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THE IMPACT OF MINDFULNESS ON

BALANCE, COGNITION AND AROUSAL

by

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ABSTRACT

The Impact of Mindfulness On Balance, Cognition and Arousal

The control group study investigated the impact of a mindfulness centering technique, taken from the Japanese martial art *Shin Shin Toitsu Aikido,* on balance and reaction time performance as well as on concurrent levels of galvanic skin response (arousal). Study design and analysis occurred within a social neuroscience framework that included the cultural view of mind, body, and emotion as an integrated whole, and brain research from multiple disciplines revealing the neural integrated organism.

Thirty-one subjects were tested in a visual-stimulus reaction time task and in an unstable rocker-board balancing task. Prior to repeating the tests, experimental group participants learned the centering technique and control group participants received a brief lecture.

Significant improvement for the experimental group over the control group was limited to one balance measure. Results in general indicated a possible trend to improved balance performance with centering. Arousal level correlated significantly with performance and task type for the entire sample. In light of ongoing neuroscience research, the study's findings point to the value of approaching clinical studies of performance from an integrated organism perspective.

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Chapter 1

INTRODUCTION

The control group study measured reaction time and balance stability before and after participants learned a mindfulness centering technique from the Japanese martial art *Shin Shin Toitsu Aikido*. The study also investigated the relationship of arousal level to performance by tracking galvanic skin response (GSR) throughout the session. The goal of the study was to establish whether or not the centering technique significantly impacts balance and reaction time performance, as well as concurrent levels of arousal.

The study arises from observations and anecdotal evidence from the *Shin Shin Toitsu Aikido* that suggest the art improves overall personal performance including mental clarity, emotional calm, and physical coordination and stability. The fluid techniques of aikido require overcoming automatic reactions – mental, physical, and emotional – that tend to arise in the face of a threat. The training seeks to develop the dynamic ability to maintain clear awareness, good decision-making, and effective action moment-to-moment in an evolving crisis.

Cultural understanding of human performance and the creation of practices that teach skills critical to survival have progressed in human history through processes of observation and trail and error. Embedded in many cultural notions of the mechanisms of skillful action is the assumption that mind, emotion, and body work as an integrated whole. In this context, effective technique (e.g., of the fighter or the athlete) requires training mind and emotion as intrinsic aspects of quality physical action. Practices that

take a holistic approach to skill mastery reside in the mythological traditions of culture and may evolve from the teaching of specific skills to addressing universal skills for living. Martial arts, in general, evolved in such a manner—beginning as combat training and becoming art form for the development of general personal mastery.

The importance of scientific examination of the practice is two-fold: the potential of the practice as a tool for improving/maintaining well being, and the research opportunity the practice provides as a high-function model (as opposed to studies of dysfunction) concerning the mind/body connection. Potential applications include managing stress, improving balance and coordination, improving cognition under duress, and improving clear thinking in conflict. Currently, there are no studies that specifically look at *Shin Shin Toitsu Aikido* and the impact of the mindfulness training on balance and cognition.

While many Eastern "life skills" practices assume a connection of mind, body, and emotion (something also taken for granted in Western culture in sports), there is little research regarding the practices due to the dualistic view of mind and body in Western science. New information in neuroscience begins to reveal what has long been understood in culture through observation and practice – that the living organism responds as an integrated whole.

The opening of the frontier of the brain has resulted in new categories of scientific study that cross traditional boundaries. John Cacioppo, one of the pioneers in the new field of social neuroscience, expresses the need to work beyond the limits of the past: "The abyss between biological and social levels of organization is a human construction, however, one that must be bridged to achieve a complete understanding of human

behavior" (Cacioppo, 2000, p. 3). This study takes place within a social neuroscience framework with the goal of examining the view that mind, body, emotion, and social behavior are four indivisible components of an integrated whole. By utilizing "a multilevel integrative analysis" (ibid) that includes both a biological and a social approach, a greater understanding of mind and behavior becomes possible.

From the social science perspective, *Shin Shin Toitsu Aikido* is rooted in the cultural traditions of mythology. Myth arises from observations and explanations of life and imparts lessons learned through symbolic stories, rituals, and practices. While the spiritual tales may be dismissed by modern science as non-factual, the scientific value of myth resides in its underlying observation of life. The tree grows from the seed regardless of the accuracy of explanations as to how and why. Bridging the gap between culture and science involves uncovering the legitimate observation and knowledge behind the symbolic form.

In neuroscience, research on emotion and consciousness provides a general view of the neural networks of the integrated organism. Research on the dynamic interplay among systems involved in awareness, information processing, and action includes studies of: anxiety and balance; sensory information processing and brain regions involved in postural stability; and attention and neural synchronization. Taken together, the array of research provides insights into the possible mechanisms involved in "centering" and its observed impact on physical, mental, and emotional responses.

Shin Shin Toitsu Aikido

Aikido is a Japanese self-defense art in which one utilizes the energy of the attack by moving with and connecting to an opponent's force rather than by blocking or

avoiding that force. The word *aikido* means "the way of harmonizing with energy" (*ai* – harmonize; *ki* – energy, *do* – way or path). Aikido is a systems approach; successful implementation of the art requires a shift of awareness from "self versus other" to an awareness of the interaction that includes self and other in a dynamic whole. The ability to accomplish this involves more than physical technique. A clear eye to the systems dynamics of an attack requires a "cool head" in the face of a threat as well as quick reflexes, good judgment, precise timing, and the ability to adapt technical repertoire from past experience to unique circumstances in the moment. The aspect of the training that develops this kind of response is called *shin shin toitsu* or "mind/body unification" (the word for mind and for body is *shin* even though the kanji are two different images). Mindful centering-in-movement or "balance" exercises provide the training means for mind/body unification. The balance practice assumes that the mental impacts the physical and vice versa, that state of mind will impact the action of body, and that stable balance is one of the physical qualities of a global high functioning state of being. The assumption is not that mind and body are separate substances that impact each other, but that mind and body are aspects of a unified whole that also integrally includes emotion. Ultimately, the internal integrated system includes interaction in the external environment and the achievement of *aiki* in the world.

Study Overview

This study takes place at one level within the larger multilevel analysis of the mind/body connection. It seeks to lay a foundation for future study by identifying and isolating a particular aspect of a mind/body practice. Most current research on the relationship of balance and cognition takes place in a traditional dualistic framework that

assumes the basic separation of mind and body. While these studies recognize the possibility that the physical process of balance may be influenced by cognitive activity (and vice versa), the view is not one of an integrated whole. Studies on balance and emotion and/or stress are limited. No current studies on balance and cognition or balance and emotion address the relationships/influences from a social neuroscience perspective or from an integrated organism paradigm. Meditation research has linked mindfulness practices to lowered levels of stress and anxiety, however no major studies have explored the impact of meditation on cognition or balance. There are currently few studies on aikido itself. While related studies on the impact of other mind/body practices (tai chi and yoga) on various physical and stress measures (including balance) have shown positive correlations, none have identified the particular aspect of the practice that impacted the changed behavior, and none have been based on a hypothesis as to why a correlation occurred. Unlike previous studies of tai chi, yoga, and aikido, this study identifies and isolates a particular aspect of a mind/body practice that can be done in a research setting.

The design of this research is based on studies of balance and cognition in aging. These studies explore whether or not cognitive activity interferes with balance and/or if a balance challenge interferes with cognition. In the studies of the impact of cognition on balance, participants focused attention on accomplishing a particular cognitive task (e.g., memorization, a math calculation, reaction to a stimuli) during which time their postural stability was monitored. While utilizing a similar testing setup, this study differs from the balance and cognition research in that it examines whether or not a general state of mindful awareness impacts postural stability and cognitive task performance.

Hypothesis – Neural Activity in Centering

Shin Shin Toitsu (unification of mind and body) involves an ongoing dynamic confluence of perception, decision-making, and movement. In the course of changing circumstances, sensory input and evaluation continuously update to inform choices for efficient action. Awareness, choice, and action – within oneself and in relationship to an opponent – come together in a seamless dynamic whole. The "custom-designed" response fuels top-level performance. In mythological terms, the practitioner becomes "one with the universe."

From a neuroscience perspective, top-level performance correlates with a high level of sensory information processing and a corresponding optimal level of attentional arousal. Sensory information processing, which takes place at conscious and non-conscious levels, contributes to perception and neural executive decisions based on that perception (Courchesne, 1997). Executive decision-making directs action. Arousal level, a component of behavioral state, has been found to influence attention, information processing, and performance. The high and low ends of arousal correlate with poorer performance. Optimal arousal for sensory information processing occurs during exploration, as compared to more extreme arousal elevation during a threat response (Devilbiss, Page, Waterhouse, 2006). Arousal level spikes during a threat response, and sensory information processing gives way to stereotypic motor output strategies (Balaban, 2001; Devilbiss, Page, Waterhouse, 2006).

While the high-performance state activates during exploratory behavior (and breaks down in a threat response), *Shin Shin Toitsu Aikido* training assumes that a high-performance state can be triggered and maintained intentionally. An understanding of the

mechanisms behind the triggering of a high performance state by *centering* may be found, in part, in studies concerning multisensory integration through neural synchronization.

Synchronization involves distance-separated neural signals and is a means of binding information concerning the same object or event, as well as concerning related anticipated activity. The large scale binding accomplished in synchronization is considered crucial in "object representation, response selection, attention and sensorimotor integration" (Engle, Fries, Singer, 2001). Research implicates synchronization in sensory information processing, exploratory behavior, and high-level performance, as well as suggests that arousal level influences the scope and configuration of synchronous activity (Devilbiss, Page, Waterhouse, 2006; Engle, Singer, 2001; Engle, Fries, Singer, 2001).

Selective attention modulates neural synchrony (Engle, Fries, Singer, 2001). Attention to a single object enhances synchrony, while presentation of a second, separate object breaks down that synchrony (Engle, Debener, Kranczioch, 2006). In spatial attention, synchronization of information about the "one object" includes the whole spatial field, thus preparing for subsequent events within the attended location. This author's hypothesis concerning the mechanisms underling *centering* expands the notion of spatial attention from the purely visual to a three-dimensional awareness of space that includes gravity and somatosensory information. The "one object" then, is the whole body in action in the three-dimensional environment. Placing awareness at center of mass (gravity) means attending to whole body location in the context of movement in relationship to gravity. Postural stability, which involves maintaining center of mass over

base of support, requires ongoing sensorimotor integration including vestibular, somatosensory, visual, and motor signals.   Attending to center would enhance the large scale synchronous binding of postural stability signaling, improving stability as well as setting up a global high performance state for subsequent events occurring in the attentional field.

The study assumes that triggering a high performance state by an attentional shift is an innate behavioral option provided care of evolution. Participants learned the centering technique in a very brief training experience and then immediately applied the attentional shift-to-center during reaction time and balance testing. The reaction time test design was based on reaction time exercises in aikido involving an arm swing movement in response to an opponent's attack. The balance challenge on a rocker board was adjusted to a moderate level relative to each participant. The assumptions concerning the balance challenge level were: 1) low difficulty would not require the attentional focus of a high performance state, therefore no change would be seen with centering and, 2) high difficulty would distract attention to the threat of falling, potentially triggering anxiety and more covert physical strategies to regain stability. Galvanic skin response, a measure that indicates relative stress level, was monitored throughout the research session to provide correlation data concerning task performance and increases/decreases of arousal level.

Conclusion

The mind/body practice of *Shin Shin Toitsu Aikido* presents an invaluable research opportunity for exploring the interconnection of brain, body, mind, emotion, and society. The living practice rooted in the "wisdom of the ages" bridges science and

society, providing a testing ground for neuroscience theory in the context of human culture. This study explores one aspect within the broader range of inquiry concerning the mind/body connection and the integrated organism paradigm.

Chapter 2

REVIEW OF LITERATURE

Introduction

The study background includes social science regarding the cultural roots of *Shin Shin Toitsu Aikido*, neuroscience relating to the integrated organism, and clinical studies on balance. The social science view comes from the mythological stories and related practices concerning the hero's journey. Neuroscience literature includes 1) the general view of the integrated organism revealed in research on consciousness and emotion, and 2) research that relates to the intersection of postural stability pathways with emotional and cognitive neural networks. Clinical studies include balance and cognition, and balance and emotion research.

