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The *Feldenkrais Method*®: A Dynamic Approach to Changing Motor Behavior

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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.

Key words: dynamic systems theory, intervention, movement, perception-action

The purpose of this article is twofold: first, to provide a tutorial on the *Feldenkrais Method*;[1] and second, to propose dynamic systems theory as a theoretical basis for testing its efficacy. The *Feldenkrais Method* was designed as an approach to changing and improving motor behavior over time—or simply, motor development—whether within a single session or over years of training. We believe this method is based on plausible tenets, made more intriguing by the many similarities to the principles of a popular contemporary theory—dynamic systems theory. Interestingly, the *Feldenkrais Method* has been in practice since the 1940s, long before many theorists began to recognize and study the connections between dynamic systems theory and human motor behavior.

Little experimental research has been published that examines the effects of *Feldenkrais* on performance. Regardless, its use with individuals and groups is increasing in a variety of settings including private practices, health clubs, schools and universities, and hospitals and clinics (FELDENKRAIS GUILD® of North America, 1996). Practitioners might work with an infant learning to stand up from the floor; an older adult trying to get down to the floor without falling; athletic teams, dance companies, or orchestras seeking to refine performance; or workers wanting to avoid repetitive motion complaints.

By describing the *Feldenkrais Method* and relating it to dynamic systems theory, we hope to motivate researchers to rigorously examine this approach to changing motor behavior. We begin with an overview of the *Feldenkrais Method*, then draw parallels and distinctions between *Feldenkrais* and dynamic systems theory. After reviewing existing research, we present suggestions for future study.

Fundamentals of the *Feldenkrais Method*

The *Feldenkrais Method* of somatic education is designed to improve function in activities of daily living, work, and recreation. Its proponents believe more effective and efficient actions can emerge from guided exploration of movement that promotes improved attention and awareness and refines the ability to detect information and make perceptual discriminations. Regular use of such attentive explorations and integration of the skills developed during these lessons into activities of daily living lead

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to further refinements and more seemingly automatic use of these motor abilities. Practitioners believe *Feldenkrais* is "an educational system that develops a functional awareness of the self in the environment" FELDENKRAIS GUILD® of North America, 1997, p. 3). Importantly, the overarching goal is to help people become self-directed learners who can apply the perceptual-motor skills and exploratory strategies teachers believe to be fostered by *Feldenkrais* lessons to a variety of learning situations. Because of the focus on learning, *Guild Certified Feldenkrais Teachers*® and *Practitioners*cm often identify the people they work with as students, not clients or patients. *Feldenkrais* teachers have applied this method to people of all ages and all abilities, with the goal of helping them learn how to improve their lives.

There are two complementary styles of teaching in the *Feldenkrais Method—Awareness Through Movement*® (ATM) and *Functional Integration*®(FI). Through the specific use of sensorimotor experiences, both approaches purport to enhance people's awareness of their habitual solutions to motor problems and the sensations accompanying those habits, demonstrate other solutions, and help students select easier, more efficient, and more effective movement options. Practitioners who use this method believe that the impact of a single lesson may be relatively minor in the moment, but they expect more noticeable effects to accumulate over a series of lessons. Sometimes rapid and dramatic changes in behavior are reported to occur within a session (e.g., see the *Feldenkrais Journal*; Rosenfeld, 1981).

ATM lessons are designed to enable *Feldenkrais* teachers to work with more than one student at a time, while allowing for individualized responses to common sets of instruction. ATMs are verbally guided movement explorations in which teachers focus the students' attention on the sensory information that accompany a series of movements and minimize focus on the larger movement outcome of the lesson. Students often come to *Feldenkrais* teachers with a specific movement problem in mind (e.g., to reduce back pain, to improve tennis serve). But during lessons, teachers primarily direct students' awareness to the exploratory process. In turn, teachers observe students' responses to the instructions and attempt to adjust directions and ask guiding questions to match the demonstrated needs of the students.

