

Future Directions for Research on the Feldenkrais Method

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Introduction.

As we go into the future, we will be competing with other health care professions who are increasingly evidence based and increasingly effective in what they do. We must continue to do research on Feldenkrais Method so that people understand its effectiveness and so that we ourselves better understand the tools that we are working with and continuing to develop. Research can become/ is becoming part of the conversation about how we use and develop the Feldenkrais Method (FM).

Research operates on several levels. Because we are interested in the manner and extent to which FM can impact people to improve their function, research should be directed toward the assessment of functional outcomes associated with participation in Awareness Through Movement (ATM) and Functional Integration (FI). This has been a primary area of interest and research up to this point both for practitioners, researchers and people looking at FM from the outside.

After a functional outcome has been demonstrated in some area (**Established Outcomes**), we can begin to ask research questions about how this happens. This process is the investigation of mechanisms (**Mechanisms**) and is a much harder question as it involves multiple possibilities all of which may not be known or understood and a more abstract level of function. Only a small amount of research has been done in this area.

A third level of research directly addresses theories (**Theory**), which are developed out of the relationships /between what we do and the physical, physiological, psychological and social laws that govern the behavior of entities in the world. Although the outcomes of FM work depend on these relationships, very little of our research has ventured in this direction.

Future research should be based in and developed out of past research and established theory. In this paper, my purpose is to take a broad view of possible research questions and not limit the discussion to one or another particular area. I will reprint paper titles in bibliography form and where possible abstracts of published research to give a vibrant sense of the research that has been done. The research will be grouped into several different areas for convenience of discussion. Each area will be approached as suggested above by first addressing functional outcomes, then mechanisms and finally theory. The references (abstracts) following each section are in rough alphabetical order within that section.

I. Low Back Pain and Chronic Pain

Outcomes: This is the area where most research has been done on FM. There are many case reports and small studies all suggesting that FM can be effective in dealing with pain. In spite of this, Maher (7) wrote in 2004 that FM is of unknown value or ineffective and should not be considered for interventions in chronic pain. As practitioners, we know that this is not the case. More research needs to be done to make this clear to other health care professionals. There are several problems with the research that has been done to this point. Studies have been done without control groups (1, 11), or with a small number of subjects or single cases being reported (2, 9, 13). Smith (12) reported no reduction of pain but used only a single 30- minute lesson as an intervention. It is unrealistic to expect that this short an intervention would significantly impact chronic pain. Yet this literature remains unanswered.

Lundblad (6) and Malmgren-Olsson (8) are models for how studies might be more effectively done. They have realistic control groups, large numbers of subjects and are carried out over extended periods of time. They each also assess multiple functional and quality of life outcomes as well as outcomes about pain itself.

Another aspect to consider is that all pain is not the same. Mechanically induced LBP may be more responsive to FM than more physiologically induced pain from cancer. Some types of pain are not understood well at all. Fibromyalgia is in this category. Some pioneering work has been done using FM with people with fibromyalgia (3, 5) with equivocal results suggesting that there may be effectiveness in this area but perhaps exactly how FM is used in this condition needs to be thought through more clearly. Mark Reese developed lessons and worked in his practice with people with fibromyalgia but none of the outcomes of that work were published. The lesson here is that we need to be more active in writing and sharing the results of our work.

Another important area for establishing outcomes is the prevention of injury. This has been suggested by Stephens (43) but no work has been done directly in this area. Discussion of clinical work with people in pain – learning how to rest has been presented by O'Connor (10), but again no objective research has been published in this area.

Mechanisms: What are the underlying processes through which FM might be working to reduce pain? 1) Perhaps there is reduced inappropriate effort or muscle tone (parasitic activity) that could lead to reduction in pain. This has been suggested by Kegerris et al (39, 40) in work with people without chronic pain. This idea could be studied directly with people who do present with chronic pain using emg assessment of muscle activity or some similar technology. 2) Perhaps there is reorganization of movement patterns that reduce stresses. This might show up as changes in biomechanical organization of movements using motion analysis before and after a series of lessons and might also be reflected in changes in emg activity. 3) Perhaps there are physiological changes such as increase in endorphins or a change in the balance or autonomic nervous system (ANS) activity away from greater sympathetic toward greater para-sympathetic activity affecting the perception of pain. Changes like this have been suggested by Kolt et al (11, 37). ANS function and endorphin levels could be measured directly and correlated with ATM or FI lessons in properly controlled studies.

Theory: The theory underlying these types of ideas is that a person performs optimally when intention and action are fully integrated and aligned. The experience of pain is linked to perception as well as physical trauma. We could learn something about how we might study this area by looking at the work of people who work with both sides of this issue. Lewis (47) and Giummarra (48) provide some recent examples of this.

1. Alexander A. **Perceived pain and disability decreases after Feldenkrais' Awareness Through Movement.** Masters Thesis. Cal State, Northridge, June 2006.

Movement method for motor learning was effective in decreasing pain perception and disability of adults who self-reported experiencing chronic low back pain. Subjects, staff members of California State University Northridge, were voluntarily recruited for this study using email and word of mouth. Final sample (N=12) was comprised of males and females, aged 35 to 67 years (average age was 51.833). The intervention consisted of a total of eleven 45-minute Awareness Through Movement classes offered over a 5-week period. Participants were free to come to all 11 classes, and average class participation was 10.25. Pain was assessed using the Visual Analogue Scale and disability was measured using the Oswestry Disability Index questionnaire, both administered pre and post intervention. Multivariate Analyses of Variance showed significant differences ($p < .05$) pre and post testing and the investigation concluded that the Feldenkrais method was effective in reducing pain perception and in decreasing disability in a population experiencing chronic low back pain. This research paper supports the use of the Feldenkrais method for decreasing pain and increasing function in daily activities for adults experiencing chronic low back pain.

2. Bearman D, Shafarman S. **Feldenkrais Method in the Treatment of Chronic Pain: A Study of Efficacy and Cost Effectiveness.** *Am. J. Pain Management.* 9 (1): 22-27, 1999.

A preliminary study was undertaken to determine both the efficacy and cost effectiveness of the Feldenkrais Method for treatment of Medicaid recipients with chronic pain at the Santa Barbara Regional Health Authority (SBRHA). SBRHA staff wished to offer treatment for chronic pain patients beyond what is provided for in the Medicaid scope of benefits. Conventional intensive chronic pain treatment programs costs range from \$7,000 to \$30,000 and are not covered by regular Medicaid benefits. Patients with chronic headaches and/or musculoskeletal problems were enrolled in the study. Seven patients began the program; all completed it. Patient satisfaction, function, and perception of pain were evaluated by using the National Pain Data Bank (NPDB) protocol of the American Academy of Pain Management. Participants reported more mobility and decreased perception of pain, both immediately after the program and in a one-year follow-up questionnaire. Results compared quite favorable with NPDB comparison groups. Cost effectiveness calculations were based on Medicaid costs for one-year periods pre- and post-intervention. Patient costs dropped from an average of \$141 per month to \$82 per month. This represents a 40% savings.