Social Science – The Cultural Roots of *Shin Shin Toitsu Aikido*

Shin Shin Toitsu Aikido's cultural roots include hero's journey mythology and practices that explore the relationship between the conscious and non-conscious self. The mind body unification (*shin shin toitsu)* exercises, including the centering technique utilized in the study, derive from yoga – a mind body tradition arising out of myth as a practice. Joseph Campbell (1990) in *The Transformation of Myth Through Time* explains that, "[yoga] comes from the root *yuj*, which means 'to yoke,' to connect or join something to something else. What is being yoked is our ego consciousness, the *aham* consciousness, to the source of consciousness" (p. 129). The practice of yoga includes bringing conscious attention/awareness to the body in movement and stillness, with an

emphasis on balance. The assumption of the practice is that the process of bringing mindful awareness to the body aligns consciousness with nonconscious processes of life in the body, and in so doing connects with the underlying "wisdom" of the body and the resources of the hero within.

In the hero's journey stories, the hero embarks on a "difficult, dangerous task of self-discovery and self-development" (Campbell, 1949, p. 23). Tales of peril and enticement provide symbolic imagery for the real challenge of overcoming the fear, or longing, or anger, or greed, or hopelessness that the external threat attempts to evoke. Tested by danger and temptation, the hero overcomes internal weaknesses that undermine his or her ability to act in the world. The stories depict the hero's mental clarity, emotional calm, and effective physical action as inextricable parts of a whole. The myths portray the accomplished hero as finding the still point within, while the associated rituals and practices allow the hero to "rehearse the universal pattern as a means of evoking within himself the recollection of the life-centering, life-renewing form" (Campbell, 1949, p. 43).

<div align="center">Neuroscience Research – The Integrated Organism</div>

From the perspective of dualism, the notion that "centering" could impact human performance is magical thinking. Separation of mind and body assumes the absence of integrated systems among mental, physical, and emotional phenomenon. The view into the brain provided by new technologies proves that assumption wrong. Brain research in multiple scientific disciplines is uncovering interconnected neural processes of mind, body, and emotion.

The General View – Consciousness and Emotion

Antonio Damasio (1999, 2003) links consciousness with body, mind, and feeling to reveal the neural structures and processes of the integrated organism. Mind arises from the integrated activity of body and brain in the process of life, in which "the brain's body-furnished, body-minded mind is a servant of the whole body" (Damasio, 2003, p. 206). Consciousness itself involves the neural representation of events in the body that come to be known through feeling or "affect." Affect includes the full range of bodily events, e.g., temperature, hunger, pain and pleasure, and the physiological events of an emotion. These bodily events are represented in the brain and ultimately become known in the "theater of the mind" (Damasio, 2003, p. 28) through a process that is the ongoing creation of consciousness. These findings parallel mythological observations linking consciousness and the body that describe the mental, physical, and emotional as intertwined aspects of a whole.

Neuroscience research on emotion redefines emotion itself as a whole organism bioregulatory system involving the coordinated response of mind, movement, and feeling (Damasio, 2003; Davidson, 2001; LeDoux, 2002). An emotion begins when something in the environment (a snake on the path) or in the mind's eye (the thought of a difficult person) triggers the brain's emotional appraisal apparatus. An "emotionally competent stimuli" (Damasio, 2003, p. 58) may be either innate (snake-like things) or learned (past experience with said difficult person). When an appraisal region of the brain identifies an emotionally competent stimulus, that region relays signals to deployment areas of the brain that then trigger the actual emotional behaviors in both body and brain. Body events may include changes in heart and respiration rate, body temperature, sweat level,

muscle tension and balance stability. The deployment of an emotion in the brain includes impacting mind in a way that is consonant with the body activity of an emotion. Attention, memory, learning, decision-making, and even the content of thought are all players in the action of an emotion (Damasio, 2003; Davidson, 2001, LeDoux 2002). The overall experience adds up the generalized "feel" of a given emotion.

Cognitive response in emotion includes working memory executive function – the process of "comparing, contrasting, judging, predicting" (LeDoux, 2002, p. 178) that we identify as *thinking*. During emotional arousal, images relating to a perceived danger take over working memory while all other inputs vying for attention are blocked (LeDoux, 1996). Executive function occurs across several interrelated regions of the prefrontal cortex that send outputs to movement control regions – both cortical and subcortical – for the action implementation of executive decisions (LeDoux, 2002). The neural view of emotion and its interconnection with attention, decision-making, and action reveals the internal workings of the hero's test in the face of danger.

<div align="center">*Postural Stability Connections*</div>

The Vestibular System

The sense of balance is a *system* concerning the relationship of the organism and the environment. Critical to that system is sensory information about the organism's location relative to the earth's gravity and to movement, information provided via the peripheral vestibular system in the inner ear labyrinth. Postural stability requires an ongoing dynamic integration of vestibular information with somatosensory and visual inputs for the maintenance of center of mass over base of support. Sensory signals from the vestibular labyrinth go to the central vestibular system, which consists of four nuclei

in the brain stem. Along with the labyrinth input, the vestibular nuclei receive

somatosensory and visual inputs critical to constructing balance moment to moment. The

vestibular system is central to the larger postural control network that translates sensory

information into the action of coherent movement. The vestibular system role in

sensorimotor integration is described by Kohen-Raz (1986) as "the complex and minutely

programmed coordination between visual and proprioceptive input on the one hand and

the output of the oculomotor, cervical and limb-positional responses on the other" (p. 36).

Tracking vestibular signals across the brain via research from a variety of

disciplines uncovers the integration of postural stability pathways in larger behavioral

networks. The vestibular trail includes neuroscience research on postural control links in

emotion and cognition, as well as research concerning several "convergence zones" in the

brain – the brainstem, cerebellum, basal ganglia, and regions of the cerebral cortex.

While these areas have long been known to participate in postural control, recent findings

on the neural substrates of balance point to connections of postural control with

autonomic function, cognition, attention, emotion, and behavior (Balaban, 2002, 2003;

Yates & Stocker, 1998; Yates, Holmes, & Jian, 2000; see review by Courchesne, 1997).

The research describes interconnected systems of systems that "add up" to

complex behavior of the whole living organism responding in an environment. Postural

stability related pathways are integrally interwoven throughout this mega-system.

Brainstem

The neural exploration of the long observed behavioral link between balance and

anxiety identifies vestibular connections to brainstems regions implicated in fear and

anxiety. Balaban's research and extensive reviews describe vestibular involvement in

autonomic control of heart, breath and digestion; in regulation of levels of wakefulness and attention; and in information processing (Balaban 2002, 2003; Balaban & Thayer, 2001).

Two of the vestibular connected brainstem structures identified in the anxiety/balance behavioral network are the locus coeruleus (LC) and the raphe nucleus. The locus coeruleus is involved in the regulation of arousal and attentional levels, and is active during anxiety and fear. The LC has bi-directional links with the vestibular nuclei. Collateralized projections from the LC direct norepinephrine (NE) to multiple regions in the brain. One of the areas in the LC-NE network is the thalamus, which relays sensory information to the cerebral cortex. A study in rats on the LC-NE thalamus pathway looked at the impact of LC-NE activation on sensory integration during different states of arousal (Devilbiss, Page, Waterhouse, 2006). During exploration the LC-NE system promotes synchronous discharge in the thalamus sensory relay nucleus, facilitating the gathering of sensory information. During greater arousal and vigilance in an anxiety/fear response the synchronicity breaks down. Devilbiss et al. (2006) cite other research linking fluctuations in tonic LC–NE levels to: 1) performance level in sustained attention tasks (Aston-Jones et al., 1994; Rajkowski et al., 1994; Usher et al., 1999), 2) in working memory (Arnsten and Dudley, 2005), and 3) in decision-related actions (Ivanova et al., 1997; Clayton et al., 2004; Nieuwenhuis et al., 2005) according to an inverted-U function. Inverted-U function states that performance peaks at an optimal level of arousal, declining at both lower and higher levels.

The raphe nucleus is another vestibular connected brainstem region Balaban (2002, 2003) and Balaban and Thayer (2001) identify as a part of the balance/anxiety

behavior network. Raphe nucleus activity increases in anxiety as it sends collateralized serotonergic outputs to a network of brain regions, including the vestibular nuclei, the central amygdaloid nucleus, the parabrachial nucleus, the cerebral cortex, and the cerebellum. These collateralized projections provide a mechanism for "coordination of vestibular, autonomic, and affective responses" (Balaban, 2002, p. 472). Balaban & Thayer (2001) site research on serotonin (Rueter, Fornal, & Jacobs, 1997) that links the level of serotonin release to the level of behavioral or motor arousal, hypothesizing that the sensitivity of vestibular nuclei increases with serotonin input from the raphe nucleus. This would parallel the attentional arousal affects of the LC-NE action in regards to sensory information processing. Research by Jacobs and Fornal (1993) theorizes that an increase in raphe nucleus activity inhibits sensory information processing and facilitates motor activity, and that inhibition of dorsal raphe nucleus activity during attentional or orienting stimulation facilitates sensory processing while depressing motor activity (as cited in Balaban, 2001). Balaban (2001) hypotheses that these "serotonergic and noradrenergic (NE) activity may act synergistically during anxiety to increase postural sway through actions in the vestibular nuclei" (p. 67). This author suggests that the same mechanisms underlie the postural stability observed in the high functioning states during Aikido training.

Cerebellum

The cerebellum has long been known to play a central role in movement control, serving as postural control headquarters, "where all the information relevant to the execution of postural responses is gathered, monitored, checked, screened and redistributed in fractions of seconds" (Kohen-Raz, 1986, p. 52). Research in multiple

disciplines now implicates the cerebellum in the broader range of human behavior, including cognition and emotion (Jueptner, Ottinger, Fellows, Adamschewski, Flerich, Müller, Diener, Thilmann, & Weiller, 1997; see review by Courchesne, et al., 1997).

Research indicates that the primary function of the cerebellum may be sensory information processing rather than motor output control (Jueptner, et. al, 1997). Sensory information processing includes *mental* activities (connecting, sorting, evaluating, prioritizing, deciding, etc.) concerning sensory information. This non-verbal, non-conscious cognition "makes sense" of divergent sensory inputs both before and during movement. The raphe nucleus projections to the cerebellum described in the anxiety research may link the cerebellum into the larger network involved in the activating/suppressing of sensory information processing.

Consonant with the research on the sensory information processing function of the cerebellum are findings that implicate cerebellar participation in a range of human activity beyond movement control. This includes mental activities such as sustaining and shifting attention, working memory, mental exploration, and complex cognitive problem solving – all of which involve sensory information processing. Cerebellar dysfunction is associated with developmental abnormalities in autism, including cognitive, attentional, emotional, and social difficulties (see review by Courchesne et al. 1997). Courchesne et al. (1997) sum up the role of the cerebellum as one of "[modulating] activity in diverse neurobehavioral systems in order to accomplish its prime function, learning to predict and prepare for imminent information acquisition, analysis or action" (p. 274).

Basal Ganglia

The view of the basal ganglia as a movement control region involved in coordinating, discriminating, and directing motor functions (Kohen-Raz, 1986) has been expanded to include involvement in cognitive and affective behaviors. Recent studies show that the basal ganglia play a diverse role in a wide range of functions including sensory feedback, attention, visual perception and learning (Brown, Schneider, and Lidsky, 1997). Anatomical findings connect the basal ganglia in a two-way relationship with multiple cortical areas. In the Brown et al. (1997) review, the authors conclude that the body of research points to the basal ganglia as having an executive role in "decision-making, movement selection, behavioral shift and working memory" (p. 157).

Damasio (1999) identifies the basal ganglia/thalamus/cortical network as being central in the process of whole scale changes that occur in approach/withdrawal (emotional) responses including physical, cognitive, and behavioral changes. Damasio's whole system view reveals postural control functions as integrated into the comprehensive response of the living organism within an environment.

Cerebral Cortex

Research regarding vestibular-cerebral cortex connections and cortical integration of postural control networks within broader behavioral systems has expanded greatly in recent years. Vestibular pathways have been identified in many areas of the cortex (see review by Fukushima, 1997), primarily multimodal regions or "convergence zones" involved in complex behaviors including movement, attention, sense of self, and social cognition. The temporoparietal region is among the vestibular connected cortical areas (Friberg et al., 1985; Bottini et al., 1994; and Vitte et al., 1996) cited in the

corticovestibular review by Fukushima. Research on the temporoparietal junction (TPJ)

implicates its involvement in a range of human activity. A study by Pérennou, Leblond,

Amblard, Micallef, Rouget, and Pélissier (2000) examined the TPJ as a nodal point in the

postural control network, showing that damage to the TPJ resulted in impaired balance.