The *Feldenkrais* teacher may select ATM lessons with a broad goal in mind of improving the students' abilities to perceive sensory information and change their behavior accordingly or for a more specific sensorimotor function, such as lying down on and standing up from the floor, or improving the movement skills used in alpine skiing (Feldenkrais, 1972, 1981; FELDENKRAIS GUILD® of North America, 1997). A sketch of an ATM in which the goal is to enable students to transition efficiently from supine to sitting is presented in the Appendix.

During an FI lesson, *Feldenkrais* teachers also use touch to direct attention, guide a student's movement, and gather additional information about how a student is acting. Thus, FI lessons are believed to afford the exchange of more specific and richer information between the teacher and student. As with ATM lessons, teachers organize FI lessons with students' functional goals in mind, without prescribing the solutions (Feldenkrais, 1981; Hanna, 1980/1993).

FI and ATM are two approaches to teaching similar lessons. A teacher could give one or more FI lessons on the movement theme of an ATM about rolling to sit (see Appendix). Part of an FI lesson might focus on investigating a component of this function. For example, the student, while lying supine, might be able to do an undifferentiated log roll but have difficulty rolling using differentiated movements. Being able to bend the legs then sequentially roll affords the possibility of moving efficiently from supine to sitting in a continuous motion. A student might find this challenging because of difficulty tilting the knees to the right and rolling the pelvis to that side. Given the complexity of human structure-function, many reasons could exist for this difficulty. The *Feldenkrais* teacher would attempt to discover how the student currently does the movement, bring this into clearer focus for both the teacher and the student, and then consider other possibilities. Within this method, a detailed awareness of how a person currently organizes a solution to a movement problem is considered to be foundational to and seamless with improvement. Feldenkrais (1981) stated, "if we do not know what we are actually enacting then we cannot possibly do what we want" (p. xi).

As a step in this process, teachers often direct students' attention to their habitual or preferred movement patterns before exploring other options. Continuing our example, having noticed that tilting the knees to the left is easier (e.g., more range of motion) than tilting to the right, the teacher considers that the source of this limitation might be proximal or distal, with singular or multiple contributing factors. For example, more detailed assessment of hip movements may reveal easy and full motion of the hips but limited mobility in the ribs. Or, closer attention to the right leg might show that internal rotation-adduction is easier than external rotation-abduction, and that external rotation-abduction of the left hip is greater than that of the right hip. One possible factor contributing to this pattern is persistent activation of the right adductors that restricts right hip abduction. The teacher has several options for helping the student perceive this. One approach is the use of contract-relax to exaggerate the feeling of muscle activation versus relaxation for the student. Another tactic is to support the leg in a position of 90° of hip flexion and 90° of knee flexion while gently guiding the student's hip joint through a small path of circumduction in clockwise and counterclockwise directions. After a few of these or other techniques, the teacher would return to the earlier movement of tilting the right knee to allow both teacher and student to notice any changes. Specifically for FI, the intent is that assessment and instruction (evaluation and treatment in a medical model) occur simultaneously and continually.

Given this introduction to ATM and FI, we next relate basic concepts on which the *Feldenkrais Method* was created and anecdotal accounts of its effects with principles of dynamic systems theory. While dynamic systems theory has only been applied to motor behavior for about 20 years, it has already offered numerous insights to this field (Thelen and Smith, 1994, 1998; Ulrich 1997; Wallace, 1996). In turn, dynamic systems theory may assist the scientific evaluation of the *Feldenkrais Method*.

Dynamic Systems Theory and *Feldenkrais* Linkages

We believe there is strong correspondence between the *Feldenkrais Method* and dynamic systems theory on five major points. Additionally, we pose three possible distinctions. We begin with the parallels.

First, self-organization is a foundational principle of dynamic systems theory and *Feldenkrais*. Dynamic systems theorists believe that humans are self-organizing systems; behavior emerges from the interaction of multiple subsystems, including experience. Behaviors are assembled in the moment and context of the current movement task. While it is efficient to develop stable behaviors for recurring task categories, these behaviors need not be encoded in detail in the system. Flexibility and adaptability can coexist with stability when solutions to movement problems are softly assembled and remain plastic. Reorganization of behavioral patterns may occur gradually or rapidly, linearly or nonlinearly (Edelman, 1993; Haken, 1983; Sporns & Edelman, 1993; Thelen & Smith, 1994, 1998; Ulrich, 1997).