3. Dean JR, Yuen SA, and Barrows SA. **Effects of A Feldenkrais Awareness Through Movement Sequence on Fibromyalgia Patients.** A study reported to the CA-PTA in 1997 also presented at the NA Feldenkrais Guild Conference in August, 1997.

The purpose of this study was to describe the effects of a Feldenkrais Awareness Through Movement® (ATM) sequences of fibromyalgia patients. Subjects met twice a week for a one hour group ATM lesson, and were instructed to follow through daily with practice tapes. After two months, subjects were placed on a one month home program. Pre-test and post-test data, which included a modified Fibromyalgia Impact Assessment (FIA) questionnaire, a pain scale, photographic postural analysis, and observational video analysis of walking, were collected and analyzed on five fibromyalgia patients. A paired T-Test on the modified FIA and other descriptive analyses showed moderate improvement in the subjects. It was concluded that the Feldenkrais Method had potential value as a possible adjunct to the physical therapy treatment of selected fibromyalgia patients.

4. Kendall SA, Ekselius L, Gerdle B, Soren B, Bengtsson A. **Feldenkrais intervention in fibromyalgia patients: a pilot study.** *J Musculoskeletal Pain.* 9(4):25-35, 2001.

Objectives: To evaluate the effect of the **Feldenkrais** intervention, in fibromyalgia patients., Methods: Twenty fibromyalgia patients started **Feldenkrais** intervention done as one individual and two group sessions weekly for 15 weeks. Nineteen started a group-based pain education program followed by a pool program. Test and self-report questionnaires were administered at the start, at six month follow up, and at the end of intervention., Results: After the **Feldenkrais** intervention improvement in balance and trends to better lower extremity muscle function were shown, but the improvements were not maintained., Conclusions: No sustained benefit of the **Feldenkrais** intervention compared to a pool program was seen. Methodological problems are discussed.

5. Lundblad I, Elert J, Gerdle B. **Randomized controlled trial of physiotherapy and Feldenkrais interventions in female workers with neck-shoulder complaints.** [Journal Article, Clinical Trial] *Journal of Occupational Rehabilitation.* 1999 Sep; 9(3): 179-94. (46 ref)

The present study aimed to investigate whether physiotherapy or Feldenkrais interventions resulted in a reduction of complaints from the neck and shoulders (prevalence, pain intensity, sick leave, and disability in leisure and work roles) in 97 female industrial workers (not on long-term sick leave). Range of motion of neck and shoulders, VO₂, endurance score (i.e., summation of pain intensity

ratings during a static shoulder flexion), cortical control according to the Feldenkrais methodology, and physiological capacity according to a dynamic endurance test of the shoulder flexors with simultaneous surface EMG were also recorded. The workers were randomized to: (1) physiotherapy group (PT-group; treatment according to the ergonomic program of the PTs of the occupational health care service), (2) Feldenkrais group (F-group; education according to the Feldenkrais methodology), or (3) control group (C-group; no intervention). Pre- and post-tests were made at one-year intervals. The two interventions lasted 16 weeks during paid working time. The F-group showed significant decreases in complaints from neck and shoulders and in disability during leisure time. The two other groups showed no change (PT-group) or worsening of complaints (C-group). The present study showed significant positive changes in complaints after the Feldenkrais intervention but not after the physiotherapy intervention. Possible mechanisms behind the effects in the F-group are discussed.

6. Maher CG. **Effective physical treatment for chronic low back pain. [Review] [52 refs]** [Journal Article. Review. Review, Tutorial] *Orthopedic Clinics of North America*. 35(1):57-64, 2004 Jan. It is now feasible to adopt an evidence-based approach when providing physical treatment for patients with chronic LBP. A summary of the efficacy of a range of physical treatments is provided in Table 1. The evidence-based primary care options are exercise, laser, massage, and spinal manipulation; however, the latter three have small or transient effects that limit their value as therapies for chronic LBP. In contrast, exercise produces large reductions in pain and disability, a feature that suggests that exercise should play a major role in the management of chronic LBP. Physical treatments, such as acupuncture, backschool, hydrotherapy, lumbar supports, magnets, TENS, traction, ultrasound, Pilates therapy, **Feldenkrais** therapy, Alexander technique, and craniosacral therapy are either of unknown value or ineffective and so should not be considered. Outside of primary care, multidisciplinary treatment or functional restoration is effective; however, the high cost probably means that these programs should be reserved for patients who do not respond to cheaper treatment options for chronic LBP. Although there are now effective treatment options for chronic LBP, it needs to be acknowledged that the problem of chronic LBP is far from solved. Though treatments can provide marked improvements in the patient's condition, the available evidence suggests that the typical chronic LBP patient is left with some residual pain and disability. Developing new, more powerful treatments and refining the current group of known effective treatments is the challenge for the future.
7. Malmgren-Olsson E. Armelius B. Armelius K. **A comparative outcome study of body awareness therapy, Feldenkrais , and conventional physiotherapy for patients with nonspecific musculoskeletal disorders: changes in psychological symptoms, pain, and self-image.** [Journal Article, Research, Tables/Charts] *Physiotherapy Theory and Practice*. 2001 Jun; 17(2): 77-95. (55 ref) Patients with nonspecific musculoskeletal disorders are often remitted for physiotherapy treatment in primary care. The rehabilitation effects for this patient group are generally poor and many of the treatment methods used have not been scientifically evaluated. The purpose of this study is to compare treatment effects of Body **Awareness** Therapy, **Feldenkrais** , and conventional individual treatment with respect to changes in psychological distress, pain, and self-image in patients with nonspecific musculoskeletal disorders. A total of 78 patients, 64 females and 14 males, with nonspecific musculoskeletal disorders were recruited consecutively to the different treatment groups in a quasiexperimental design. The patients were measured three times during the study period: before the interventions, after six months, and after one year. The results showed significant positive changes over time in all three treatment groups with regard to reduced psychological distress, pain, and improved negative self-image. There were few significant differences among the groups but effect-size analysis indicated that the group treatments using Body **Awareness** Therapy and **Feldenkrais** might be more effective than conventional treatment.
8. Narula M, Jackson O, Kulig K. **The Effects of Six Week Feldenkrais Method on Selected Functional Parameters in a Subject with Rheumatoid Arthritis.** *Physical Therapy* 72: (suppl.) S86,1992
9. O'Connor M. Webb R. **Learning to rest when in pain.** [Journal Article, Pictorial, Research] *European Journal of Palliative Care*. 2002 Mar-Apr; 9(2): 68-71. (18 ref) Margaret O'Connor and Robert Webb report on the usage of a lesser-known approach -- the **Feldenkrais** Method -- in teaching people to cope with pain on **movement** .