A study on attention orienting in visuospatial working memory found increased

activation of the right TPJ in late cued change detection (Yeh, Kuo, Liu, 2007). Research

also links the TPJ with an embodied sense of self that includes visuospatial perspective,

self location, and a sense of spatial unity (Arzy, Thut, Mohr, Michel, Blanke, 2006;

Blanke, Mohr, Michel, Pascual-Leone, Brugger, Seeck, Landis, Thut, 2005). Other

studies examine the TPJ's role in the social cognition "theory of mind" concerning how

we perceive another person's state of mind. One study found the right TPJ to be active in

the attribution of mental states (Saxe, Wexler, 2005), and another study found

impairment in the ability to correctly reason about the beliefs of others in patients with

damage to the left TPJ (Samson, Apperly, Chiavarino, Humphreys, 2004). Autism

studies have found aberrant connections among regions involved in theory of mind tasks,

including in the white matter structure between the extrastriate region and the TPJ

(Barnea-Goraly, N., Hower, K., Menon, V., Eliez, S., Lotspeich, L, Reiss, A.L. 2004).

Vestibular links in the cortex include areas identified in multisensory processing.

Multisensory processing involves the integration or *binding* of signals from different

sensory modalities related to the same object or event that initially are processed

separately (Macaluso, 2006). Regions identified in this process of creating coherent

multisensory representations include the parietal, occipital, and frontal cortex.

Multisensory studies on monkeys by Andersen et al. (1997) and Duhamel et al. (1992) (as

cited in Galati, Committeri, Sanes, and Pizzamiglio 2001) have identified multimodal neurons in the posterior parietal regions where visual, auditory and tactile information converge and are systematically combined with vestibular and proprioceptive cues to create and maintain "updated multimodal body-centred representations in space" (Galati et al., p. 737). A related study in humans by Galati et al. (2001) found spatial coding of visual and somatic sensory information in body-centered coordinates in a bilateral fronto-parietal network that included the vestibular linked posterior parietal regions around the intraparietal sulcus.

Multisensory integration activity in the cortex occurs during the process of attention. Attention is believed to improve responsiveness by amplifying neural activity involving the attending stimuli (Wang, Clementz, Keil, 2007). Of particular relevance to the current study is research on the processes of spatial attention. Studies on spatial attention have found that increased activity in neurons coding for spatial location provides "a simple and effective means for achieving optimized processing at attended locations" (Driver & Frackowiak, 2001 as cited by Wang, Clementz, Keil, 2007). Voluntary attention to a spatial location improves processing of other stimuli that occur within that location (Macaluso, 2006; Liu, Stevens, Carrasco, 2006). Among the cortex regions implicated in voluntary spatial attention is the vestibular-linked intraparietal sulcus (IPS) (Macaluso, 2006). In a review of the lateral intraparietal area (LIP) of the IPS, Gottlieb (2006) describes the LIP role in the guidance of spatial attention as that of "a multifaceted behavioral integrator that binds visuospatial, motor, and cognitive information into a topographically organized signal of behavioral salience" (p.9). This process allocates attentional priority, placing the LIP "at the interface of perception, action, and cognition" (ibid). Another study implicating vestibular involvement in

spatial attention showed that damage in the right occipito-parietal region that impairs inertial vestibular processing also undermines multimodal visuo-spatial updating in gaze orientation (Ventre-Dominey, Vallee, 2006).

The binding of multisensory information in attention may also be accomplished through the *synchronization* of neuron oscillation frequencies, particularly in the gamma band range between 30 to 100 hertz, among neurons in noncontiguous brains regions (Engle, Debener, Kranczioch, 2006). Strong synchronization occurs among distance-separated cells during attention to a single object; the synchrony breaks down with the introduction of a second, independent stimulus (Engle, Singer, 2001). Tactile (somatosensory) spatial attention has been found to enhance gamma synchrony in the somatosensory cortex, as well as to recruit visual cortex areas (Bauer, Oostenveld, Peeters, Fries, 2006). Spatial attention has also been shown to enhance synchronization with stimuli that appear in the attended location (Fries, Reynolds, Rorie, Desimone, 2001). A study on human postural control and the role of the cerebral cortex found EEG gamma burst activity at the point just prior to participant's postural stability limits, as well as at the initiation of compensatory movement to prevent falling (Slobounov, Hallett, Stanhope, Shibasaki, 2005). While the authors suggest that the gamma burst represents a neural detector for postural instability, in the light of the attention/synchronization research the gamma burst may occur at the point conscious attention is directed to maintaining balance in order to prevent a fall. The gamma activity would indicate synchronization of multimodal inputs for creating/maintaining postural stability.

The modulation of neural synchrony by attention plays a role in the integration of sensory and motor signals. A study of cats performing a visuomotor coordination task found synchronization between visual, parietal and motor cortices (Engle, Fries, Singer, 2001). Other animal studies have also found synchronization during the anticipation of sensorimotor tasks (Liang, Bressler, Ding, Truccolo, Nakamura, 2002; Riehle, Grammont, Diesmann, Grün, 2000). Cortical synchronization in attention may link to the brainstem LC-thalamus research that ties level of arousal to synchronous sensory processing in thalamus-cortical sensory relays.

Actions for postural stability and gaze control in visual tracking take place in the context of larger behavioral strategies such as approach/withdrawal or affective response. Among the corticovestibular interactions presented in the Fukushima et al. review (1997) are regions that receive visceral and internal milieu input and that participate in autonomic control and affective response. These regions include the insula, somatosensory area II, and the cingulate cortex – areas Damasio (1999) includes in a somatosensing complex with the brainstem and hypothalamus. This expands the somatosensory category beyond the musculoskeletal feeling information implicated in postural control to include the full range of feeling states such as pain, body temperature, visceral sensations, and emotion. The insular cortex receives autonomic input and signals relating to this broad range of feeling states, and is implicated in the deployment of emotion. The cingulate cortex receives visceral and internal milieu signals along with musculoskeletal and vestibular data, and has been implicated in movement control as well as emotion, attention, and consciousness (Damasio, 1999). Approach and withdrawal behaviors, including drive behaviors and affective responses, by necessity

involve postural and movement control in relationship to the environment, as well as autonomic and cognitive components. The interrelationship of autonomic, visceral, and affective networks with postural control and environmental engagement networks creates a "mega-system" at the level of the whole living organism responding in life. Interestingly, vestibular information (in and of itself a system involving multiple sensory signals) runs throughout the mega-system.

Clinical Studies

The study of the relationship between postural stability and cognition, referred to as *dual-task performance* testing, measures the impact of different kinds of cognition on postural stability (Maylor et al., 2001; Riley et al., 2003; Weeks et al., 2002) and the impact of varying degrees of postural challenge on different types of cognitive tasks (Mueller et al., 2004; Teasdale et al., 1993). The basic assumption of the dual-task experiments is one of interference between cognition and balance that occurs as a result of limited attentional processing capacity (Woollacott & Shumway-Cook, 2001). Findings from studies have varied with some confirming the hypothesis of interference, some finding enhancement of stability during cognitive task (Riley et al., 2003) and some with mixed results depending on the type of task and balance conditions (Maylor et al., 2001). Alternative theories have been suggested to explain why interference is not always the case. Riley et al. (2003) suggest the multiple resources theory, which hypothesizes that different kinds of activities utilize different processing resources, to explain why stability improved during digit memorization. Mueller et al (2004) cite the single-channel or bottleneck theory, which assumes limited access as opposed to limited capacity, to explain the varying results of their study on postural challenge and reaction

time. Maylor et al. (2001) conclude that the interaction is complex with multiple variables resulting in a range of outcomes. In general, these dual-task performance theories are not based on the more recent neuroscience information concerning attention.

The studies measure postural stability by having participants stand on a force platform that measures center of pressure (COP) displacement and velocity. COP displacement or variability measures the direction and distance of movement away from a centered stance. COP velocity is the speed at which the displacement occurs. In studies that challenge balance by destabilizing the force platform (Mueller et al., 2004) the time it takes to recover stable COP (COP latency) is measured. In some studies (Weeks et al., 2002) seated versus standing are the comparative postural control demand conditions.

Concurrent cognitive tasks used in studies include a range of activities such as (a) visuo-spatial memorization and word association memorization (Maylor et al., 2001), (b) number sequence memorization (Riley et al., 2003), (c) math calculation and motor control focal task (Weeks et al., 2002), and (d) reaction time testing to auditory stimuli presented through ear phones (Mueller et al., 2004). Maylor et al. (2001) also monitored the "phase" of the cognitive processing, which included encoding (receiving instructions) and maintenance (memorization task).

Along with monitoring the interaction of cognition and postural stability, some studies have also explored the impact of advance information, or *task preparation*, on the ability to handle concurrent activity. Unlike the current study in which the preparation concerns an overall state of mindfulness, the task preparation studies provide information specific to the task, such as the time and/or direction of an impending balance disruption. Results from these studies have varied. For example, in Mueller et al. (2004) reaction

times improved with cueing in some test conditions and not in others, and COP latency actually increased from baseline values.

While the majority of studies predict interference between cognition and balance, study conditions in which postural stability improved rather than deteriorated are of particular interest in relationship to the current study. Postural stability improved during a digit memorization task (Riley et al., 2003) as well as in an arithmetic focal task involving mental addition and subtraction (Weeks et al., 2002). In the Maylor et al. (2001) study postural stability improved significantly during the encoding phase when participants were taking in information before engaging in either a spatial or non-spatial memorization task.

Concerning the relationship of emotion and balance, a force plate study on the influence of moods states and anxiety on balance performance found negative mood states (anxiety as well as tension, depression, and hostility) correlated with participant's difficulty in utilizing vestibular inputs to maintain balance. A positive state (vigor) was found to correlate with improved balance control (Bolmont, Gangloff, Vouriot, Perrin, 2002). A study in grade school children on the impact of test anxiety on balance performance found that less anxious children performed significantly better on a balance task (Collins, 1975). To measure anxiety level, the study used the Palmer Sweat Index, which measures the number of active sweat glands in a fingertip. The balance task involved standing on a dynabalometer, a round "rocker board" mounted on a ball and socket device attached to a base. The board rocked in all directions. The board would touch down on the base at a 10 degree tilt; contact with the base triggered the recording of data.

Chapter 3

METHOD

Participants

The study included 31 participants – 8 men and 24 women between the ages of 19 and 67. Participants were recruited at Regis University among graduate students, faculty, and staff at the School for Professional Studies, and among doctoral students in the Rueckert-Hartman School for Health Professions physical therapy program. In the community, participants were recruited from Colorado Chorale membership. The call for participants was delivered via e-mail and classroom announcements.

Potential participants were screened to eliminate anyone with a history of balance problems, and/or physical limitations such as knee injury or back trouble. Participants completed a questionnaire (see Appendix F) to identify past experience and skill level in activities involving balance. This included mind/body practices, martial arts, dance, and sports requiring balance control (e.g., skiing, bike riding, gymnastics). Informed consent (see Appendix E) was obtained prior participation.

Equipment

Galvanic Skin Response

Galvanic skin response (GSR) was monitored by a GSR2 meter (Thought Technology Ltd., West Chazy, NY) with output to CalmLink biofeedback software (Mind Growth, Calais, VT) on an AMD computer with a Sound Blaster sound card and a Soyo monitor. The GSR unit provided input to the CalmLink software via the AMD

microphone input jack. CalmLink generates a graph of the GSR activity; graphs were printed on an Epson Stylus 400 color printer. The CalmLink graph data was exported to Excel for analysis.

The GSR2, which was developed for at-home biofeedback, runs on a 9-volt battery. The unit registers a skin resistance range of 1,000 to 3,000,000 ohms. The electrical skin resistance generates a tone that rises and falls as skin resistance decreases and increases. The unit has a variable frequency range of 0 to 40,000 HZ. The ohm signal is "tuned" to register within the variable frequency range by adjusting a wheel on the unit. The unit does not provide translation information, which means that the unit-of-measure is not identified in either ohms or hertz. At the beginning of each session the tuning wheel was used to set the GSR2 output so that it registered in the graph's mid-range. The output is "level" per second, and has meaning only in terms of the individual's relative ups and downs within a given session.

The GSR unit was attached with Velcro to a holster strapped around the participant's waist. The holster consisted of a piece of chap leather, 3¾ inches wide and 21 inches long, covered with Velcro. The holster piece was fastened to waistband made of ¾-inch wide, 2-sided Velcro that could be adjusted to fit around the participant's waist. Remote electrodes from the GSR unit were attached to two fingers of the participant's non-dominant hand with Velcro straps.

