stressor, associated with negative moods and abnormal memories. Yet the role of AHN in development of persistent pain has remained unexplored. Here we test the influence of AHN in post-injury inflammatory and neuropathic persistent pain-like behaviors by manipulating neurogenesis: pharmacologically through intracerebroventricular infusion of the antimitotic AraC; ablation of AHN by x-irradiation; and using transgenic mice with increased or decreased AHN. Downregulating neurogenesis reversibly diminished or blocked persistent pain; oppositely, upregulating neurogenesis led to prolonged persistent pain. Moreover, we could dissociate negative mood from persistent pain. These results suggest that AHN mediated hippocampal learning mechanisms are involved in emergence of persistent pain.
SAVE THE DATE FOR OUR CLINICAL CONFERENCE 2016

CHRONIC LOW BACK PAIN: WHAT YOU SEE IS WHAT YOU GET

JUNE 24-26 | MINNEAPOLIS, MN

Chronic Low Back Pain is one of the most prevalent diagnoses of our time. It continues to add to the global burden of healthcare costs. This burden has led to many different practitioners treating it with various perspectives, approaches and philosophies. Who is right? Who is wrong? As the late Patrick Wall once stated, “If we are so good [at treating pain], then why are our patients so bad?” Join us in 2016 for a multidisciplinary vantage point of healing Low Back Pain and decide for yourself if what you see is truly what you get.

Registration opens October 1, 2015

Confirmed Speakers Include:

Keynote Speakers:
Mark Jones - Australia
Steve Linton - Sweden
Jo Njis - Belgium
Frank Keefe - US/Duke

Physical Therapy Speakers:
Tim Flynn
Louie Puenteedura
John Childs
Steve Schmidt
Kory Zimney
Mark Pirtle

Additional Discipline Speakers:
Pain Management Doctor
Chiropractor
Family Doctor
Case Manager
Dietician and more!
Is HIV Painful? An Epidemiologic Study of the Prevalence and Risk Factors for Pain in HIV-infected Patients  
Clinical Journal of Pain; September 2015 - Volume 31 - Issue 9 - p 813–819

**OBJECTIVES:** To evaluate the prevalence, impact, and risk factors for pain among a cohort of human immunodeficiency virus (HIV)-infected adults treated with combination antiretroviral therapy if indicated according to current guidelines.

**METHODS:** This was a cross-sectional epidemiological observational study. All patients attending 1 HIV-outpatient center in the United Kingdom in a 10-month period were eligible. Patients completed a validated questionnaire enquiring about demographics, HIV factors, and symptoms of pain.

**RESULTS:** Of 1050 eligible participants, 859 (82%) completed a questionnaire. The 1-month period prevalence of pain lasting >1 day was 62.8% among whom 63% reported current pain. The prevalence of pain at most anatomic sites was broadly similar to that observed in population studies using the same questionnaires except that we found considerably higher rates of foot/ankle pain. The median duration of pain was 3 years (range, 0 to 51 y) and the median pain score was 5.0 on an 11-point visual analogue score. Over 40% of people in pain had consulted their primary care physician and >20% were taking analgesics daily. Independent risk factors for current pain were older age (P=0.001), time since diagnosis of HIV infection (P=0.001), and receipt of a protease inhibitor-based regimen (P=0.04).

**DISCUSSION:** Pain, and notably foot/ankle pain, is common among adults living with prevalent HIV and is associated with substantial morbidity and health care utilization.

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Leading a Horse to Water: Facilitating Registration and Use of a Prescription Drug Monitoring Program  
Clinical Journal of Pain; September 2015 - Volume 31 - Issue 9 - p 782–787

**OBJECTIVES:** Prescription Drug Monitoring Programs (PDMPs) can help inform patient management, coordinate care, and identify drug safety risks, abuse, or diversion. However, many clinicians are not registered to use these systems, and use may be suboptimal. We sought to describe outreach efforts in 1 state (Oregon); quantify uptake of system use; identify barriers; and identify potential system improvements.

**METHODS:** Program reports of outreach efforts and operational metrics provided rates of registration and use. A statewide survey identified perceived barriers and potential improvements from users and nonusers of the system.

**RESULTS:** Even with extensive registration efforts, <25% of clinicians and pharmacists acquired PDMP accounts over 2 years of operation. Rapid increases in registration and use in 2013 corresponded to new requirements among large pharmacy chains that pharmacists register for and use the PDMP. Among surveyed PDMP nonusers, nearly half were unaware that they could register. Among users and nonusers, over two thirds indicated that time constraints were a major barrier and over half thought that inability to delegate access was a major barrier. Desired improvements included linking state systems, faster entry of pharmacy data, and use of unique patient identifiers. Users also wanted better insurance coverage for mental health and addiction referrals.