10. Phipps A, Lopez R, Powell R (advisor), Lundy-Ekman L (advisor), Maebori D (CFP). **A Functional Outcome Study on the Use of Movement Re-Education in Chronic Pain Management.** Master's Thesis at Pacific University, School of Physical Therapy, Forest Grove, Oregon, May 1997.
11. Smith AL. Kolt GS. McConville JC. **The effect of the Feldenkrais method on pain and anxiety in people experiencing chronic low back pain.** [Journal Article, Research, Tables/Charts] *New Zealand Journal of Physiotherapy.* 2001 Mar; 29(1): 6-14. (54 ref)
 The aim of this pilot investigation was to evaluate the **Feldenkrais** Method's effect on pain and state anxiety in people experiencing chronic low back pain. Participants (N = 26) were aged between 25 and 78 years, and were recruited from a community health centre, a rehabilitation hospital, and from the general community. The sample was divided into two groups: **Feldenkrais** and control. The **Feldenkrais** group experienced a 30-minute **Awareness Through Movement** session whilst the control group listened to a narrative of the same duration. Pain was assessed pre and post intervention using the Short-Form McGill Pain Questionnaire. State anxiety was also measured pre and post intervention using the State Scale of the State-Trait Anxiety Inventory. Multivariate Analyses of Variance showed that the **Feldenkrais** intervention was effective in reducing the affective dimension of pain ($p < .05$), but not the sensory or evaluative dimensions, nor state anxiety. These findings are discussed in relation to previous research and some of the theoretical concepts assumed to underlie the **Feldenkrais** Method. The clinical implication of the findings involves the potential for the **Feldenkrais** Method to complement existing modes of pain management for people experiencing chronic low back problems.
12. Stephens J. **Feldenkrais method: background, research, and orthopaedic case studies.** [Journal Article, Case Study, Tables/Charts] *Orthopaedic Physical Therapy Clinics of North America.* 2000 Sep; 9(3): 375-94. (46 ref)
 Functional Integration and **Awareness Through Movement** are aspects of the **Feldenkrais** method that have been used successfully in the rehabilitation of people with orthopaedic problems. These methods include approaches to motor learning that can be used to facilitate change and integration in postural and general musculoskeletal control. This article describes the background and development of the **Feldenkrais** method, including its philosophic and scientific basis. An outcome survey of the use of the **Feldenkrais** method is presented along with four case studies that demonstrate the integration of this method into physical therapy practice. The **Feldenkrais** method is an excellent approach to use in the rehabilitation of people with orthopedic physical problems.

II. Outcomes for people with neurological pathologies: CVA (stroke), traumatic brain injury, multiple sclerosis, Parkinson's, spinal cord injury, and other.

Outcomes: Initial work in this area was more qualitative and descriptive suggesting improvements in function and quality of life using either small, uncontrolled studies or case studies. (16, 15, 17, 18 19, 23, 24, 25, 49) The next step has begun to be taken by identifying specific outcome variables and assessing how they are affected within group over time or compared to a control group. These studies have used well accepted and validated outcome measures to document improvements in balance and mobility (13, 21, 22) and quality of life (21). More work remains to be done with all the different populations and pathologies to understand if there are groups or individuals who are more or less responsive to FM.

Mechanisms: Several approaches have been made to the question of how these changes may be affected. Many neurologically based pathologies leave people with impaired sensory processes and incomplete body images. Connors (14) has begun to address the question of whether FM is useful in the process of trying to recover body image and has found some initial encouraging results. Similar results were also reported for one person in the group studied by Batson (13). Johnson reported decreased perceived stress in her work with people with multiple sclerosis (20). Many questions remain to be addressed. Is it possible to establish sensory function following a neurological lesion using FM? What is the role of sensory and perceptual function in recovery of function? How is motor imagery changed by

neurological lesions? Is it possible to recover the ability for motor imagery using FM? What is the relationship between motor imagery ability and recovery of function? Some of these questions about motor imagery have begun to be studied by Batson (not yet published) but much more remains to be done. If FM can impact the ability for motor imagery, can the rate and extent of recovery of function be improved in this way? If motor imagery is improved, is there carryover to differentiation of movements that had been lost in the stroke or brain injury? Differentiation of movement can be easily assessed using a format such as the Motor Assessment Scale, the Wolf Motor Function test, or video motion analysis.

Theory: One of the theoretical issues being addressed by the above works has to do with questions about how body image (self image) is constructed and the relationships between body image and action/function. In using the name Awareness Through Movement to describe one of his methods of working, Feldenkrais suggested that movement has primacy in developing awareness and hence has an important role in construction of body image. An important question related to this idea is whether, in rehabilitation (or in development), movement would be an effective strategy for recovering sensory and perceptual functions of whether they can be recovered optimally through direct sensory experience only.

Another issue of interest raised by Stephens (21) and possibly peculiar to FM is that in a complex intervention like ATM that can be addressed to many people at the same time, that individuals may have very different responses and improve in different ways through the same lesson. Thus to look for everyone to respond in the same way is to miss much of what is going on. It would be interesting to see this point confirmed by other research and it is important to keep this in mind when designing research and analyzing data.