Timer

A digital timer (Taylor) running on a AAA-battery was utilized to track trail start times.

Balance Testing Equipment

The balance testing utilized a Belgau balance board with rockers that adjust to provide a moderate challenge level relative to the participant's balance ability. When the rockers are parallel with the front and back of the board (perpendicular to the participant's feet) the board is the most stable; the level of difficulty (instability) increases as the rockers rotate toward a position parallel to the sides of the board (parallel to the participant's feet). A grid on the surface of the Belgau board helps the user evenly align his/her feet on the board.

The Belgau board was set on a wood base, 26 x 20 x ¾ inch, covered with a Formica veneer to create a hard surface. Non-slip shelving paper (Griptex Wonderliner) covered the Formica to prevent the rocker board from sliding. Two 19-inch 2 X 3 pine boards mounted at the right and left edge of the base limited the rocker board's maximum incline to 7 degrees. A portable wood railing 50 inches high provided participants with a steady hand-hold while they got on and off the board. Four sandbags placed on the railing base kept it stable. A laser emitter and receiver were attached directly across from each other on the base of the railing so that the laser line cleared the top of the board. The rocker board broke the laser line when the board swayed beyond a 2.5 % incline. The laser sensor setup connected into the mouse driver of the AMD computer; the breaking of the laser line acted as a mouse click. A visual basic program designed for the study tracked the balance performance including how many times the laser line was broken, the length of intervals both in and out of balance, and the total time in balance. A separate mouse connected through the USB port of the AMD computer allowed the tester to start and stop the test.

At the beginning of the pre-trial practice, participants stood on a stable board built to the same specifications as the rocker board. The stable board was used to find the participant's correct foot placement on the board and to practice testing procedures.

Reaction Time Equipment

For the reaction time test, participants stood to view a video of a person swinging her arm at random intervals. The video was played on an Apple PowerBook G4 using Micromedia Flash Player version 6.0 and projected onto a wall with an Optima DLP™ Projector, model EP739. A laser emitter and receiver placed opposite each other on tripods were set so that the participant's dominant hand blocked the laser line when the arm was at hanging at rest. The laser sensor setup connected into the mouse driver of the Apple computer. The at-rest arm blocking the laser circuit acted as a mouse being held down. The movement of the participant's hand in reacting to the video image took it out of the laser path; the reconnecting of the of the laser circuit acted as a release of the mouse.

The reaction time testing software was created in Macromedia Flash MX and exported as a standalone application. The software included digitized video divided into two segments – one of a person standing with her arms at her sides and one of her swinging one arm forward and up. The arms-down section of the video looped back on itself. Variation in the number of times the loop repeated prior to the running of the arm-swing segment generated differing intervals between swings. A random number generator (the software generated a number between 0 and 1) would determine when the arms-down segment would switch to the arm-swing segment. To prevent excessively long wait times, a random factor

was used based on a lower loop limit of 0 and an upper limit of 3 loops. The

random factor of .3 was calculated by dividing 1 by the maximum number of

loops. The algorithm was in the form of the following logic:

> If the number of arm-down loops is greater than or equal to the lower loop
>
> limit AND the randomly generated number is greater than or equal to the
>
> random factor OR the upper limit to the number of loops has been
>
> reached, then break out of the arm-down loop and run the arm-swing
>
> segment.

The software allowed the random factor to be adjusted to create longer

and/or shorter intervals between arm swings. The random factor of .3 was

selected for this study because it kept the interval between arms swings in the

range of 1.1 to 7.8 seconds.

After one run of the arm-swing segment, the software returned to the arm-down

loop. A new random number was generated each time through the loop. A few frames of

dissolved video hide the slight discrepancy between the end of the arm raise and the

return to the loop.

At the end of the test, the software summarized in milliseconds 1) the

interval between the first frame of the video arm swing and the mouse button

release (reaction time), 2) the interval between each of the arm-swings, 3) the

frame-rate of the displayed video, and 4) the total time elapsed for the trial.

The software allowed the tester to set the number of arm-swing repetitions in a

trial prior to starting the trial. Practices trials included 8 arm-swings; recorded trials

included 11 arm-swings. The software also allowed the video image to be run with the

swinging arm on either the right or left side of the screen so that it mirrored the dominant arm of the participant.

Laser Setup

The laser emitter and receiver for the balance and reaction time tests both used the same 24-volt power supply. The power supply was connected to an electro-mechanical card relay with 4 relays.   Two relays were utilized, one for the balance setup and one for the reaction time setup. The laser cables and wiring to the mouse port connected through the relay. The power supply/card relay setup was placed in a sound insulated cardboard box to mute the clicking noise made by the relay.

Each laser emitter and receiver was held in a plastic irrigation saddle tee with a 1/8-inch plastic PVC riser that screwed into a metal irrigation flange. For the balance setup, the flanges were mounted on the base of the wooden handrail with wood screws. For the reaction time setup, the flanges were attached to the tripods with Velcro.

Procedures

Pre-Testing

Introduction

The research session began with an introduction and overview of the study presented in PowerPoint, followed by the participant reading and signing an informed consent.   Participants were then fitted for the equipment, taught the testing procedures, and given practice trials of the reaction time and balance tests. At the conclusion of the balance fitting and practice, the session outline was reviewed.

Testing Overview

1. Mood Assessment
   a. 132 adjective checklist; participants marked all words that described their mood at the time
2. Trials
   a. 30 seconds quiet standing
   b. Reaction time
      i. Three trials of 11 arm swings each
   c. Quiet standing on balance board
      i. Three trials of 30 seconds each
   d. 15 minute learning experience
      i. Centering group questionnaire about their learning experience
   e. Repeat Trials
      i. Centering group questionnaire about their centering performance

Equipment Fitting/Procedures

Galvanic skin response (GSR). GSR sensors were placed on the index and middle fingers of the participant's non-dominant hand, and the holster with the unit attached was fastened around the participant's waist. The tuning wheel was adjusted to move the graphic output to the mid-range of the graph.

Reaction Time Equipment. Fitting the reaction time equipment involved adjusting the participant's stance along with the height of the tripods so that the dominant hand blocked the laser line when the arm was at rest by the participant's side. The participant's foot positioning was then marked on the floor with masking tape. Once the equipment and stance were correctly established, participants completed two practice trials of 8 arm-swings each.

Balance equipment fitting. The balance equipment fitting began with the participant standing on the stable board to establish proper foot placement. Correct

placement was shoulder width apart, with feet equal distance from the board's vertical centerline and toes on the same horizontal line. The tester marked the participant's correct foot positions on the rocker board with masking tape.

The initial setting of the adjustable rockers on the balance board was based on the participant's questionnaire answers concerning their experience and skill in balance activities. During equipment fitting, participants did several 20 second trials on the board to determine the best rocker level setting for a "moderate" balance challenge. A moderate challenged was defined as 5 to 7 breaks or "touches" of the laser line.

Balance equipment procedures. Prior to stepping on the balance board, participants placed both hands on the railing and visually located their foot placement. One foot was placed on the board (in the marked position) so that side of the board came to rest solidly against the the platform's raised outside edge. With the placement of the second foot the participant brought the board to level while still holding onto the railing. At the end of each trial, the participant placed both hands on the railing, put down one edge of the board, and slowly stepped off of the board.

<div align="center">

Testing

</div>

Quiet Standing

Participants positioned themselves in the footmarks for the reaction time testing. The tester instructed the participant to stand quietly without movement of head or limbs for 30 seconds. The tester gave the direction "30-second quiet standing beginning now." On "now" the tester simultaneously started the timer and the GSR recording.

Reaction Time

At the end of quiet standing, participants remained in the same position ready to continue with the 3 reaction time trials. Reaction time trials begin 30 seconds after the end of quiet standing. The tester provided verbal time cues, e.g., "reaction time testing will begin in 30 seconds." At 5 seconds the tester counted down "5, 4, 3, 2, 1, Now," starting the reaction time video on "Now." The tester recorded the start time of the trial on a log sheet. At the end of the 11-swing trial, the participant remained standing in the same position and the tester entered a label for the next trail. The entire process, including time cues and count down, repeated for the 2nd and 3rd trials. At the conclusion of the 3 trials, the participant moved to stand in front of the balance board. The tester copied and saved the reaction time data to an Excel spreadsheet.

Balance Stability

The tester instructed the participants to take hold of the railing and step up onto the board. As in the reaction time trials, the tester provided verbal count down cues. At 5 seconds the tester instructed, "left (right) hand down, 3, 2, 1, Now," starting the balance recording on "Now." The participant removed their non-dominant hand from the railing at the 5-second cue of "left (right) hand down" and the dominant hand on "Now." The tester recorded the start time of the trial on a log sheet. At the end of the 30-second trial, the tester instructed the participant to put both hands on the railing and step off the board. The tester entered a label for the next trial and the process began again for the 2nd, and then 3rd trial.

At the conclusion of the balance testing, the tester stopped the GSR recording, saved the data, and immediately restarted the recording. The process took approximately 5 seconds.

Learning Segment

The tester flipped a coin to determine which learning experience the participant would receive. "Heads" placed the participant in the control group, a didactic presentation on the study background; "tails" was the centering training.

Control Group - Study Background

Participants sat and watched a PowerPoint presentation that lasted approximately 12 minutes. The lecture began with an outline of goals for the learning segment and for the second set of trials. The learning segment was described as a means of providing a consistent experience among participants and between learning groups. The second set of trials was described as a means for the comparison of data to verify patterns and relationships, if any, and to see if any learning effect occurred in repeating the trials. Participants were not told that they were in the control group.

The learning segment gave a brief overview of the 3 clinical measures of the study (reaction time, balance, and stress response) in the framework of the social science and neuroscience that underlies the study. The lecture included an explanation of the choice of measures as they derive from the practice of aikido and its application in social skills training. At the conclusion of the presentation, participants stood and moved briefly, including several knee bends and arm swings. They then repeated the trials exactly as they had done prior to the learning session.

Centering

The centering learning segment began with participants sitting to watch a PowerPoint presentation that briefly explained aikido, centering, and the training process. The goal for the group was to learn the centering technique and then apply the technique in the second set of trials. The training occurred with participants standing, and was supported by the PowerPoint presentation.

Before beginning the training, the tester asked participants for a verbal agreement to the following: 1) "Engage with an open mind," and 2) "Ask to stop the training if at any time you feel you cannot engage with an open mind, or you feel ill-at-ease with any aspect of the exercises."

The centering skill taught in the study involved the mental action of placing awareness or attention at the physical center of gravity. The learning process, taken directly from *Shin Shin Toitsu Aikido*, included "no-tech" biofeedback in the form of a balance stability check (done with a gentle push from the side), and the comparison of the participant's experiences among contrasting mental actions.

At the conclusion of the centering training, the tester reviewed the centering technique and outlined the process of applying the technique during the second set of trials. Participants then completed a survey concerning the training experience. Participants rated the following 3 statements on a scale of 1 to 5, with 1 being "not true at all" and 5 being "completely true:"

1) I understand how to do the centering technique taught in this training.
2) I understand what I will be doing with centering during the second set of tests.
3) I believe I can apply what I have just learned to the second set of tests.

During the second set of trials the tester instructed participants to "center your focus" at 10 seconds prior to the start of each of trial. During the balance trials participants were also instructed to "move from center" when stepping up onto the board. With the exception of the instructions to center, the second set of trials followed the same procedures as the first.

At the conclusion of the second set of trials, participants completed a survey about successfully they applied the centering technique before and during each of the trails (see Appendix D).

Data Analysis

Data analysis included Analysis of Variance, Pearson Correlations, and Sign Tests of pre- to post- data for the Entire sample, and for/between the Centering Group and Control Group.

Chapter 4

RESULTS

Hypothesis

Analysis of Variance found no significant differences between Centering Group

scores and Control group scores post training and therefore did not reject the null

hypothesis. The Sign Test showed significant difference between pre- and post- training

for the Centering group on the Balance measure of touches of the laser line (BL/T), with

no significance for the Control group between any pre-/post- performance measures. No

significance was found between pre/post performance on the reaction time task for either

group.