**DISCUSSION:** Increasing registration and use of PDMPs remains important. Clinician feedback indicates that program enhancements and health care system changes would facilitate using and responding to PDMP information. It appears premature to judge the efficacy of PDMPs until best practices for their use are identified and impacts are assessed.
Physical Therapy Position Available in Story City, Iowa

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- Large referral network
- More one-on-one time with patients

Common Diagnoses Treated:
- Back Pain
- Neck Pain
- Radiculopathy
- CRPS
- Fibromyalgia
- Sports Injuries
- Shoulder Injuries
- Peripheral Neuropathy
- MORE…

Common Treatments Used:
- Neuroscience Education
- Spinal Mobilization
- Spinal Manipulation
- Graded Motor Imagery
- Mirror Therapy
- Sensory Discrimination
- Laterality
- Exercise
- MORE…

Call 515.733.2707 or email sheryl@ispinstitute.com to inquire
ISSLS Prize Winner: Dynamic Loading–Induced Convective Transport Enhances Intervertebral Disc Nutrition

Spine; August 2015 - Volume 40 - Issue 15 - p 1158–1164

STUDY DESIGN. Experimental animal study of convective transport in the intervertebral disc.

OBJECTIVE. To quantify the effects of mechanical loading rate on net transport into the healthy and degenerative intervertebral disc in vivo.

SUMMARY OF BACKGROUND DATA. Intervertebral disc degeneration is linked with a reduction in transport to the avascular disc. Enhancing disc nutrition is, therefore, a potential strategy to slow or reverse the degenerative cascade. Convection induced by mechanical loading is a potential mechanism to augment diffusion of small molecules into the disc.

METHODS. Skeletally mature New Zealand white rabbits with healthy discs and discs degenerated via needle puncture were subjected to low rate axial compression and distraction loading for 2.5, 5, 10, 15, or 20 minutes after a bolus administration of gadodiamide. Additional animals with healthy discs were subjected to high-rate loading for 10 minutes or no loading for 10 minutes. Transport into the disc for each loading regimen was quantified using post–contrast-enhanced magnetic resonance imaging.

RESULTS. Low-rate loading resulted in the rapid uptake and clearance of gadodiamide in the disc. Low-rate loading increased net transport into the nucleus by a mean 16.8% and 12.6% in healthy and degenerative discs, respectively. The kinetics of small molecule uptake and clearance were accelerated in both healthy and degenerative discs with low-rate loading. In contrast, high-rate loading reduced transport into nucleus by a mean 16.8%.

CONCLUSION. These results illustrate that trans-endplate diffusion can be enhanced by forced convection in both healthy and degenerative discs in vivo. Mechanical loading–induced convection could offer therapeutic benefit for degenerated discs by enhancing uptake of nutrients and clearance of by-products.

HAVE YOU TAKEN A THERAPEUTIC NEUROSCIENCE EDUCATION COURSE?

In line with our ongoing research, we are asking all PTs and PTAs who have taken one or more of our Therapeutic Neuroscience Education classes to please take a few minutes and complete a survey specific to the clinical application of therapeutic pain neuroscience education. Your participation is entirely voluntary.

At the end of the survey you will be given the option to enter a drawing for one of 10 therapeutic pain neuroscience education books/booklets offered by the International Spine and Pain Institute.

The current study is aimed at physical therapists and physical therapists assistants. All other professionals (MD, DO, RN, OT, COTA, Psychologists, etc.), need not complete the survey at this time.

CLICK HERE for the survey
Course Description:
A human pain experience associated with sensitization of the nervous system should be viewed as a continuum. During the acute phases of injury or postoperatively the nervous system is hypervigilant doing what it does best – protect by pain. With time, tissue recovery and skillful treatment the nervous system decreases its temporary sensitization in line with recovery. One in four people however, following injury or surgery, never experience a lessening sensitization of the nervous system, but increased sensitization, pain and dysfunction. The clinical presentation of past the healing time, sensitization to stimuli that should not hurt, widespread sensitization to palpation and neurodynamic tests and various psychosocial issues is known as central sensitization. For therapists treating various peripheral neuropathic pain states such as carpal tunnel syndrome, cubital tunnel syndrome, cervical radiculopathy, etc., with neurodynamics interventions, this “too hot to handle” clinical presentation may create a significant challenge. This 8-hour hands-on course aims to explore the clinical examination and treatment of central sensitization for the upper extremity, with a focus on peripheral nerves. This class will include updated neurobiology of central sensitization and peripheral neuropathic pain, sensorimotor and neurological testing, pain neuroscience education, graded motor imagery, sensory discrimination and neurodynamics.