13. Batson G and Deutsch JE. **Effects of Feldenkrais Awareness Through Movement on Balance in Adults With Chronic Neurological Deficits Following Stroke: A Preliminary Study.** Complementary Health Practice Review, Vol. 10 No. 3, October 2005 203-210
The Feldenkrais Method is a complementary approach to motor learning that purports to induce change in chronic motor behaviors. This preliminary study describes the effects of a Feldenkrais program on balance and quality of life in individuals with chronic neurological deficits following stroke. Two male (48 and 53 years old) and 2 female participants (61 and 62 years old), 1 to 2.5 years post-stroke, participated as a group in a 6-week Feldenkrais program. Pretest and posttest evaluations of the Berg Balance Scale (BBS), the Dynamic Gait Index (DGI), and the Stroke Impact Scale (SIS) were administered. Data were analyzed using a Wilcoxon signed-rank test. DGI and BBS scores improved an average of 55.2% ($p = .033$) and 11% ($p = .034$), respectively. SIS percentage recovery improved 35%. Findings suggest that gains in functional mobility are possible for individuals with chronic stroke using Feldenkrais movement therapy in a group setting. Keywords: Feldenkrais; balance; stroke; complementary medicine
14. Connors K and Grenough P. **Redevelopment of the Sense of Self following Stroke, using the Feldenkrais Method.** Poster presented at the Feldenkrais Annual Research Forum, Seattle WA, August, 2004.
15. Gilman M, Yaruss JS. **Stuttering and relaxation: applications for somatic education in stuttering treatment.** J Fluency Disorders. 25(1): 59-76, 2000
16. Ginsburg C. **The Shake-a-Leg Body Awareness Training Program: Dealing with Spinal Injury and Recovery in a New Setting.** Somatics. Spring/Summer, 1986 pp31-42.
17. Goldman Schuyler, Kathryn. **A Systems Approach to Learning and Change: Cindy's Story.** Somatics 14(3): 14-23, Fall/Winter 2003-2004
This is a conversationally written report of the process and impact on Feldenkrais work with a 45 year old woman with Autism/Cerebral Palsy(?). It tracks the development of the strategy of the work, the dynamics of the process of change and concludes with some theoretical considerations and practical implications.

18. Ofir R. **A heuristic investigation of the process of motor learning using Feldenkrais method in physical rehabilitation of two young women with traumatic brain injury.** Unpublished Doctoral Dissertation, Union Institute, NY, 1993. *Brief abstract only. Documents improvements with Feldenkrais intervention. Videotape supports text*
19. Bost H, Burges S, Russell R, Ruttinger H, Schlafke U. **Feldstudie zur Wirksamkeit der Feldenkrais-Methode bei MS - betroffenen.** Deutsche Multiple Sklerose Gesellschaft. Saarbrücken, Germany. 1994. (Summary available in English translated by Hans Hartmann, Sc.D.)
20. Johnson SK, Frederick J, Kaufman M, Mountjoy B. **A controlled investigation of bodywork in multiple sclerosis.** *The Journal of Alternative and Complementary Medicine* 5(3): 237-43, 1999. *Results show lower perceived stress after Feldenkrais sessions compared to a sham intervention control group.*
21. Stephens J. Call S. Evans K. Glass M. Gould C. Lowe J. **Responses to ten Feldenkrais Awareness Through Movement lessons by four women with multiple sclerosis: improved quality of life.** [Journal Article, Research, Tables/Charts] *Physical Therapy Case Reports.* 1999 Mar; 2(2): 58-69. (43 ref)
 Four women with multiple sclerosis who were ambulatory and worked full-time participated in 10 **Awareness Through Movement** classes over 10 weeks. Assessment before and after the series of classes included the Incapacity Status and the Environmental Status Scales of the Minimal Record of Disability, the Fatigue Severity Scale, and the Index of Well-Being. Before each class and at the final data collection, each person was asked several questions about her medical and functional status. Analyses of walking and supine-to-stand were done using the PEAK Motus video motion analysis system. A follow-up interview was done with two women one year after the classes ended. Three of the four participants experienced an increase in symptoms at some time during the 10 weeks; nonetheless, all made improvements. Outcomes show that two broad areas of improvement were ease and steadiness of daily **movement** s, and sense of well-being. These Outcomes suggest that **Awareness Through Movement** is beneficial for some people with multiple sclerosis, although in different ways for each person.
22. Stephens J. DuShuttle D. Hatcher C. Shmunes J. Slaninka C. **Use of awareness through movement improves balance and balance confidence in people with multiple sclerosis: a randomized controlled study.** [Journal Article, Clinical Trial, Research, Tables/Charts] *Neurology Report.* 2001 Jun; 25(2): 39-49. (33 ref)
 This study examined the effectiveness of a structured, group motor learning process, **Awareness Through Movement (ATM)**, on balance, balance confidence, and self-efficacy. Twelve people with multiple sclerosis were randomly assigned to either ATM or control groups. The ATM group participated in 8 classes, 2 to 4 hours each while the control group participated in educational sessions, over 10 weeks. Six outcome measures were used: the Basic Balance Master modified Clinical Test of Sensory Interaction in Balance (mCTSIB) and Limits of Stability tests; the Activities-specific Balance Confidence Scale; prospective falls; Equiscale; and the Multiple Sclerosis Self-Efficacy Scale. The ATM group exhibited significantly improved mCTSIB scores indicating an average center of pressure position closer to theoretical center, had significantly fewer abnormal mCTSIB tests, and demonstrated improved balance confidence compared to controls. There was a trend toward improvement in all other measures in the ATM group compared to controls. These results suggest that this type of motor learning intervention can be effective in improving a variety of physical and psychological parameters related to balance and postural control.
23. Shenkman M, Donovan J, Tsubota J, Kluss M, Stebbins P, Butler R. **Management of Individuals with Parkinsons Disease: Rationale and Case Studies.** *Physical Therapy* 69: 944-955, 1989 *Mentions Feldenkrais Method as treatment option*
24. Shelhav-Silberbush, Chava. **The Feldenkrais Method for Children with Cerebral Palsy.** pp116. MS Thesis. Boston University School of Education, Feldenkrais Resources, Berkeley CA, 1988
25. Wendell LL. **Some effects of the Feldenkrais Method on Parkinson's symptoms and function.** Unpublished case study by LL Wendell client and Marilyn Johnson, Feldenkrais Practitioner. June 2000. *This is a brief, interesting, single case study documenting observations on changes in function before and after a year of Feldenkrais lessons.*

III. Well Elderly: mobility, balance, other.

Outcomes: The first research on FM was done by Gutman in 1977, investigating the effects of ATM lessons on a group of well elderly people. This work was well conceived with the use of 2 control groups but may have been poorly executed as changes in a no activity control group were significant and masked changes seen in other groups. This work did find that FM led to improvements in perception of quality of life. Considering the research with well elderly has been so popular over the last 2 decades and that so many elderly people participate in ongoing ATM classes, it is surprising that much more research has not been done in this area. An initial report (26) demonstrated improved mobility and several subsequent reports showed significant changes in balance (28) and mobility and quality of life (29). These last 3 studies were well done including large groups, random assignment to control and intervention groups and well-validated and reliable outcome measures. More work in this area is important. Many questions remain. Can differentiation of movement and coordination be improved? Can quickness, speed and efficiency of movement be improved? Is ATM or FI or some combination a better way to improve function in elderly people? Is there an optimal way of producing changes: Weekly or more frequent lessons vs. short (half day) to moderately long (3-5 days) workshops. Does improvement of function in this way affect longevity? Does exposure to FM (over what period of time) affect an individual's functional intelligence, problem solving ability, social activity or other psychological functions? Also the organization of an activity like walking can be investigated using non-linear dynamic methods to describe step-to-step variability. (see Stergiou et. al. 50-53)

Mechanisms: Some of the same questions come up again as with neurological pathology. Sensory capacity is known to decline with age. Is it possible to alter this trend and is improved motor and sensory function then capable of altering the aging process?