ANOVA

Test		Sum of Squares	df	Mean Square	F	Sig.
BL/I	Between Groups	.974	1	.974	.296	.591
	Within Groups	88.933	27	3.294		
	Total	89.906	28			
BL/L	Between Groups	8.622	1	8.622	.339	.565
	Within Groups	687.097	27	25.448		
	Total	695.719	28			
BL/T	Between Groups	.193	1	.193	.037	.849
	Within Groups	141.352	27	5.235		
	Total	141.546	28			
RT	Between Groups	2927.539	1	2927.539	1.716	.200
	Within Groups	49469.171	29	1705.833		
	Total	52396.710	30			

BL/I – total time in balance; BL/L – longest interval in balance; BL/T – touches of laser line; RT- reaction time

SIGN TEST – PERFORMANCE COMPARISONS

	BL/T All	BL/T Centering	BL/T Control	RT All	RT Centering	RT Control
z-score	2.41	2.32	1.07	-0.54	-1.00	0.26
p-level	p<.008**	p<0.01*	p<0.13	p<0.29	p<0.16	p<0.37

**p<0.05; *p<0.0

Results - Entire Sample

Reaction Time – Significant Correlations

Pre- reaction time (RT) had a significant positive correlation with post- reaction

time, a significant negative correlation with pre- total time in balance (BL/I), and

significant positive correlation with post- GSR during reaction time testing (RT-GSR).

The negative correlation between pre- RT and post- BL/I is positive relative to

performance, that is, faster RT and longer time in balance versus slower RT and less time

in balance.

REACTION TIME
SIGNIFICANT CORRELATIONS

Test		Pre- RT	Post- RT	Pre- BL/I	Post RT-GSR
Pre- RT	PC		.816(**)	-.504(**)	
	Sig.[tt]		0	0.005	
	N		31	29	
Post- RT	PC	.816(**)			.373(*)
	Sig.[tt]	0			.042
	N	31			30[1]

**p<0.05; *p<0.01; Sig.[tt]- 2-tailed significance; pre- prior to learning
 segment; post- following learning segment
[1]Sensitivity analysis on GSR data used GSR mean value for missing data
 (N increased from 28 to 30).

Balance Measures – Significant Correlations

Significant correlations were found for the entire sample among the three balance

measures within pre- and within post-learning scores, as well as between pre- and post-

scores. The correlation significance was greater among the three measures post-learning.

Total time in-balance (BL/I) and longest balance interval (BL/L) correlated positively

with each other, and negatively with number of touches of the laser line (BL/T). Again,

the negative correlation with touches of the laser line is a positive correlation relative to

performance.

Level of rocker-board difficulty (Level) had significant positive correlations with pre- BL/L and post- BL/I for the entire sample. There were significant negative correlations between Level and both pre- and post- BL/T. Relative to performance, the more difficult the Level (lower integer) the poorer the performance, and vice versa.

BALANCE – SIGNIFICANT CORRELATIONS

		Level	Pre-BL/I	Pre-BL/L	Pre-BL/T	Post-BL/I	Post-BL/L	Post-BL/T
Pre-BL/I	PC			.725(**)	-.749(**)	.572(**)	.531(**)	-.456(*)
	Sig. tt			0	0	0.001	0.003	0.013
	N			29	29	29	29	29
Pre-BL/L	PC	.412(*)	.725(**)		-.767(**)	.454(*)	.371(*)	-.405(*)
	Sig. tt	0.026	0		0	0.013	0.048	0.029
	N	29	2		29	29	29	29
Pre-B/T	PC	-.379(*)	-.749(**)	-.767(**)		-.520(**)	-.464(*)	.562(**)
	Sig. tt	0.043	0	0		0.004	0.011	0.002
	N	29	29	29		29	29	29
Post-BL/I	PC	.407(*)	.572(**)	.454(*)	-.520(**)		.847(**)	-.872(**)
	Sig. tt	0.029	0.001	0.013	0.004		0	0
	N	29	29	29	29		29	29
Post-BL/L	PC		.531(**)	.371(*)	-.464(*)	.847(**)		-.855(**)
	Sig. tt		0.003	0.048	0.011	0		0
	N		29	29	29	29		29
Post-BL/T	PC	-.481(**)	-.456(*)	-.405(*)	.562(**)	-.872(**)	-.855(**)	
	Sig. tt	0.008	0.013	0.029	0.002	0	0	
	N	29	29	29	29	29	29	

BL/I – total time in balance; BL/L – longest interval in balance; BL/T – touches of laser line; RT- reaction time; Level – degree of rocker board instability; PC – Pearson Correlation; Sig.tt- 2-tailed significance; *p<0.05; **p<0.01

Galvanic Skin Response – Significant Correlations

Galvanic Skin Response levels were calculated relative to each participant's baseline GSR (considered as 0). GSR during pre- Balance (BL-GSR) had significant positive correlation with GSR during post- balance, and with GSR during post- reaction time (RT-GSR). Pre- BL-GSR also had a significant positive correlation with post-reaction time performance (RT). Post- RT-GSR had a significant negative correlation with post- reaction time performance (RT).

GALVANIC SKIN RESPONSE – SIGNIFICANT CORRELATIONS

		Pre RT	Post RT	Pre BL//l	Post RT-GSR	Pre BL-GSR	Post BL-GSR
Post RT-GSR	PC		-.432(*)				0.373(*)
	Sig.^{tt}		0.022				0.042
	N		28				30[1]
Pre BL-GSR	PC	.454(*)		-.727(**)			.778(**)
	Sig.^{tt}	0.015		0			0
	N	28		27			30[1]
Post BL-GSR	PC			-.514(**)	0.373*	.778(**)	
	Sig.^{tt}			0.006	0.042	0	
	N			27	30[1]	30[1]	

PC – Pearson Correlation; Sig.^{tt}- 2-tailed significance; *p<0.05; **p<0.01
[1]Sensitivity analysis on GSR data used GSR mean value for missing data (N increased from 28 to 30).

Sign Tests

Sign tests showed significant lowering in post RT-GSR for the entire sample, with no significance relative to group.   Sign tests also found significant lowering of post BL-GSR for the entire sample, with an even higher significance for the Control group. Concerning performance, Balance performance (BL) improvement was significant for the entire sample and for the Centering group. Applying the sign test to GSR changes from RT-GSR to BL-GSR found an increase to BL-GSR to be significant for the entire sample both pre- and post-. This relationship was also significant for the Centering group both pre- and post-.

SIGN TESTS

Reaction Time (GSR and Performance)						
	RT-GSR All	RT-GSR Centering	RT-GSR Control	RT All	RT Centering	RT Control
z-score	2.27	1.81	1.39	-0.54	-1.00	0.26
p-level	p<0.01*	p<0.35	p<0.08	p<0.29	p<0.16	p<0.37

Balance (GSR and Performance)						
	BL-GSR All	BL-GSR Centering	BL-GSR Control	BL/T All	BL/T Centering	BL/T Control
z-score	2.27	0.26	3.05	2.41	2.32	1.07
p-level	p<0.01*	p<0.40	p<0.001**	p<.008**	p<0.01*	p<0.13

GSR during RT to Balance (Pre; Post)						
	Pre All	Pre Centering	Pre Control	Post All	Post Centering	Post Control
z-score	2.65	2.32	1.39	4.16	2.67	1.39
p-level	p<0.004**	p<0.01*	p<0.08	p<0.001**	p<0.004**	p<.08

RT-GSR – Galvanic skin response during reaction time; BL-GSR – Galvanic skin response during balance;
RT- reaction time; BL/T – balance touches of the laser line; *p<0.05; **p<0.01

MAACL-R (Multiple Affect Adjective Check List – Revised)

Norm Comparisons

MAACL-R Affect Traits adjective check list results showed the scores for university students (who made up 61% of the entire sample) to be both less "negative" and more "positive" than University Student norms. Comparison of results to norms by gender and number of items checked is a mixed picture. Given the small sample size, the "by number of items checked" comparisons may hold little significance.

MAACL-R SCORES AND NORMS

	A	D	H	PA	SS	DYS	PSS
RESULTS							
By # of items √							
Women 1-21	0.80	0.20	0.20	2.00	0.60	1.00	2.60
22-39	0.91	0.09	0.64	9.45	2.09	1.64	11.55
40+	1.29	0.14	0.29	17.14	4.29	1.71	21.43
Men 1-19	1.00	0.00	0.00	2.00	0.00	1.00	2.00
20-35	0.00	1.00	0.00	5.00	2.00	1.00	7.00
36+	0.00	1.00	0.00	15.00	4.00	1.00	19.00
University Students							
All	1.16	0.26	0.50	10.20	2.20	2.00	12.40
Women	1.30	0.10	0.70	9.87	2.00	2.10	11.90
Men	0.75	0.75	0.00	11.50	3.00	1.50	14.50
NORMS							
By # of items √							
Women 1-21	0.85	0.45	0.47	4.12	0.94	1.77	5.06
22-39	1.37	0.68	0.93	10.23	2.25	2.98	12.47
40+	2.27	1.23	2.35	16.68	4.00	5.85	20.68
Men 1-19	0.46	0.30	0.48	3.51	1.16	1.23	4.67
20-35	0.75	0.31	0.91	9.58	2.52	1.97	12.10
36+	1.44	0.78	1.84	16.06	4.53	4.06	20.58
University Students							
All	1.44	0.99	0.89	7.52	2.08	3.32	9.60
Women	1.54	0.98	0.99	7.42	1.95	3.51	9.37
Men	1.22	1.01	0.66	7.74	2.39	2.89	10.13

A = Anxiety; D = Depression; H = Hostility; DYS = Dysphoria (A+D+H)
PA = Positive Affect; SS = Sensation Seeking; PSS = PA + SS

MAACL-R – Significant Correlations

Anxiety (A) correlated positively with Hostility (H). Dysphoria (the compellation of Anxiety, Depression, and Hostility) correlated positively with Anxiety and Hostility. Positive Affect correlated positively with Sensation Seeking and total number of adjectives checked (TOT). PSS correlated positively with PA, SS, and TOT. The control group correlated positively with SS and TOT.

The one performance measurement that had significant correlation with MAACL-R scores was pre- total time in-balance (BL/I), which had a positive correlation with both Anxiety and Depression.

MAACL-R SIGNIFICANT CORRELATIONS

		A	D	H	PA	SS	DYS	PSS	TOT	Pre-BL/l	Control Group
A	PC			.421(*)			.888(**)			.403(*)	
	Sig. tt			0.018			0			0.03	
	N			31			31			29	
D	PC						.403(*)			.414(*)	
	Sig. tt						0.024			0.026	
	N						31			29	
H	PC	.421(*)					.667(**)				
	Sig. tt	0.018					0				
	N	31					31				
PA	PC					.676(**)		.984(**)	.857(**)		
	Sig. tt					0		0	0		
	N					31		31	31		
SS	PC				.676(**)			.798(**)	.725(**)		.357(*)
	Sig. tt				0			0	0		0.048
	N				31			31	31		31
DYS	PC	.888(**)	.403(*)	.667(**)						.446(*)	
	Sig. tt	0	0.024	0						0.015	
	N	31	31	31						29	
PSS	PC				.984(**)	.798(**)			.879(**)		
	Sig. tt				0	0			0		
	N				31	31			31		
TOT	PC				.857(**)	.725(**)		.879(**)			.438(*)
	Sig. tt				0	0		0			0.014
	N				31	31		31			31

A = Anxiety; D = Depression; H = Hostility; DYS = Dysphoria (A+D+H)
PA = Positive Affect; SS = Sensation Seeking; PSS = PA + SS; TOT = Total checked
PC – Pearson Correlation; Sig.tt- 2-tailed significance; *p<0.05; **p<0.01

Training Group versus Control Group – Miscellaneous Data Comparisons

PRE- TO POST-LEARNING:
PERFORMANCE & GSR (MEAN COMPARISONS)

	Training Group	Lecture Group
Reaction Time	- 5 ms	- 8 ms
Balance		
Total Time In	+ .99 s	+ .7 s
Longest Interval	+ 2.94 s	+ 2.86 s
Touches	- 2.18	- .95
GSR		
During RT	- 675	- 740
During Balance	- 202	- 454

PRE- TO POST- AVERAGES (BASED ON SIGN TEST)

	RT-GSR	RT	BL/T-GSR	BL/T
Centering Group	73% lowered	33% improved	53% lowered	80% improved 7% same
Control Group	69% lowered	62% improved	93% lowered	64% improved 13% same

RT & GSR RELATIONSHIP BY PARTICIPANT COUNT

	Centering Participants	Control Participants
Faster RT/Lowered GSR	2	6
Faster RT/Raised GSR	3	3
Slower RT/Lowered GSR	9	2
Slower RT/Raised GSR	1	2

BL/T & GSR RELATIONSHIP BY PARTICIPANT COUNT

	Centering Participants	Control Participants
Fewer BL-T/Lowered GSR	6	9
Fewer BL-T/Raised GSR	6	-
More BL-T/Lowered GSR	1	3
More BL-T/Raised GSR	-	1
Same BL-T/Lowered GSR/	2	1

Chapter 5

DISCUSSION

The study investigated whether or not focusing attention at one's center of gravity impacted reaction time and balance performance. The study also investigated the relationship of arousal level to performance by tracking galvanic skin response (GSR) throughout the session. No significant effect of centering on either reaction time or balance performance was found in the analysis of variance. Sign test analysis showed significant performance improvement in the Centering group concerning one balance measure. Significant correlations were found for the entire sample between GSR and performance, as well as between GSR and task type. A broader analysis of means and percentages suggests possible trends. Post-learning segment, performance means improved and GSR means lowered – for the sample as a whole as well as for each group. In raw participant data, centering corresponded to lowered GSR in combination with poorer reaction time performance (slower reaction times). Concerning balance, centering corresponded to improved performance (fewer touches of the laser line). The relationship of GSR and balance for the Centering group was mixed, as compared to the Control group that had lowered GSR in combination with poorer balance performance.