During *Feldenkrais* lessons, students are not told rules for how to do a movement but are guided to explore action possibilities and attend to the accompanying sensations. The presumption is that they will self-organize behaviors emerging from individual constellations of intrinsic factors in relation to the extrinsic factors posed during lessons. (Feldenkrais, 1972, 1975/1980, 1981, 1977/1993).

Nested within the principle of self-organization is the concept that behavior is dynamic and, therefore, plastic. In a classic statement, Feldenkrais (1949/1996) said, that with very few exceptions "behaviour is acquired and has nothing permanent about it but our belief that it is so" (p. 6). For example, Feldenkrais thought that cortical mappings along with movement patterns would reorganize in response to activity. He speculated, "the area for the third finger would be larger in a person who has learned to play a musical instrument than in one who has not" (1972, p. 14). Elbert, Pantev, Wienbruch, Rockstroh, & Taub (1995) observed this proposed effect for the left hands of string players. They used magnetic source imaging to demonstrate increased strength of response to and shifts in cortical response to tactile stimulation of the digits of the left hands in musicians versus controls. In addition, the amount of shift in cortical representation correlated strongly with experience.

A second similarity exists in describing behavior that assembles into preferred patterns or coordination modes. In dynamic systems terms, such behavioral states are called attractors. The stability of attractors is variable, depending on intrinsic factors such as experience or practice with the task, extrinsic factors such as environmental conditions, and the dynamics of the task itself (Thelen & Smith, 1994; Ulrich, 1997; Wallace, 1996; Zanone & Kelso, 1994).

A stable behavior, such as a habit, can be useful, as in a well practiced skill, or problematic, as in sitting or standing postures that lead to musculoskeletal dysfunctions and pain. Feldenkrais (1949/1996) offered a vivid description of problematic habitual behavior that "can be likened to a groove into which the person sinks never to leave unless some special force makes him do so. With time, the groove deepens, and stronger forces are necessary to remove him from it" (p. 118).

This leads to a third commonality: both dynamic systems theory and *Feldenkrais* view perturbation as instrumental for changing habitual behavior. From a dynamic systems perspective, the transition between two stable patterns is marked by a period of instability characterized by large fluctuations in behavior in which the organism explores the functional space. This period of instability arises from perturbations, such as critical change in a contributing subsystem or input from a new source. Changing habitual behavior, good or bad, requires perturbing the actual production of the pattern to allow organization of alternate patterns that might be similar or quite different. Less stable behaviors are more easily nudged from their shallow attractor spaces into alternative behavior states than are more stable ones. (Thelen & Smith, 1994, 1998; Zanone & Kelso, 1997).

One may consider the elements of *Feldenkrais* lessons as "special forces" that disturb habitual behaviors. With verbal instructions or manual guidance, teachers attempt to highlight students' usual movements, limit the use of these standard motions, and encourage exploration of other movement options. Teachers intend for these perturbations to destabilize habitual behaviors enough to allow students to self-organize individually appropriate alternative solutions.

A fourth connection between dynamic systems theory and *Feldenkrais* is their common belief that multiple subsystems affect behavior. The explanatory power of dynamic systems theory resides in the relationships among the parts that form the whole system (Prigogine & Stengers, 1984; Thelen & Smith, 1994, 1998; Thelen, Schöner, Scheier, & Smith, 2001; Ulrich, 1997). From a Bernsteinian account of behavior, these relationships constrain the innumerable degrees of freedom within the human to certain biomechanically efficient movements, while accommodating the various patterns of coordination that can result in similar behavior (Bernstein, 1967). These relationships are influenced by many factors, such as the system's history of experiences, the availability of resources, and the demands and constraints of a given task in a specific context. As the mix of factors changes, so does the behavior of the system (Haken, 1983; Prigogine & Stengers, 1984; Thelen et al., 2001; Thelen & Smith, 1994, 1998; Thelen & Ulrich, 1991).