Theory: A theoretical issue in this area has to do with learning. Feldenkrais subtitled his book The Potent Self, learning to learn. Is it possible to rekindle the learning mechanism of the young in the elderly? Another issue based in Dynamic Systems Theory relates to the dynamics and stability of attractors. Is it possible to develop new attractors? Can these processes be qualitatively and quantitatively described and mapped across time?

26. Bennett JL, Brown BJ, Finney SA, and Sarantakis CP. **Effects of a Feldenkrais Based Mobility Program on Function of a Healthy Elderly Sample.** *Abstract Issues on Aging* 21(1):27, 1998, publication of Geriatric section of APTA. Poster presented at CSM in Boston in February 1998.
27. Gutman G, Herbert C, Brown S. **Feldenkrais vs Conventional Exercise for the Elderly.** *J Gerontology* 32(5): 562-572, 1977 Design problem control group which did nothing improved as much as the Feldenkrais group. Does suggest improved preception of quality of life in Feldenkrais group
28. Hall SE, Criddle A, Ring A, Bladen C, Tapper J, Yin R, Cosgrove A, Hu Yu-Li. **Study of the effects of various forms of exercise on balance in older women.** Unpublished Manuscript Healthway Starter Grant, File #7672, Dept of Rehabilitation, Sir Charles Gardner Hospital, Nedlands, Western Australia, 1999. *Shows improvements in balance and function from Tai Chi and ATM compared to a control group. Good study!*
29. Stephens JL, Pendergast C, Roller BA, Weiskittel RS. **Learning to Improve Mobility and Quality of Life in a Well Elderly Population: The Benefits of Awareness Through Movement.**

International Feldenkrais Federation (IFF), IFF Online Research Journal, <http://www.iffresearchjournal.org/index2005.htm>, November 2005.

Objectives: This study tested the hypothesis that an alternative movement learning method, Awareness Through Movement, would produce improvements in coordination, mobility, economy of movement and quality of life in older adults. **Methods:** A group of 31 older adults was studied using a prospective, repeated measures control group design. The SF-36 was used to assess health status - quality of life. Video motion analysis was used to collect data on walking and on a floor to stand transfer movement. **Results:** Coordination of the transfer movement improved significantly in the experimental group. Vitality and mental health scores also improved significantly in this group. Interesting differences between young-old and old-old changes were observed. **Conclusions:** Awareness Through Movement may be an additional effective method for pursuing the objectives of Healthy People 2010. Cardiac Rehab, Pediatrics

IV. Cardiopulmonary Function.

Outcomes: An area that is often ignored in rehabilitation is cardiopulmonary function. Saraswati (32) did ground breaking work in this area showing some improvements in breathing mechanics and air movement in 1989. This was followed up much later with qualitative work by Brand (30) who suggested improvements in the process of cardiac rehabilitation following myocardial infarct using FM techniques. A follow-up, controlled study by Lowe (31), while finding no significant quantitative differences in body perception or well being variables, did identify significantly more well being related comments by participants in the FM compared to other groups and found that those participating in FM but not progressive relaxation wanted to continue the intervention beyond the study. As in many cases the intervention by Lowe was short (several days/FI lessons) and may have been much more effective if carried out for a longer time period. Again experimenting with the length of the FM intervention is important. Long-term studies could look at questions about post MI activity levels, mortality and longevity. Some long-term assessment of post MI quality of life using SF-36 or some similar instrument would be interesting.

Mechanisms: We know almost nothing in this area. The key may be related to stress and methods of breathing. Brand focused on these areas. However, physiological responses also need to be documented. What happens to blood pressure, heart rate, breathing rate, O₂ saturation, healing rates?

Theory: The idea of Functional Integration suggests that optimal function is achieved when all systems contributing in an integrated way being optimally responsive to the control processes on a moment to moment basis. Is cardiopulmonary function more (or optimally) responsive, or is the responsiveness of the system changed by FM work? This could be investigated using methods of non-linear dynamics to assess levels of variability in relation to normal daily activities and events that are stressful both physiologically and psychologically. (see Stergiou et al. 50-53)

30. Brand, CS. **Stress Management in Cardiac Rehabilitation: Observations on Attention and Emotion.** Paper presented at The Annual Conference of the Feldenkrais Guild of North America, Los Angeles, CA September, 1998.

31. Lowe, Bernd; Breining, Katja; Wilke, Stefanie; Wellmann, Renate; Zipfel, Stephan; Eich, Wolfgang. **Quantitative and qualitative effects of Feldenkrais , progressive muscle relaxation, and standard medical treatment in patients after acute myocardial infarction.** [Peer Reviewed Journal] *Psychotherapy Research*. Vol 12(2) Sum 2002, 179-191.
Examined the effectiveness of the **Feldenkrais** method of functional integration and of progressive muscle relaxation (PMR) compared with the standard medical treatment during the acute phase after

myocardial infarction. Three patient groups (20 in each) received 1 of 3 treatment options: 2 sessions of **Feldenkrais** therapy, 2 sessions of PMR, or no intervention. Evaluations using quantitative and qualitative methods were performed an average of 3.7 and 7.8 days after Ss' myocardial infarction, respectively. Significant improvements, independent of the intervention, were found over the evaluation period in the Perception of Body Dynamics body image scale and in the Physical Well-Being and Emotional Well-Being quality-of-life scales. A statistically significant, differential effect of any one intervention with respect to the control group did not arise in any of the quantitative questionnaire variables examined. However, subjective improvements of varying description were noted by 17 of 20 patients after the 1st **Feldenkrais** therapy and by 13 of 20 patients after the 1st PMR treatment. The qualitative patient statements support using the **Feldenkrais** method or PMR for particular cases in an acute medical setting and continuing treatment during rehabilitation or on an outpatient basis.

32. Saraswati, S. **Investigation of Human Postural Muscles and Respiratory Movements**. M.Sc. University of New South Wales. 1989

V. Psychological functions – Imagery.

Outcomes: Again, initial work in this area has been qualitative. (33, 34, 37) It has been suggested that FM improves some dimensions of body awareness. The different dimensions of body awareness (37) that are responsive remain to be elucidated. In a very well done study, Laumer (36) demonstrated a positive change in a number of important variables in a group of girls with anorexia nervosa compared to a matched control group. The outcome measures used in this study had mostly to do with body perception and satisfaction. Other variables need to be investigated. What impact is there on psychological variables such as anxiety and self-efficacy in this population? Are patterns of social interaction changed? Are problem solving skills improved in relation to management of body image issues?