In the context of a traditional approach that considers reaction time to be cognitive, balance to be physical, and emotion not relevant, this mix of outcomes provides limited information of value. Considered in a neuroscience context, the results

are congruous with theories of neural multimodal integration and may provide insights for future research.

<div align="center">Entire Sample – GSR to GSR</div>

The positive correlations for the entire sample between RT-GSR and BL-GSR, and between pre- and post- GSR, suggest a consistency in individual emotional response during the course of the study. The one exception was the lack of correlation between pre- RT-GSR and any other measure. As RT was the first test of the session, the lack of any correlation may be indicative of considerable diversity among individuals' reactions to an unfamiliar situation. The patterns that follow suggest that participants settled into the research process. Lower post- GSR could be attributed to 1) greater comfort due to familiarity with circumstances and expectations; 2) less performance anxiety due to improved performance resulting from practice.

Sign Test significance for the entire sample regarding the relationship between RT-GSR and BL-GSR both pre- and post- indicated that GSR was higher during the balance task than the reaction time task. Mean analysis also showed BL-GSR to be higher than RT-GSR. This corresponds to research findings (Devilbiss, Page, Waterhouse, 2006)) on arousal indicating that non-threatening stimuli (the reaction time video) elicit less arousal than threatening stimuli (the potential of falling presented by an unstable surface). Findings relating GSR to other study measures are discussed below.

Reaction Time

Entire Sample

Participant performance on reaction time remained consistent for the entire

sample from pre- to post-, as indicated by a highly significant, strong positive correlation.

Interestingly, pre- RT also showed a highly significant negative correlation to post- BL/I,

that is, faster reaction times corresponded with longer total time in balance (and vice

versa). Balance concluded the pre-testing, and reaction time opened post- testing; the

correlation suggests that performance prior to the learning segment is predictive of post-

performance.   Concerning the relationship of GSR to RT performance, a negative

correlation between the two (higher arousal correlated with lower reaction times and vice

versa) seems to contradict research describing the relationship of performance to arousal

as an inverted U. Taken in the context of the overall lowering of post GSR-RT, however,

the levels may be high relative to that context and still represent an optimal arousal level

for good performance. The lack of threat in the RT test, and the greater general comfort

of participants suggested by lower post- GSR would further support this interpretation.

Reaction time performance showed no improvement from pre- to post- for the entire

sample in either the Sign Test or mean comparison. This may have been due to the ease

of the task allowing participants to quickly achieve their optimal performance level.

Centering Group

During post- RT, the tester observed that some Centering group participants did

not seem to "make an effort" to respond quickly, that is, their attention to center appeared

to override attending to the RT task. Several outputs support this observation. Analysis

of raw data showed lowered GSR in 73% of Centering group participants while only 33%

improved their reaction times. Of the 11 individuals with lower GSR, 9 had slower

reaction times. Graphic output of Centering group participants with slower reaction

times showed a smoother line (less amplitude, fewer spikes). In comparison, 69% of

control group participants had lower GSR while 62% had improved reaction time, with

the relationship between GSR and RT performance mixed.   The different profiles

between the 2 groups suggest that the centering task calmed participants and undermined

RT performance, with lower GSR representing a sub-optimal arousal level for best

performance. This impact of centering may be due to participants not sufficiently

grasping the centering technique, suggested by the inability to maintain visual attention to

the RT task while attending to the somatosensory orientation of centering. The same

problem did not occur during the balance challenge, perhaps due to the similarity

between centering and attending to maintaining postural stability.

Balance

Entire sample

Significant correlation among the three balance measures (BL/I, BL/L, and BL/I)

for the entire sample confirmed study expectations. The three measures also had strong

correlation pre- and post-, indicating a consistency of participant performance. Sign Test

significance between pre- and post- BL/T indicates improved performance for the entire

sample. The greater significance of post- correlations among the three balance measures

supports the case for improved post- balance performance.

Pre- BL-GSR had a highly significant strong negative correlation with pre- BL/I

and to a lesser degree with post- BL/I (the lower GSR the longer the time in balance and

vice versa). This met study expectations concerning the relationship of GSR to balance

performance. The Sign Test showed significance between pre- and post- BL-GSR, indicating that GSR lowered for the entire sample during post- balance. This corresponds with entire sample improvement in BL/T. Balance, unlike reaction time, showed both post- performance improvement and lower GSR for the entire sample. Due to the greater threat arousal triggered by unstable balance, the lower GSR during the second trial may have represented greater calm with a now familiar task. This would bring arousal down to a more optimal level for performance.

Balance GSR Graphic Pattern

An observable pattern in the shape of GSR during the 30-second balance test was apparent across the entire sample in the graphic output of GSR data. (see Appendix C). A spike in GSR would occur at the beginning of the test, followed by a steep "ski slope" trend, with smaller spikes occurring in the downward slope. While the size of the first spike, the number and degree of smaller spikes, and the angle of the slope varied, the general downward slope occurred in the majority of participants' balance GSR. The first spike may represent high arousal caused by the threat of loss of balance – the elevated arousal serving to direct overt attention to preventing a fall. The sharp decline in arousal that immediately follows occurred while attention was engaged in the sensorimotor activity of maintaining stability. Considered in the context of the attention and synchrony literature, the steep drop in arousal may correlate with neural synchrony and high levels of sensory information processing.

Balance and Group

Centering group significant post- improvement was found in the Sign Test for BL/T, while no significance was found for the Control group. A possible trend toward greater improvement of balance in the Centering group is supported by the comparisons of raw data percentages and "counts." Interestingly, all of the Control group participants with improved stability had lower GSR, as compared to only half in the Centering Group. The control group's improved stability would appear to be connected to lower GSR. Again, familiarity with the task during the second balance trials may have evoked less of a threat response, resulting in arousal dropping to a more optimal level for balance performance.

Level Correlation

A significant correlation was found for the entire sample between "Level" (the degree of difficulty created by adjusting rocker board stability) and balance performance measures (greater instability of the board correlated with poorer performance and vice versa). The rocker board stability level was adjusted during setup with the goal of finding a "moderate" challenge level for the participant. Too easy of a level relative to the participant's ability would not provide room for demonstrable improvement. Too difficult a level would potentially undermine the intentional control of mental focus, trigger greater anxiety, and engage more covert physical strategies to maintain balance. The statistical correlation confirmed the tester's observation that a moderate challenge level was not successfully established for all participants. This discrepancy in starting level may be a contributing factor in the lack of significant difference between the

Centering and Control group post- measures. Future testing would need to establish a better protocol for setting rocker stability level.

<div align="center">MAACL-R</div>

MAACL-R trait evaluation was included in the study to identify any emotional extremes that might influence performance. While the entire sample was well within average parameters, there were several unexpected positive correlations between "negative" mood traits (Anxiety, Depression, and Dysphoria) and the pre- balance measure of Longest interval in balance. The correlation did not occur with any other measures, nor did it occur with any post- performance measures. Further evaluation of data found that among the 5 participants with a combination of the highest pre- B/L and the highest A, D, H, and DYS scores, all were graduate students under a great deal of pressure, all were athletically active in sports or exercise involving balance, and 4 of the 5 demonstrated a high degree of balance stability during setup. Given the makeup of the entire sample and the correlation being with only one pre- balance measure, it is unlikely that the correlation indicates a positive connection between these negative mood states and postural stability.

<div align="center">Considerations for Future Research</div>

The current study was limited in sample size and diversity, with participants who were predominately highly educated, physically active, and socially engaged. Incentives to participate included a desire to help out and a curiosity about the study, often based on an interest in issues of balance. Further study would benefit from a larger more representative sample.

Splitting up the current study into several more limited inquires would address design problems and allow for more control of variables. A number of participants expressed that they were fatigued during post- testing, a condition that could impact arousal and performance. Shorter study sessions would minimize fatigue. The current study combined two different *shin shin toitsu* activites, 1) learning the focus technique and 2) applying that technique under pressure. Separating these two activities would provide better controls and clearer outcomes. The first step would be to examine the hypothesis that the centering technique immediately evokes both greater postural stability and a high performance state. This would involve technology unavailable to the current study, including measurement of 1) muscle activity utilizing electromyography (EMG) during covert physical effort to maintain postural stability as compared to during focus on center, and 2) neural synchrony utilizing electroencephalography (EEG) and magnetoenecephalography (MEG) equipment. The study would require developing a means for delivering a consistent and measurable "push" corresponding to the Aikido training technique of testing postural stability by pushing with the hand on the learner's upper torso. A separate study would test the application of the centering technique during reaction time and a balance challenge.   Centering training delivered in multiple sessions in between pre- and post- testing would help assure that participants had a strong enough grasp of the technique to apply it under pressure. This would alleviate the problem observed during RT testing of participants not being able to center and attend to the task. The testing and training would occur separately, eliminating the possibility of fatigue.

The design of the reaction time test was based on reaction time training in Aikido involving responding with an arm swing to match the timing of an opponent's strike to the head. In Aikido training, the difference in response when the student is "centered" is readily visible to the observer. The observed faster reaction may be concerning the range of movement (the responder reaching the top of the swing or the bottom of the strike more quickly), rather than the initiation of the move as measured in the study. This was seen in the video taping of the exercise prior to the study. Future study would measure speed of response across the range of movement. This should be considered in the context of arousal/performance research that looks at the kinds of responses optimized or undermined by different arousal configurations. Faster response across the time range of skilled movement may involve a different arousal pattern than the first moment of reaction to an environmental stimulus. The "first moment" response may be faster with higher arousal, as potentially indicated by study outcomes.

Conclusion

The fundamental challenge of clinical measurement of the impact of attentional focus on performance measures is revealed in the neuroscience view of the integrated organism. Neural systems of mind, movement, and emotion are interwoven and deploy as orchestrated whole responses that can be triggered from multiple directions. An emotionally competent stimulus that changes a range of physical and cognitive processes can be a physical experience (sudden postural instability), or a social one (showing up for a research session with no knowledge of what it will involve). Attentional focus may be intentional or automatic, and is impacted by environmental demands. The multi-modal integrated systems challenge impacted the study in two major areas, 1) the difficulty

encountered in establishing a consistent baseline for balance testing, and 2) the possibility that the *automatic* attentional response during the reaction time test and the balance challenge was itself a high performance configuration.   Concerning the balance baseline, greater alarm when first experiencing instability on the rocker board and/or more situational anxiety may have contributed to a participant's "moderated challenge" level not accurately reflecting their general balance ability. A calmer state at the start of pre-balance testing potentially would have resulted in the challenge level being too easy.

Concerning automatic attentional influences on outcomes, the literature reviewed here suggests that the reaction time and balance tasks may have triggered a high performance behavioral state. The automatic attentional processes activated during reaction time would include anticipatory synchronization and sensorimotor integration. The attentional processes during the balance challenge would match those hypothesized to occur during centering, that is, the neural synchronization associated with attending to the sensorimotor activity of keeping center of mass over base of support. In aikido training, balance challenges are considered a means for developing *shin shin toitsu*. Therefore, while centering may impact reaction time and balance, it is also possible that the sensorimotor integration in both tasks caused participants to be more "centered." Future studies that first identify measurable markers of the centered state could track the influence in both directions.