Thelen and Smith (1998) argued that a dynamic systems view of behavior could account for situations in which "the same conditions lead to different behavioral outcomes, depending on the immediate previous history of the system" (p. 593). The unique set of experiences possessed by each person—from the events of the preceding hour to the happenings across a lifespan—is a significant component that impacts the particular movement patterns individuals produce.

While many neuroscientists give primacy to the role of the brain in organizing behavior, *Feldenkrais* and dynamic systems theory agree that it is but one component among the many cooperatively directing patterns of action. Feldenkrais (1949/1996) articulated this concept when he stated, "there is no function which has necessitated apprenticeship in which the somatic, motor, emotive or mental element can be singled out as the cause of the others" (p. 136). The interplay of these components with extrinsic and task-specific factors may account for the acceptance in *Feldenkrais* instruction of variable student responses to the same lesson and differing student improvement rates over a sequence of lessons.

Feldenkrais also emphasized the influence of lifelong histories of experiences, along with genetic inheritance and cultural influences, to give a developmental explanation for the movement variability among people (Feldenkrais, 1972, 1985). He noted, for example, more mobility of the hips, pelvis, and low back in people of Asian countries compared to those raised in western countries, which he attributed to cultural differences in sitting habits (Feldenkrais, 1981). Others have documented notable variations in how humans within cultures acquire crawling, independent walking, and reaching that are based on differences in experience with the task and neuromuscular characteristics (Adolph, Vereijken, & Denny, 1998; Bottos et al., 1989; Bottos, Puato, Vianello, & Facchin, 1995; Thelen, Corbetta, & Spencer, 1996).

Our fifth linkage between dynamic systems theory and *Feldenkrais* concerns their mutual emphasis on the continual interaction between the perception and action subsystems. Through perception, we detect intrinsic and extrinsic information that lets us understand our actions and drives the organization of contextually appropriate actions. In turn, our actions influence our perceptions. Dynamic systems theorists have drawn from the direct perception or ecological perspective that originated with Gibson (1950, 1966) to often conceptualize perception and action as the two subsystems critical to human motor behavior. The interactive roles of more microscopic subsystems can be subsumed within the larger systems of perception and action. In this manner, the integrated roles of nerves and muscles in both sensory and motor functions become more apparent. Researchers have examined how humans use perception to guide actions, such as catching balls or juggling or reaching, and, conversely, the use of exploratory actions to make perceptual discriminations, such as determining the length of unseen hand-held objects (Mark et al., 1997; Savelsbergh & Bootsma, 1994; Turvey, Park, Dumais, & Carello, 1998). After studying the development of reaching, Thelen and Smith (1998) stated that the development of motor behavior "must emerge from the continuous processes of moving and perceiving" (p. 608). In other words, perception and action are coupled in a tight interdependence.

Feldenkrais (1985) strongly linked perception and action in his work, noting that the human organism's "behavior and environment are a whole that cannot be subdivided and acted upon separately" (p. 36). He believed that in order to sense one must move. Musculoskeletal proprioceptors responsive to movement parameters inform us of internal states and specify our relation to our environment. For Feldenkrais (1949/1996), "re-education of the kinaesthetic sense, and resetting it to the normal course of self-adjusting improvement of all muscular activity—the essence of life—is fundamental" (p. 155). It is through movement that touch, visual, taste, and even olfactory receptors contact external stimuli. Indeed, many *Feldenkrais* lessons are intended to develop the ability to orient the teleceptors of the head while in a variety of positions and across a range of tasks. In turn, our perceptions guide and motivate our movements. A critical assumption in *Feldenkrais* is that developing one's ability to make finer perceptual distinctions is dependent on movement and, recursively, refining perception fine-tunes movement (Feldenkrais, 1972, 1981, 1984, 1994, 1949/1996).