Mechanisms: In a 10 week study, Kerr (35) demonstrated that state anxiety was reduced in the FM group. This could help to explain the finding by Laumer noted above. Stephens (38) found positive changes in recent memory and positive social support that were highly correlated with decreased fatigue in a group of people with multiple sclerosis compared to a control group. The long-term effects of these interventions are important to study. Are positive effects still seen a month or a year later? Also it is important to evaluate the length of intervention needed to produce positive effects. If 10 ATM lessons produce a good positive effect, are 25 lessons or 50 lessons necessarily better? Are 5 lessons sufficient?

Theory: Feldenkrais was interested in providing a method for people to become more adaptable to the real changes of life that occur. A question at this level is whether significant adaptive changes occur when working with FM. This is a difficult thing to document and seems necessarily qualitative in nature. An example of this type of change may be seen in Goldman-Schuyler's Cindy's Story.(17) It would be very interesting to approach this idea in a much more systematic way across a larger number of people exposed to some significant amount of FM.

33. Deig, Denise. **Self Image in Relationship to Feldenkrais Awareness Through Movement Classes**. Independent Study Project. University of Indianapolis, Krannert Graduate School of Physical Therapy, Indianapolis, Indiana. 1994
34. Hutchinson, Marcia G. **TRANSFORMING BODY IMAGE. Learning to Love the Body You Have**. The Crossing Press. Freedom CA 95019, 1985 Developed from doctoral dissertation: "The effect of a treatment based on the use of guided visuo-kinesthetic imagery on the alteration of negative body cathexis in women" . Boston University, 1981.

35. Kerr GA, Kotynia F, Kolt GS. **FELDENKRAIS awareness through movement and state anxiety.** [Journal Article, Research, Tables/Charts] *Journal of Bodywork and Movement Therapies.* 2002 Apr; 6(2): 102-7. (30 ref)
 The ability of the FELDENKRAIS Method to reduce state anxiety was investigated. Specifically, both a single FELDENKRAIS Awareness Through Movement lesson and a 10-week FELDENKRAIS Awareness Through Movement programme were studied. Participants volunteered to take part in one 1-hour class each week for 10 weeks. Individuals who declined to participate in the 10-week programme were given the opportunity to participate in a single 1-hour lesson during week 5. Participants were divided into two groups: new and returning students, based on previous experience with Awareness Through Movement lessons. Participants were administered the state scale of the State-Trait Anxiety Inventory (Spielberger et al. 1983) prior to the beginning of the first lesson (week 1--T1), immediately before and after the fifth lesson (week 5--T2 and T3), and after the final lesson (week 10--T4). Findings indicated that state anxiety scores decreased significantly over a single lesson (T2 T3) for both new (n=13) and returning (n=42) students. In addition, state anxiety scores were significantly lower after the 10-week programme (T4) when compared with baseline scores (T1) for new (n=3) and returning (n=42) students, with new students experiencing a significantly greater reduction than returning students. These findings can be interpreted as further support for the efficacy of the FELDENKRAIS Method in reducing state anxiety.
36. Laumer U, Bauer M, Fichter M, Milz H. **Therapeutic Effects of Feldenkrais Method "Awareness Through Movement" in Patients with Eating Disorders.** *Psychother Psychosom Med Psychol* 47(5): 170-180, 1997; (Published in German) Full English translation available at: <http://www.iffresearchjournal.org/laumereng.htm>
 Based on the movement-pedagogical concept of Feldenkrais and the findings-of disturbed body perception by eating disordered patients this research aimed at studying the therapeutical effects of the Feldenkrais Method "Awareness through Movement" with eating disorder patients, 15 eating disordered patients treated at the Roseneck hospital for behavioural medicine rated-by means of a questionnaire consisting of scales of the Body Cathexis Scale (BCS), the Body Parts Satisfaction Scale (BPSS), the questionnaire for body perception (Fragebogen zum Korpererleben; FKE), the Emotion inventory (Emotionalitatsinventar; EMI-B), the Anorexia-Nervosa-Inventory for Self-rating (ANIS) and the Eating Disorder Inventory-2 (EDI)-various aspects of their eating disorder before and after participating in a nine hour course of the Feldenkrais Method. The data of these patients were compared to those of the members of a control group, also consisting of 15 eating disordered patients who did not participate in a Feldenkrais course. The participants of the Feldenkrais-course showed increasing contentment with regard to problematic zones of their body and their own health as well as concerning acceptance and familiarity with their own body. Other results were a more spontaneous, open and self-confident behaviour, the decrease of feelings of helplessness and decrease of the wish to return to the security of the early childhood, which indicates the development of felt sense of self, self-confidence and a general process of maturation of the whole personality. The outcome points to the therapeutical effectiveness of the Feldenkrais Method with eating-disorder patients within a multimodal treatment program.
37. Ryding C, Rudebeck CE, Mattsson B. **Body awareness in movement and language: concordance and disparity.** [Journal Article, Research] *Advances in Physiotherapy.* 2004; 6(4): 158-65. (18 ref)
 Background and purpose: Body Awareness Scale-Health (BAS-H) is a physiotherapy scoring instrument that assesses the quality and harmony in posture and simple **movement** s. In the present work, we have studied the concordance between body **awareness** scores and described body experience to further refine the concept of body **awareness** . Method: Sixteen general practitioners were assessed according to BAS-H and interviewed using a semi-structured method concerning their own body experience in relation to three themes. The interviews for the five participants who were found to have the most well-developed body **awareness** were compared, with the five that had the least developed body **awareness** . Results: The participants in the group with well-developed body **awareness** described a more positive attitude towards the body, and they gave clearer descriptions about their experiences of emotions and conditions such as hunger and tiredness. However, there were important exceptions. Body **awareness** has two dimensions-an outward/expressive dimension that is expressed in posture and **movement** and an inward/introspective dimension. Summary hypotheses: The study was summarized in several hypotheses concerning the relationship between expressive and introspective body **awareness**.
38. Stephens JL, Cates P, Jentes E, Perich A, Silverstein J, Staab E, duShuttle D, Hatcher C, Shmunis J, Slaninka C. **Awareness Through Movement Improves Quality of Life in People with Multiple**

Sclerosis. J Neurol Phys Ther. 27(4): 170, 2003. Abstract, Poster presented at APTA Combined Section Meetings, Nashville TN, February, 2004