Objectives:
Upon completion of this educational session the participants will be able to:
1. Develop an updated clinical understanding of the biology and physiology associated with central sensitization and peripheral neuropathic pain
2. Skillfully interview patients with upper extremity dysfunctions to distinguish nociceptive, peripheral neurogenic and central sensitization pain states
3. Learn, practice and be able to apply a neurological, sensorimotor and neurodynamics physical examination to patients suffering upper extremity pain
4. Learn, practice and be able to apply various treatments aimed at peripheral neuropathic and central pain states
5. Apply the information from the educational session into clinical practice

Course Layout:
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>08:00</td>
<td>Update on the neurobiology and neurophysiology of central sensitization and peripheral neuropathic pain</td>
</tr>
<tr>
<td>09:00</td>
<td>Skillful interview and differential diagnosis of pain mechanisms</td>
</tr>
<tr>
<td>09:45</td>
<td>Break</td>
</tr>
<tr>
<td>10:00</td>
<td>Physical examination: Neurological, sensorimotor and neurodynamics</td>
</tr>
<tr>
<td>12:00</td>
<td>Lunch</td>
</tr>
<tr>
<td>1:00</td>
<td>Evidence, clinical rationale and guidelines for treatment</td>
</tr>
<tr>
<td>2:00</td>
<td>Pain neuroscience education: Know pain, know gain</td>
</tr>
<tr>
<td>2:30</td>
<td>Desensitizing the nervous system</td>
</tr>
<tr>
<td>3:15</td>
<td>Break</td>
</tr>
<tr>
<td>3:30</td>
<td>Neurodynamic treatments for the median, radial and ulnar nerves</td>
</tr>
<tr>
<td>5:00</td>
<td>Clinical application: Case studies</td>
</tr>
</tbody>
</table>
## 2015

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>Sat</td>
<td>September 12</td>
<td>Concussions: What Every Health Care Provider Should Know - WI PTA</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Sep 26 &amp; 27</td>
<td>Therapeutic Neuroscience Education I: Educating Patients About Pain</td>
</tr>
<tr>
<td>Saturday</td>
<td>October 3</td>
<td>Too Hot to Handle: Desensitizing a Hypersensitive Patient</td>
</tr>
<tr>
<td>Sunday</td>
<td>October 4</td>
<td>Preoperative Therapeutic Neuroscience Education</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Oct 10 &amp; 11</td>
<td>A Study of Neurodynamics: The Body’s Living Alarm</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Oct 10 &amp; 11</td>
<td>The Upper Quadrant: A Differential Diagnosis Approach to Manual Therapy</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Oct 24 &amp; 25</td>
<td>A Study of Neurodynamics: The Body’s Living Alarm</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Oct 31 &amp; Nov 1</td>
<td>Therapeutic Neuroscience Education: Teaching People About Pain</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Nov 7 &amp; 8</td>
<td>Spinal Manipulation I: A Physical Therapy Approach</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Nov 14 &amp; 15</td>
<td>The Lower Quadrant: A Differential Diagnosis Approach to Manual Therapy</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Nov 14 &amp; 15</td>
<td>Therapeutic Neuroscience Education I: Educating Patients About Pain</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Nov 21 &amp; 22</td>
<td>A Study of Neurodynamics: The Body’s Living Alarm</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Dec 5 &amp; 6</td>
<td>Spinal Manipulation I: A Physical Therapy Approach</td>
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## 2016

<table>
<thead>
<tr>
<th>Date</th>
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<tr>
<td>Sat/Sun</td>
<td>March 12 &amp; 13</td>
<td>Spinal Manipulation I: A Physical Therapy Approach</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Mar 19 &amp; 20</td>
<td>The Upper Quadrant: A Differential Diagnosis Approach to Manual Therapy</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>April 16 &amp; 17</td>
<td>Therapeutic Neuroscience Education I: Educating Patients About Pain</td>
</tr>
<tr>
<td>Fri/Sat/Sun</td>
<td>Jun 24-26</td>
<td>Conference: Chronic Low Back Pain, What You See is What You Get</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Sep 10 &amp; 11</td>
<td>Therapeutic Neuroscience Education: Teaching People About Pain</td>
</tr>
<tr>
<td>Sat/Sun</td>
<td>Oct 8 &amp; 9</td>
<td>Therapeutic Neuroscience Education: Teaching People About Pain</td>
</tr>
</tbody>
</table>

Courses are always being scheduled, keep checking back if you don’t see what you are looking for!
If you are interested in hosting a one or two-day class at your facility, contact us.

Education is Therapy...