The general findings of this study in combination with ongoing neuroscience research on the extensive neural interconnections of postural control and integrated behavioral networks points to the importance of pursuing this kind of clinical research. The parallels between the cultural view of mind, body, and emotion as represented in the

practice of *Shin Shin Toitsu Aikido* and research revealing the neural integrated organism underscore the value of utilizing traditional mind/body practices in scientific research. The meeting of myth and science potentially opens doors to a deeper understanding of human experience.

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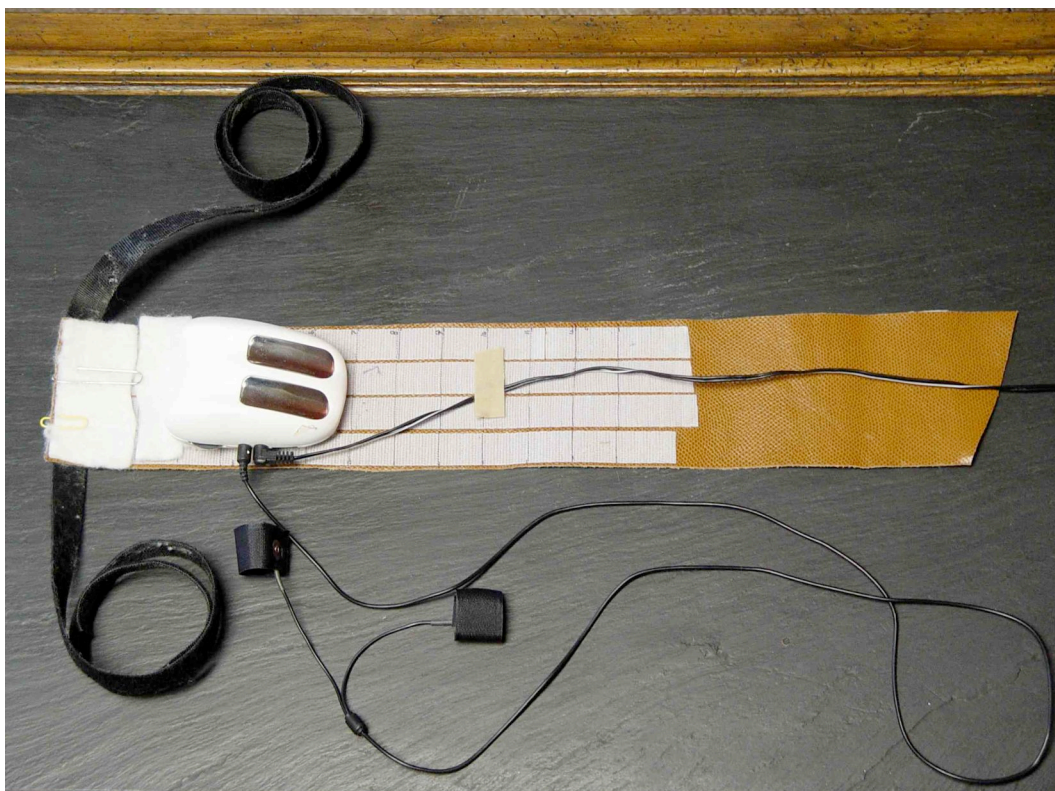
APPENDIX A

Research Equipment
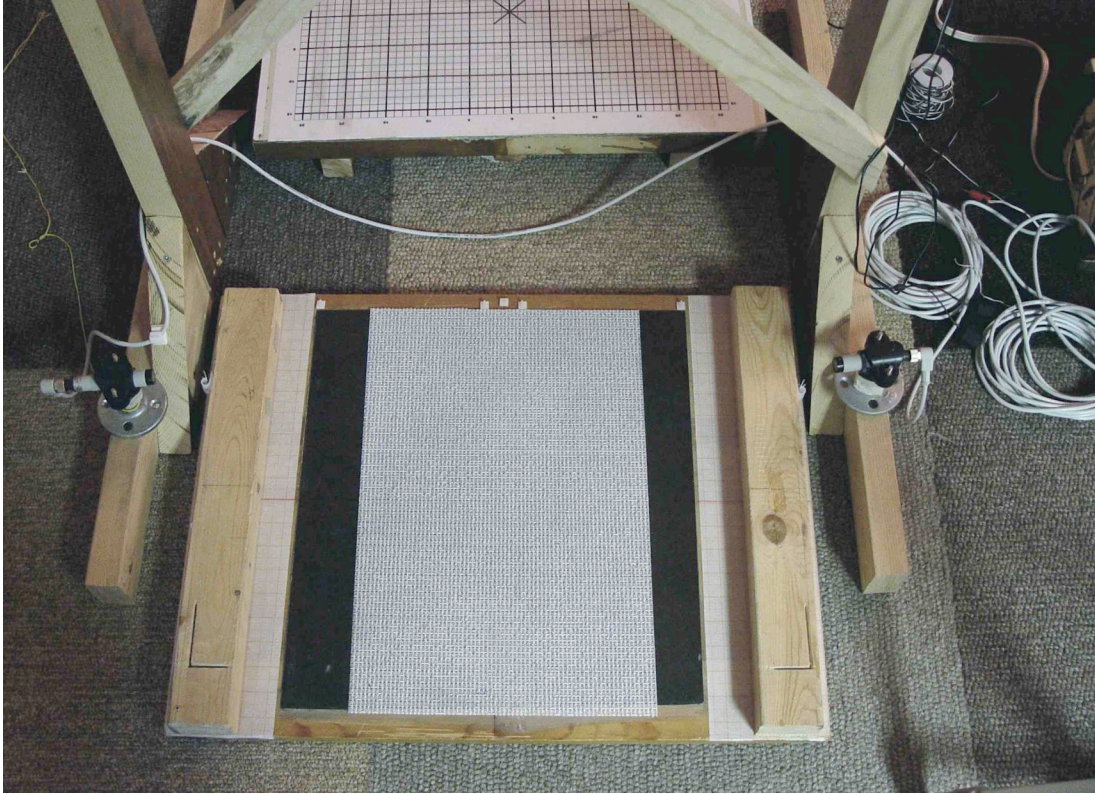
Pictures

Balance Testing & Reaction Time Setup

Laser Relay Box and Mouse Connections for both Reaction Time and Balance Testing

GSR Unit on holster with Velcro waist strap

Baseboard with non-slide surface for rocker board (at the foot of the railing)
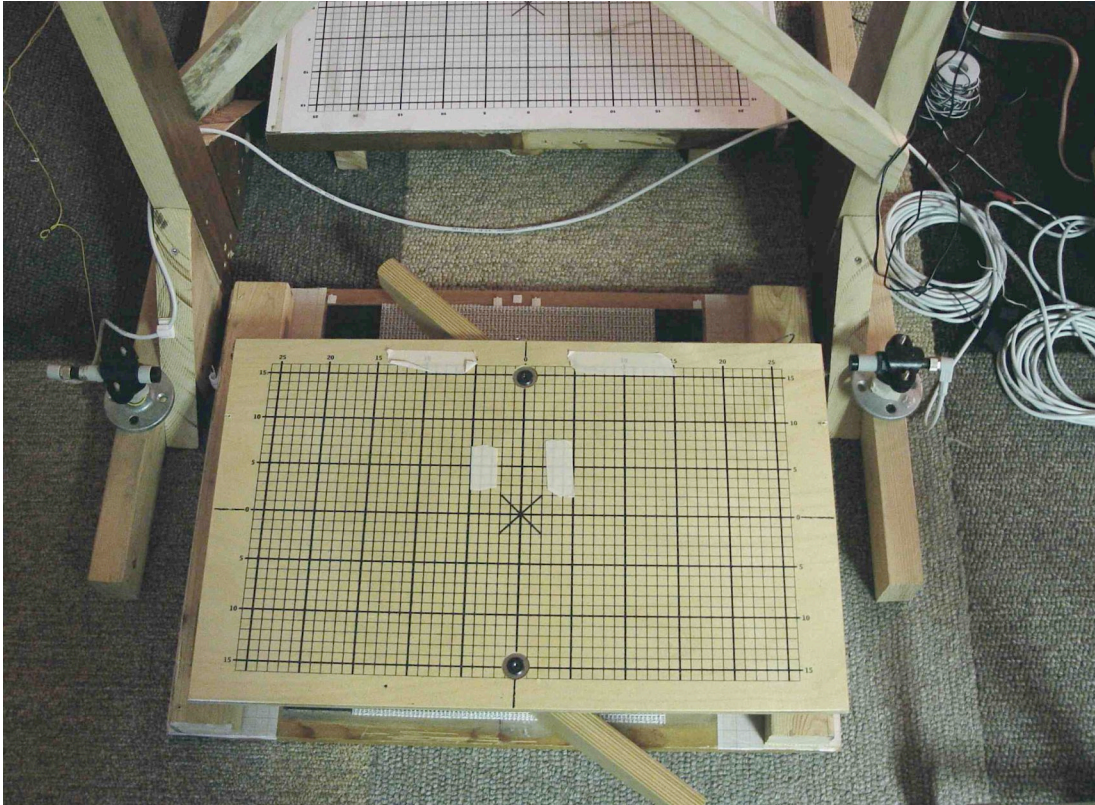
Rocker board in place between lasers at the foot of the railing

APPENDIX B

Laser Setup - Equipment

Equipment	Make/Part Number	Description
24 Volt Power Supply	Rhino/ PSP24—24S	Switching power supply, 24 VDC (adjustable), 1A (24W) output, DIN rail mounting, slim, plastic case with pluggable screw terminal connector, 85-264 VAC / 85-375 VDC universal input, foldback short circuit protection, UL508, 1950 & CE. Plastic DIN rail insert provided for easy panel mounting.
Elector-mechanical Card Relay	Automation Direct RS4N-DE	Card relay (4 included), mounted in socket, 24 VDC coil, SPST, 5A contact rating. TY3 relay remover included.
Laser Emitter – 2	Automation Direct FALH-X0-0E	Photoelectric sensor, 18 mm diameter, laser light, emitter, 10-30 VDC, 50 meter sensing distance, M12 quick-disconnect
Laser Receiver – 2	Automation Direct FALD-BN-0E	Photoelectric sensor, 18 mm diameter, laser light, receiver, 10-30 VDC, NPN, 50 meter sensing distance, selectable NO or NC output, M12 quick-disconnect
2 Meter Quick Disconnect Cable – 2	Automation Direct CD12L-0B-020-C0	M12 cable for quick-disconnect sensors, 12 mm right angle plug, 4 poles, 2 meter cable with PVC jacket for sensors with M12 connector.
7 Meter Quick Disconnect Cable – 2	Automation Direct CD12M-0B-070-C1	M12 cable for quick-disconnect sensors, 12 mm right angle plug, 4 poles, 7 meter cable with PVC jacket for sensors with M12 connector.
Computer Mouse – 2	1) Noteworthy/ NWMOU2 2) Mitsumi/ECM-S3902	Two-button mouse; input 5VDC/10mA PS/2 compatible mouse
USB/PS2 Converter –2	1) Radio Shack/26-226 2) Dynex/DX-C10187	
Plug & Jack – 2 sets	Radio Shack/274-283	Mono; 1/8"
Irrigation Saddle Tee – 4	Home Depot	Plastic PVC fitting
Irrigation Flange – 4	Home Depot	Metal PVC fitting
Irrigation Riser	Home Depot	Plastic PVC fitting
Tripods – 2	Sunpak PlatinumPlus 5800D	Medium duty tripod; extends to 59.4 inches; 3-way panhead with reference marks; bubble level; geared center column with tension adjustment
Power strip – 2	Target/170272 Power Sentry/170243	15 A; 125V; 60 HZ 15 A; 125V; 60 HZ