In the *Feldenkrais Method*, the teacher repeatedly directs and guides the student's perceptual attention, whether through verbal suggestion or tactile cueing, as movement occurs. At different times, *Feldenkrais* teachers guide students to attend to various forms of perceptual information. In a thorough set of lessons, students monitor kinesthetic, haptic, and visual information, and may also focus on vestibular and auditory sensations. Commonly, teachers challenge students to notice differences in pressure, patterns of breathing, areas of the body in or out of contact with other surfaces, positional relationships between body segments, levels of muscle tension, and the shape and arrangement of the skeleton. Teachers attempt to improve the ability of students to make these perceptual discriminations by placing students in nonhabitual positions, altering their relationship to gravity, repeating similar movement patterns in various positional contexts, experimenting with differentiated and undifferentiated eye movements, doing both open and closed kinetic chain versions of movements, and many more techniques (Feldenkrais, 1972, 1979, 1984, 1994, 1949/1996).

From these five proposed similarities, we shift to three areas of conceivable differences between dynamic systems theory and *Feldenkrais*. The first concerns the importance of goal. Dynamic systems theory focuses heavily on behavior in context, with the goal driving the system organization. In studies, the task goal is up front and transparent to participants (e.g., Vereijken, Whiting, & Beek, 1992; Zanone & Kelso, 1997). During a *Feldenkrais* lesson, emphasis is placed on attending to sensory information present during exploratory movements. Teachers of this method argue that by first improving the sensitivity of perception one can learn to adapt any behavior more easily. Thus, during instruction, the motor *goal* or task is secondary to the *process* of improving perceptual-motor skills for subsequent use in self-organizing task-specific behaviors (Feldenkrais, 1972, 1984, 1985).

A second distinction might exist regarding nonlinearity. Dynamic systems theory expressly predicts both nonlinear and linear change in the behavior of an open system operating far from equilibrium (Haken, 1983; Prigogine & Stengers, 1984; Wallace, 1996). Whether change occurs rapidly or gradually, this principle accounts for episodes of nonlinear changes in coordination patterns. As subsystems change, behavioral modes become unstable and more variable. Exploring the task-relevant workspace facilitates the organization of other options for coordinating behavior. Not all options are equally viable for all systems; therefore, different systems (i.e., different people) might discover different solutions that best fit their current states (Schmidt & Fitzpatrick, 1996; Turvey & Fitzpatrick, 1993; Ulrich, 1997; Zanone & Kelso, 1994, 1997). The foundational ideas of *Feldenkrais* do not explicitly discuss nonlinear shifts in behavior. However, anecdotal accounts of sudden behavior reorganization, such as the shift in the lifelong irregular breathing pattern of an adult with cerebral palsy to a quiet and slow rhythm during a single FI lesson with Feldenkrais (Hanna, 1980/1993), suggest that nonlinear change can emerge via *Feldenkrais* instruction (Feldenkrais, 1977/1993; see issues of *Feldenkrais Journal* and *SenseAbility*). The nonequilibrium behavior of open systems might explain the variable rates of change and range of behaviors *Feldenkrais* teachers report observing in their students.

A third possible distinction considers the treatment of subsystems. Both dynamic systems theory and *Feldenkrais* emphasize that it is the interactions among subsystems that determine system behavior. Dynamic systems theory takes a step further and attempts to identify which subsystem (or subsystems), functioning as a control parameter, most probably drives a behavioral transition. For example, shifts in strength or body composition influence the kicking and stepping behavior of infants; changes in postural control affect the transition to independent walking (Thelen & Smith, 1994; Thelen & Ulrich, 1991; Ulrich, 1997). While *Feldenkrais* teachers are focused on facilitating individually appropriate changes in relevant subsystems, they believe certain factors may influence behavior across individuals, such as the role of eye movements in coordinating reaching or turning (Feldenkrais, 1972, 1949/1996).

In summary, dynamic systems theorists (e.g., Thelen & Smith, 1994, 1998; Ulrich, 1997; Zanone & Kelso, 1994) and the basis for the *Feldenkrais Method* (Feldenkrais, 1972, 1981, 1985, 1949/1996) both describe human behavior as self-organizing from individual, complex, continual processes that relate perception, action, and experience. Stable behaviors need to be perturbed to permit their reorganization into related or new patterns of coordination. Distinctions between dynamic systems theory and *Feldenkrais* pertaining to the role of goal or task, nonlinearity, and the identification of control parameters may represent differing points of emphasis for the dynamic systems researcher and the *Feldenkrais* practitioner. Overall, the strength of these linkages suggests that dynamic systems theory is an appropriate basis for researching the *Feldenkrais Method*. We now turn attention to research that has assessed the *Feldenkrais Method* and its efficacy. We review the limited experimental studies in the next section and suggest directions for future research from a dynamic systems perspective.