PURPOSE/HYPOTHESIS: To assess quality of life changes associated with a successful balance intervention in a group of people with MS. **NUMBER OF SUBJECTS:** 12 people with MS mean age 54 yrs, mean Kurtzke EDSS level 4.75 **MATERIALS/METHODS:** Subjects were randomly assigned to 2 groups: Awareness Through Movement intervention (ATM) and control group (EDU). The ATM group participated in 8 Awareness Through Movement sessions while the EDU group participated in 4 educational sessions over 2 months. Balance and mobility measures were performed before and after the intervention period. These results were published in *Neurology Report* 2001; 25(2): 39-49. To assess quality of life the MSQLI was administered before and after the intervention. The MSQLI has 10 sub-scales including: Modified Fatigue Impact (MFIS), Pain Effects, Perceived Deficits (PDQ), and Modified Social Support Survey (MSSS). All scales are valid for people with MS with reliability scores ranging from .78 to .97. Data analysis used Kruskal - Wallis ANOVA for group comparisons and Spearman r_s for correlations. **RESULTS:** There were 3 significant group differences: 1) increase in pain effects in the ATM group ($p < 0.03$); 2) decrease in perceived difficulty recalling recent events (PDQ-RM) in the ATM group ($p < 0.035$); and 3) improvement in perceived availability of others for companionship (MSSS-POS) in the ATM group ($p < 0.035$). Improvement on the PDQ-RM was highly correlated with decreased Fatigue Impact. Improvement in MSSS-POS was highly correlated with decrease in cognitive fatigue impact and a decrease in total PDQ, retrospective memory and planning and organization subscale scores. **CONCLUSIONS:** The larger picture that emerges is that an intervention that was successful in improving balance and mobility had other spin-off benefits that were physical, psychological and social improving quality of life. ATM is intended to improve people's awareness and understanding of their bodies and to help individuals create alternative strategies for setting and achieving goals in their life. This spin-off impact may be present in other kinds of interventions but it has not been measured or documented. **CLINICAL RELEVANCE:** In an environment where patients and payers increasingly demand significant functional outcomes and measurable improvements in quality of life, it is important to document not only the physical outcomes but also the outcomes that reflect quality of life.

VI. More on Mechanisms – what's going on:

Some mechanisms underlying change have been discussed already in the preceding sections. Some research has addressed the question of mechanisms directly. This has been done in a preliminary way at two levels in the process of motor control: muscle activity (39, 40) and length (43) and related changes that may be happening in the control areas in the brain itself. The study by Nair (42) using fMRI technology to assess brain activity changes needs to be done with a larger group of people and compared with other more standard rehabilitation techniques to discover if there is anything special about the responses to FM. It would also be very enlightening to take an ATM lesson right into an fMRI unit and track the changes produces in brain activity during a lesson involving movements of the tongue or fingers. How would these changes be different or the same in different people? What is different in older vs. younger people? How are the changes seen related to learning in a model such as that proposed by Doyon et. al. (54, 55)?

Bruce (41) explored FM as a process of learning in a theoretical study. In the study of hamstring lengthening by Stephens (43), the question of learning was raised but not answered. Did the lengthening of the HS muscle being studied evolve slowly over time as might have been expected during a process of acquisition normally seen during motor learning? Many people have difficulty with the concept of learning as applied to muscle length. Demonstration of an acquisition curve and retention of the learned behavior of some reasonable period of time like a week would go a long way toward placing this phenomenon in the arena of motor learning. How many repetitions are needed for this learning to occur and over what period of time? Stephens subjects did 15 minutes of ATM daily over a period of 3 weeks. The number of repetitions varied widely from person to person. What is the

minimum number, done with an effective ATM/learning approach that will produce the same or possibly a better outcome? Would 2 trials per day for a week be enough? Is there a limit to the length that can be achieved? What controls that limit? Can this same approach be applied to any muscle group in the body by any person? How does this kind of intervention effect performance of running and jumping? Are there changes in emg activity with this process as demonstrated by Kegerris et al?

39. Brown, E and Kegerris S. **Electromyographic Activity of Trunk Musculature During a Feldenkrais Awareness through Movement Lesson.** *Isokinetics and Exercise Science.* 1(4): 216-221, 1991.
40. Ruth S, Kegerris S. **Facilitating Cervical Flexion Using a Feldenkrais Method: Awareness Through Movement.** *J Sports Phys Ther.*16(1): 25-29, 1992
41. Bruce, F.M. **Making sense in movement : the dynamics of self-learning and self-change.** [Microform Thesis or Dissertation] *Kinesiology Publications, University of Oregon Eugene, OR, 2004, 3 microfiche (234 fr.)*

The purpose of this study is to explore the relationship between self-generated movement and processes of self-learning and self-change. It is hypothesized that: 1) Moving is a primary mode of interacting with a world that we construct through our interactions; 2) self-moving is a way of knowing, which structures both the knowing self and the perception of personal reality; 3) self-change is a process of self-learning which changes the ways in which the self perceives and interacts with personal reality, the nature of which reality changes in a mutually causal relationship with processes of self-change. This study is a philosophical inquiry in narrative form, informed by my experience as a dancer and a practitioner of The **Feldenkrais** Method of Somatic Education. Dynamical Systems Theory is employed as a concept-generating metaphor, by means of which personal experience is interwoven with theoretical approaches to cognition as embodied and environmentally embedded. A conceptual structure is developed in which the cognizing self, as a dynamical system, is defined as an environmentally dependent self-organizing, complex of structural change, absent any central controller. The cognitive domain encompasses all the possible functional interactions, where function is taken to comprise moving, sensing, feeling, and thinking. The integrated nature of function stipulates that: 1) Each component of function represents and postulates the others and functions as a whole; 2) all human actions, including processes of abstract thought, are accompanied by distinct patterns of muscular activity. Thus, a change in habitual patterns of **movement** is reflected in a change in habitual patterns of function, and a change in any other aspect of function is reflected in changes in patterns of **movement** . The implications for processes of learning and change are discussed, together with potential pedagogical applications. **General Note** Thesis (Ph.D.) Texas Woman's University, 2003; includes bibliography (leaves 210-223). Available from Kinesiology Publications (formerly Microform Publications), IIHSP, 1243 University of Oregon, Eugene, OR 97403-1243
42. Nair DG, Fuchs A, Burkart S, Steinberg FL, Kelso JA. **Assessing recovery in middle cerebral artery stroke using functional MRI.** *Brain Inj.* 2005 Dec;19(13):1165-76.