Research Past and Future

To date, the number of published, peer-reviewed studies examining the effectiveness of the *Feldenkrais Method* for changing motor behavior and improving function is low. Some considered the effects of single lessons on healthy adults or people with relatively minor physical complaints (Brown & Kegerreis, 1991; Chinn, Trujillo, Kegerreis, & Worrell, 1994; Ruth & Kegerreis, 1992; Seegert & Shapiro, 1999). Others have observed older adults (Gutman, Herbert, & Brown, 1977), people with multiple sclerosis (Johnson, Frederick, Kaufman, & Mountjoy, 1999; Stephens et al., 1999), and adults with chronic pain (Bearman & Shafarman, 1999) for changes subsequent to a series of *Feldenkrais* lessons. Although all but one of these studies (Gutman et al., 1977) reported alterations in observed measures after intervention, these studies have design limitations (e.g., lack of appropriate control groups) that weaken the impact of their findings and leave room for alternative explanations of outcomes.

One well controlled, randomized study demonstrated significant functional changes after *Feldenkrais* lessons. Lundblad, Elert, and Gerdle (1999) conducted a yearlong study of female factory workers who had complaints of neck and shoulder pain. Researchers randomly assigned participants to a control group, physiotherapy group, or *Feldenkrais* group. Work-based interventions lasted 16 weeks. Lundblad et al. (1999) conducted an extensive battery of work performance and physiological tests before and after the interventions. They summarized that little or no change occurred in the physiotherapy group, the control group often worsened, and the *Feldenkrais* group improved with respect to neck and shoulder complaints and function over the study year.

These studies offer clues to the functional impact *Feldenkrais* might have on behavior. Clearly, more research is needed to justify or disprove its effectiveness in clinics and schools. Research questions focused on whether or not *Feldenkrais* lessons can change motor behavior might not require any particular theoretical framework. But questions concerning how the method produces change, queries into the process of change occurring within individuals, or efforts to differentiate *Feldenkrais* from other interventions bring theoretical assumptions to the foreground.

We have proposed that dynamic systems theory shows notable similarities in many of its principles to the basic tenets of the *Feldenkrais Method*. This theory embraces the complex and interactive qualities of the learning process supposedly facilitated by the *Feldenkrais Method*, and so may be an appropriate (though arguably not the only) perspective for research. Given the significant parallels and cognizant of possible distinctions, we propose that dynamic systems theory affords an appropriate framework for constructing research questions about the *Feldenkrais Method* that extend beyond whether it *can* change behavior to *how* performers respond. We offer several possibilities below.

Dynamic systems theory and *Feldenkrais* hold in common the principle that multiple subsystems interact to produce behavior. Changing a subsystem and, thus, the relationship among subsystems might cause a behavior to change. Certain *Feldenkrais* lessons emphasize one functional subsystem in an effort to facilitate reorganization of the integrated system. For example, anecdotal reports of teachers claim that a lesson about differentiating eye movements (a subsystem behavior) while quietly lying supine has led to increased range of turning while seated (a system behavior). Typically, one would expect an increase in range of motion to follow stretching exercises or other activities that increase tissue temperature. Resting supine while doing eye movements would not be expected to induce these changes. Researchers could use motion analysis or other range of motion detectors to establish baseline turning ranges of participants prior to the lesson and then remeasure turning afterwards. If turning increases following a lesson with eye movements only, the principle that multiple subsystems interact to coordinate behavior would be supported.

Another shared principle of dynamic systems theory and *Feldenkrais* is that perturbations can cause stable behaviors to shift into other coordination patterns. Practitioners believe the elements of *Feldenkrais* lessons stimulate students to reorganize current behaviors into refined or new modes of coordination. Researchers could follow the individual course of learning in response to the perturbations produced within a single lesson about the relationship of pelvic motion to the trunk and head. Because such ATMs involve frequent repetitions of a relatively periodic movement, they are amenable to analysis of parameters, such as relative phase. Researchers could first gather kinematic data as a participant sits on a stool and responds to simple instructions to shift the weight from one side of the pelvis to the other. A phase variable could be derived relating the motion of the pelvis with that of the head. Three phase relations are conceivable: absolute phase locking in which the pelvis and head move together, relative phasing with the pelvis leading the head, and variable phasing, if the head remains fairly stationary as the pelvis moves. Once the initial coordination pattern is known, researchers could track this variable as the participant follows the instructions of an ATM "pelvic clock" lesson and again at its conclusion for any changes in the coordination pattern. If performers change their initial preferred phase relations to other patterns after the lesson, this would support the contention that *Feldenkrais* lessons perturb existing behaviors and so facilitate the reorganization of other coordination modes. Researchers might also be interested in observing changes in this exemplary pattern longitudinally over a series of related pelvic clock lessons and including follow-up retention observations. A variation on this longitudinal study may be informative about the transfer and generalization of *Feldenkrais* learning by using this test movement in a series of lessons that has no pelvic clock lessons at all, or perhaps in only a single lesson.

We also propose a design that could address the differing emphasis of dynamic systems theory and the *Feldenkrais Method* regarding on what a performer should focus—goal or process—while learning a new task. Several researchers have demonstrated Bernstein's (1967) ideas that when adults acquire a novel skill they pass through three phases. Initially they freeze out degrees of freedom, stiffening up and coupling joints to act as a unit rather than independently. Subsequently, performers increase exploratory behavior, loosening up joint couplings and searching for more efficient patterns of movement, before settling into the third phase, in which patterns become stable and efficient (Newell, 1996; Vereijken, Van Emmerik, Whiting, & Newell, 1992; Ulrich 1997). One could argue that the approach advocated by *Feldenkrais* would facilitate the process of skill acquisition particularly well for performers who are in Phase 1 and need to explore options to detect the relevant perceptual information needed to move on to Phases 2 and 3. A dynamic systems theorist might argue that by focusing on the goal, the complex human system would be drawn to explore, as control (a subsystem) improved, thus progressing more dynamically over time without explicit attention to the process from tightly coupled to more variable and exploratory. The test would be in the rate of progress and changes in other learning measures made by two groups of individuals, if "guided" by these competing principles.

One could adapt the paradigm of Vereijken and colleagues, who used a ski simulator (e.g., Vereijken, Van Emmerik, et al., 1992; Vereijken, Whiting, et al., 1992) for such a study. As Vereijken previously demonstrated, training regimes that varied performers' target frequency or instructed them to attend to the frequency versus the amplitude of platform movement were no more effective, and sometimes less effective, learning strategies than discovery learning. The behaviors of performers who learn via discovery to move the simulator platform as quickly and as far as possible could be compared with others who receive *Feldenkrais*-based guidance in their discovery process. For example, prior to getting on the simulator, participants might first be instructed to do a variety of lateral sway tasks that attempt to make them aware of the different sensations and action possibilities associated with coordination patterns that emphasize or minimize certain joint motions. Once participants are on the ski simulator, the teacher might ask them to notice a variety of features of their actions, such as where their heads are relative to the apex of the simulator or how they sense their weight shifting at their feet.

We noted another possible distinction between dynamic systems theory and *Feldenkrais* concerning control parameters. Dynamic systems theorists often try to identify a subsystem that generally acts as a control parameter for a given behavior, while *Feldenkrais* teachers remain more interested in the interactions among subsystems and identifying individually appropriate factors for facilitating change. For example, strength is a control parameter for certain behaviors, and activities to increase strength are typical components of preventative and rehabilitation programs. Some *Feldenkrais* practitioners have anecdotally reported increases in strength in students after a series of lessons, even though the lessons did not focus on strength development and the students did not engage in typical strengthening exercises. Researchers might compare these two positions in a study that examines changes in strength, a factor that obviously influences one's ability to lift a load from the floor or perform a squat lift. Groups engaged in a weight-training course or a work hardening program based on a traditional hypertrophy model of strength development could be compared with participants in a series of ATM lessons only. The ATM participants conceivably would be learning to make more efficient use of their existing strength capacities but would not be engaged in muscle hypertrophy tasks per se. A third group might be included that combines methods. If the ATM group makes notable improvements in strength as measured by the amount of weight they lifted, this would support the *Feldenkrais* position that, given individual differences, no one subsystem or control parameter can a priori be deemed most in need of change in order to shift the behavior of the system. Besides tracking how much weight a person could lift, researchers might also be interested in monitoring the efficiency and, thus, the safety with which performers execute their lifts.