PRIMARY OBJECTIVE: To understand the temporal evolution of brain reorganization during recovery from stroke. **RESEARCH DESIGN:** A patient who suffered left middle cerebral artery stroke 9 months earlier was studied on three occasions, approximately 1 month apart. This patient received interventions based on Feldenkrais Method twice a week for 8 weeks. **METHODS AND PROCEDURES:** Brain activation was studied using functional Magnetic Resonance Imaging (fMRI). During each session, the patient performed a finger-to-thumb opposition task, which involved one bimanual and two unimanual conditions. Each condition consisted of overt movement of fingers and imagery of the same task. **RESULTS:** With recovery, greater recruitment was observed of the affected primary motor cortex (M1) and a decrease in activation of the unaffected M1 and supplementary motor area. In addition, the widespread activation of brain areas seen during the initial session changed to a more focused pattern of activation as the patient recovered. Imagery tasks resulted in similar brain activity as overt execution pointing to imagery as a potential tool for rehabilitation.
43. Stephens J., Davidson J., DeRosa J., Kriz M., Saltzman, N. **Lengthening the Hamstring Muscles Without Stretching Using "Awareness Through Movement".** *Phys Ther* 2006 86: 1641-1650.

Background and Purpose. Passive stretching is widely used to increase muscle flexibility, but it has

been shown that this process does not produce long-term changes in the viscoelastic properties of muscle as originally thought. The authors tested a method of lengthening hamstring muscles called “Awareness Through Movement” (ATM) that does not use passive stretching. Subjects. Thirty-three subjects who were randomly assigned to ATM and control groups met the screening criteria and completed the intervention phase of the study. Methods. The ATM group went through a process of learning complex active movements designed to develop increased length in the hamstring muscles. Hamstring length was measured before and after intervention using the Active Knee Extension Test. Results. The ATM group gained significantly more hamstring muscle length (+7.04°) compared with the control group (+1.15°). Discussion and Conclusions. The results suggest that muscle length can be increased through a process of active movement that does not involve stretching. Further research is needed to investigate this finding.

VII. Theory:

The question of theory has been addressed in each section of this paper. Buchanan (44) has written a useful summary of the application of Dynamic Systems Theory to the understanding of how FM may be working. Others have addressed the underlying ideas of learning and awareness more directly. (45, 46) As we continue to develop the research base of FM, we will continue to test the theoretical and practical ideas we have and refine and broaden the understanding and application of the process of FM that seems so powerful.

44. Buchanan PA, Ulrich BD. **The Feldenkrais Method: a dynamic approach to changing motor behavior.** [Review, Tutorial] *Research Quarterly for Exercise & Sport.* 72(4):315-23, 2001 Dec. This tutorial describes the **Feldenkrais** Method and points to parallels with a dynamic systems theory (DST) approach to motor behavior. **Feldenkrais** is an educational system designed to use **movement** and perception to foster individualized improvement in function. Moshe **Feldenkrais**, its originator, believed his method enhanced people's ability to discover flexible and adaptable behavior and that behaviors are self-organized. Similarly, DST explains that a human-environment system is continually adapting to changing conditions and assembling behaviors accordingly. Despite little research, **Feldenkrais** is being used with people of widely ranging ages and abilities in varied settings. We propose that DST provides an integrated foundation for research on the **Feldenkrais** Method, suggest research questions, and encourage researchers to test the fundamental tenets of **Feldenkrais**. [References: 50]
45. Shelhav-Silberbush, Chava. **Movement and Learning: The Feldenkrais Method as a Learning Model.** PhD **Dissertation**, Faculty of Sociology and Behavioral Science. Heidelberg University, Germany. 1998. Not yet reprinted or translated into English. Published in German. *Controlled study with a group of learning disabled children in Germany*
46. Vollmer, Fred. **How do I move my body?** [Journal Article] *Journal of Mind & Behavior.* Vol 19(4) Fall 1998, 369-377.
(from the journal abstract) What is it for me to do something is the question discussed in the present paper. It has been suggested that my doings are elicited by tryings, intentions, and other causal mechanisms. These theories do not offer any convincing analysis of what it is for me to act. Insight is sought by looking at some case studies involving temporary loss of the ability to move one's body. What the case studies show, I conclude, is that when I move my body in the normal way, I do not first have to do something else that causes my body to move. Normal actions are events bodily beings can generate spontaneously (directly). An essential condition for having this kind of control is inside (proprioceptive) **awareness** of the body. When inner **awareness** of the body is lost, control can be taken over by visual **awareness**. But then **movement** loses its spontaneous character and depends on planning and intense concentration. One can think of the self ("I") from which my actions flow, as the mental life to which they belong, or as the consciousness that controls them.
47. Lewis JS, Kersten P, McCabe CS, McPherson KM, Blake DR. Body perception disturbance: A contribution to pain in complex regional pain syndrome (CRPS). *Pain.* 2007 May 15; [Epub ahead of print]

48. Giummarra MJ, Gibson SJ, Georgiou-Karistianis N, Bradshaw JL. Central mechanisms in phantom limb perception: the past, present and future. *Brain Res Rev.* 2007 Apr;54(1):219-32.
49. Ann J. Individuals with dementia learn new habits and are empowered through the Feldenkrais method. [Journal Article, Case Study] *Alzheimer's Care Quarterly.* 2006 Oct-Dec; 7(4): 278-86. (29 ref)
50. Stergiou N, Harbourne R, Cavanaugh J. Optimal movement variability: a new theoretical perspective for neurologic physical therapy. *J Neurol Phys Ther.* 2006 Sep;30(3):120-9.
51. Buzzi UH, Stergiou N, Kurz MJ, Hageman PA, Heidel J. Nonlinear dynamics indicates aging affects variability during gait. *Clin Biomech (Bristol, Avon).* 2003 Jun;18(5):435-43.
52. Staessen JA, Asmar R, De Buyzere M, Imai Y, Parati G, Shimada K, Stergiou G, Redon J, Verdecchia P; Participants of the 2001 Consensus Conference on Ambulatory Blood Pressure Monitoring. Task Force II: blood pressure measurement and cardiovascular outcome. *Blood Press Monit.* 2001 Dec;6(6):355-70.
53. Byrne JE, Stergiou N, Blanke D, Houser JJ, Kurz MJ, Hageman PA. Comparison of gait patterns between young and elderly women: an examination of coordination. *Percept Mot Skills.* 2002 Feb;94(1):265-80.
54. Bellec P, Perlberg V, Jbabdi S, Pelegriani-Issac M, Anton JL, Doyon J, Benali H. Identification of large-scale networks in the brain using fMRI. *Neuroimage.* 2006 Feb 15;29(4):1231-43. Epub 2005 Oct 24.
55. Doyon J, Benali H. Reorganization and plasticity in the adult brain during learning of motor skills. *Curr Opin Neurobiol.* 2005 Apr;15(2):161-7. Review.