These questions and more regarding the *Feldenkrais Method* await answers. It is our hope that the tutorial about the method, the presentation of the connections between dynamic systems theory and *Feldenkrais*, the highlights of existing research, and suggestions for studies motivated by dynamic systems theory will encourage more researchers to critically examine the efficacy of *Feldenkrais*.

Exploring Application and Theory

Feldenkrais Method practitioners claim to intervene in a wide variety of situations and facilitate a person's own process of self-improvement through attentive, guided movement explorations. Yet, well designed experimental study of these assertions has so far been minimal. Based on the similarities we described between the principles of dynamic systems theory and the concepts of *Feldenkrais*, we proposed that rigorous studies of this method could be designed from a dynamic systems perspective and suggested several specific research questions. We believe that studies of the *Feldenkrais Method* hold importance for professionals in the movement sciences on three fronts. First, these studies will refute, promote revision of, or lend support to *Feldenkrais* proponents' claims. Second, this research may well expand our theoretical understanding of the processes of learning and human motor behavior development. Third, we believe this affords an important opportunity to bridge the gap between theory and practice. Whether or not the principles of dynamic systems theory and the *Feldenkrais Method* are the match we suggest they are, the process of discovery seems likely to be an informative exploration.

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Appendix A. Example ATM Sketch: Rolling to Sit by Sweeping the Arms

Before beginning this or any ATM lesson, a teacher will typically speak to students about focusing their attention on the process of proceeding through the lesson, attending to sensory information, and minimizing their concerns about achieving a particular outcome. The teacher may or may not tell the students what the name or task of the lesson is before they do the ATM.

1. Lie on your back with your legs spread a comfortable distance apart. Bend your knees and bring your feet to stand. Rest your arms on the floor above your head.
2. Tilt your knees to the left, and then sweep your arms along the floor toward the left. Let yourself curl so that your nose and face come toward your left knee. Return to your starting position, and repeat this movement several times. Is there enough space between your legs so that your right knee could tilt to rest on the floor?
3. Rest in the middle with your arms by your sides and your legs long. Do you notice any changes in your contact with the floor or in your breathing?
4. Bend up your knees and bring your arms overhead. Now, begin the movement by sweeping your arms, then let the tilting of the knees follow as you move your nose closer to your left knee. Reverse the movement, pause, and repeat several times. How is this different from leading with your knees?
5. Pause in the middle, then return to initiating the movement with the tilting of your knees then sweeping your arms to the left as you curl your face toward your left knee. Is there a place you can find for your left arm so that your elbow can bend and you can take some weight on your left arm?
6. Rest in the middle. As you rest, remember the sequence of movements you just did. Imagine doing that same sequence to the right.
7. Now actually do that series of movements to the right. How is it to do the movements to the right compared to your left?
8. Rest a moment. Notice the position and sensation of your legs.
9. Resume the movement to one side, and, as you return to the middle, let the movement continue to the other side. So, you find yourself sweeping your arms, rolling to one side, coming onto your elbow and up to side sit; reversing that; and sweeping, rolling and coming up to sit on the other side.
10. Rest and scan yourself for any differences from when you first laid down on the floor. Then use what you have just learned to come up to sit, then stand. Notice if your standing is different, then walk around and observe how walking feels.

Note

1. *Feldenkrais*®, *Feldenkrais Method*®, *Functional Integration*®, and *Awareness Through Movement*® are registered service marks; and *Guild Certified Feldenkrais Practitioner*cm and *Guild Certified Feldenkrais Teacher*® are certification marks of the FELDENKRAIS GUILD®.

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