APPENDIX C

Examples of Balance Testing GSR Graphic Pattern

53A
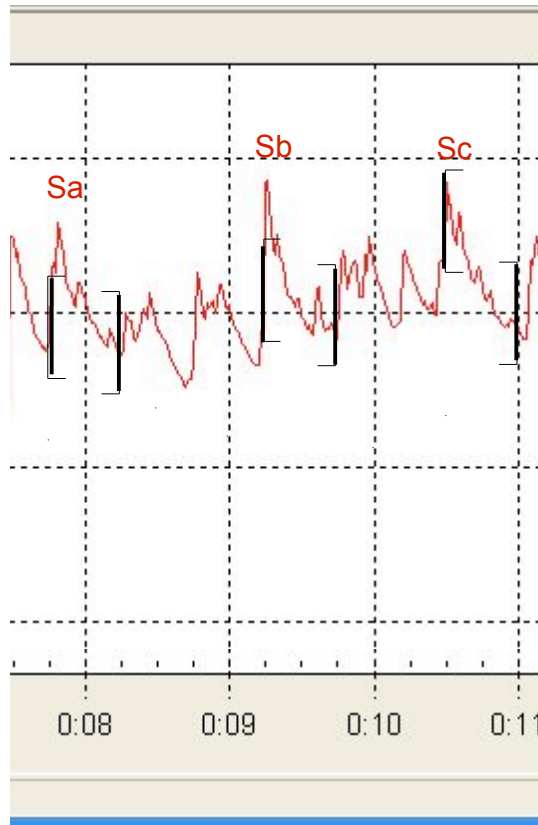
59A
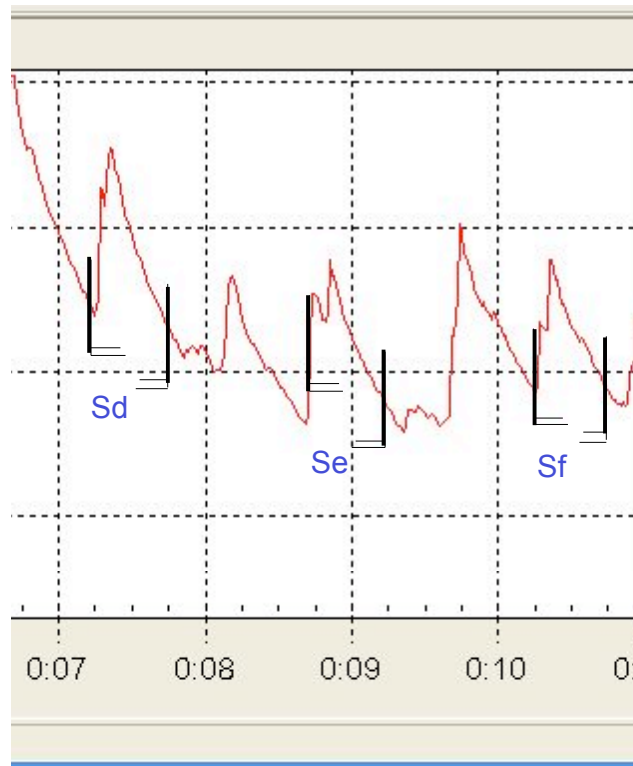
55A
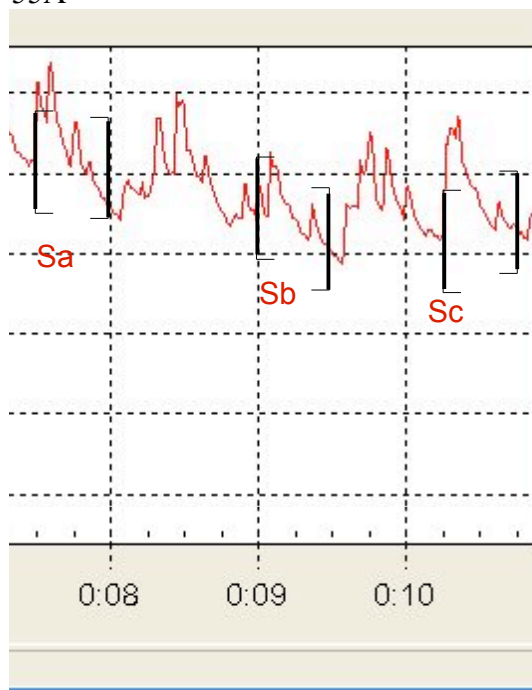
55B
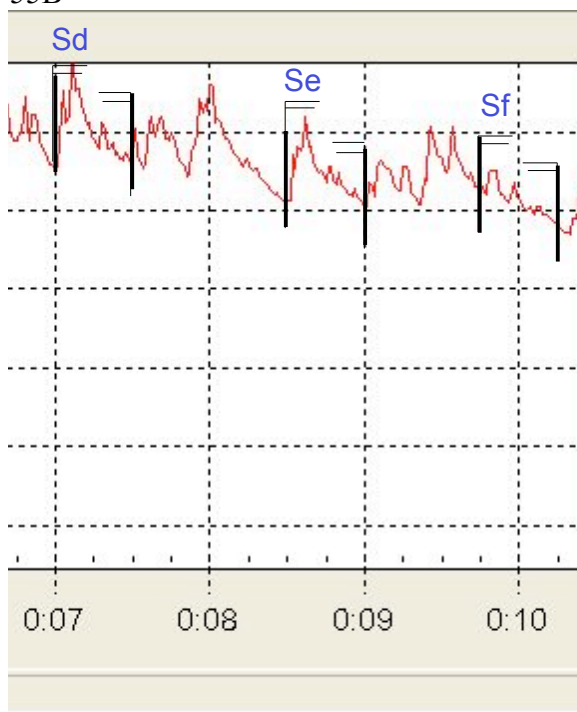
APPENDIX D

Centering Group Post-Surveys

ID #_____

After training

1 – not at all true   **2** – mostly not true   **3** – somewhat true   **4** – mostly true   **5** – completely true

I understand how to do the centering technique taught in this training.	1 2 3 4 5
I understand what I will be doing with centering during the second set of tests.	1 2 3 4 5
I believe I can apply what I have just learned to the second set of tests.	1 2 3 4 5

After 2nd set of trials

1 – not at all true   **2** – mostly not true   **3** – somewhat true   **4** – mostly true   **5** – completely true

<u>Quiet Standing</u>

I successfully centered prior to quiet standing.	1	2	3	4	5
I remained centered during quiet standing.	1	2	3	4	5

<u>Reaction Time</u>

I successfully centered for the **1st** reaction time trial.	1	2	3	4	5
I remained centered during the **1st** reaction time trial.	1	2	3	4	5
I successfully centered for the **2nd** reaction time trial.	1	2	3	4	5
I remained centered during the **2nd** reaction time trial.	1	2	3	4	5
I successfully centered for the **3rd** reaction time trial.	1	2	3	4	5
I remained centered during the **3rd** reaction time trial.	1	2	3	4	5

<u>Balance</u>

I successfully centered for the **1st** balance trial.	1	2	3	4	5
I remained centered during the **1st** balance trial.	1	2	3	4	5
I successfully centered for the **2nd** balance trial.	1	2	3	4	5
I remained centered during the **2nd** balance trial.	1	2	3	4	5
I successfully centered for the **3rd** balance trial.	1	2	3	4	5
I remained centered during the **3rd** balance trial.	1	2	3	4	5

<u>Other Comments</u>

APPENDIX E

Informed Consent

Informed Consent Form

Invitation to Participate
     You are invited to participate in a research study on the mind/body connection conducted by Ms. Susan Chandler, a student from the Regis University Master of Arts in Liberal Studies Department under the direction of Dr. Robert Collins. The study will take place at the Regis Adult Learning Center.

Basis of Subject Selection
     You are invited to participate because you are 18 years of age or older, you have no history of balance problems, and no physical injury or limitation that impacts your balance or control of posture.

Explanation of Procedures
     Participation includes one session approximately 75-minutes in length.
The session will begin with familiarizing the participant with the study setup and procedures.

     The actual study will begin with the participant filling out a brief mood assessment questionnaire. That will be followed by the research trial, which will consist of: 1) quiet standing for thirty seconds; 2) reaction time testing with a visual stimulus presented on a screen; 3) quiet standing on a balance board; and 4) galvanic skin response that will be measured throughout the study. There will then be a 15-minute learning session with the researcher, after which time the testing procedures will be repeated.

     The study includes two 15-minute learning sessions. Each participant is randomly selected to receive one of the two sessions. Which session you receive will be determined by the toss of a coin after your first set of tests.

     One of the learning sessions is experiential and involves focus. The other is informational and will provide you with more knowledge on the background of the study. In the experiential session there will be physical contact in the form of balance check – the researcher will push lightly on the participants arm or lower back.

     In order to not influence outcomes, the specific content of the learning experiences will not be described prior to the study. Participants will have the opportunity to schedule a time to receive the learning session they did not experience.

Potential Benefits
The study may provide useful insights regarding aspects of the mind/body connection. As a Regis student, participation in a clinical study may provide insight useful to your own research project in the future.

In Case of Injury
If you are hurt by this research, please immediately contact Dr. Robert Collins at (800)831-3258 or (303)458-4302, ext. 7063. You will not be paid for any loss if you are hurt as a result of the study, such as lost wages, pain, or suffering. This should not be taken as a waiver of any legal rights you may have.

Financial Obligations
All testing will be provided to you at no cost.

Assurance of Confidentiality
Your name will not be linked with your scores in any way. Instead, your data will be identified only by a subject number. Information obtained from this study may be published in professional journals or presented at professional meetings. In such publications or presentations, your identity will never be revealed.

Withdrawal from the Study
Participation is voluntary. If you decide to participate, you are free to withdraw from the study at any time without prejudice from the researchers or consequence in any way from Regis University.

Offer to Answer Questions
If you have any questions now or at any time during the study, please feel free to ask them. If you have questions after the conclusion of the study, please call Dr. Robert Collins. If you have any questions concerning your rights as a subject, you may contact Bud May, the Director of Regis University Institutional Review Board at 303 458-4206.

YOU ARE VOLUNTARILY MAKING A DECISION WHETHER OR NOT TO PARTICIPATE IN THIS STUDY. YOUR SIGNATURE MEANS THAT YOU HAVE DECIDED TO PARTICIPATE KNOWING WHAT WILL HAPPEN, AND KNOWING THE POSSIBLE GOOD AND BAD. YOUR SIGNATURE ALSO MEANS THAT YOU HAVE HAD ALL YOUR QUESTIONS ANSWERED TO YOUR SATISFATION. YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP.

_____

Printed Name of Subject

_____

Signature of Subject   Phone Number   Date

IN MY JUDGMENT THE SUBJECT IS VOLUNTARILY AND KNOWINGLY GIVING INFORMED CONSENT AND POSSESS THE LEGAL CAPACITY TO GIVE INFORMED CONSENT TO PARTICIPATE IN THIS RESEARCH.

_____   _____

         Signature of Investigator   Date

INVESTIGATOR
Susan E. Chandler

APPENDIX F

Participant Pre-Study Questionnaire

ID #:

Participant Name: _____ _____ _____
                    First   Middle   Last

Address: _____
               Street, Apt.

               _____   _____   _____
               City   State   Zip

Telephone: _____

e-mail: _____

Date: <u>6/11/07</u>

Dept: _____ Major: _____ Age: _____ Gender: M ☐ F ☐

1. Do you experience any problems with balance (e.g., dizziness; falling)?
   No ☐ Yes ☐ if yes, please state the nature of the balance problem you experience:

   _____

   Check the level of balance impairment on a scale of 1 to 9
   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
   | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
   (mild)   (severe)

2. Do you have any muscle and/or joint injuries, conditions, and/or pain that interfere with standing comfortably for any period of time?
   No ☐ Yes ☐ if yes, please describe the issue/condition:

   _____

   Check the level of impairment or pain on a scale of 1 to 9
   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
   | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
   (mild)   (severe)

3. Do you have any upper body muscle and/or joint injuries, conditions, and/or pain that would interfere with freely moving your arm in a forward swinging motion?
   No ☐ Yes ☐ if yes, please describe the issue/condition:

   _____

   Check the level of impairment or pain on a scale of 1 to 9
   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
   | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
   (mild)   (severe)

4. Do you have any uncorrected vision problems?
   No ☐ Yes ☐ if yes, please describe the issue/condition:

   _____

   Check the level of impairment on a scale of 1 to 9
   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
   | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
   (mild)   (severe)

5. Do you have any experience in the martial arts?
   No ☐   Yes ☐   if yes, what style of martial art? _____
   For how long (in months or years)? _____
   Are you currently practicing? No ☐   Yes ☐
   Check your level of ability on a scale of 1 to 9

     1   2   3   4   5   6   7   8   9
   ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
   (beginner)   (expert)

6. Do you have experience in a mind/body practice (e.g., Yoga, Mind Gym)?
   No ☐   Yes ☐   If yes, what kind of practice? _____
   For how long (in months or years)? _____
   Are you currently practicing? No ☐   Yes ☐
   Check your level of ability on a scale of 1 to 9

     1   2   3   4   5   6   7   8   9
   ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
   (beginner)   (expert)

7. Do you have experience meditating?
   No ☐   Yes ☐   If yes, what style? _____
   For how long (in months or years)? _____
   Are you currently meditating? No ☐   Yes ☐
   Check your level of ability on a scale of 1 to 9

     1   2   3   4   5   6   7   8   9
   ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
   (beginner)   (expert)

8. Do you have experience in a workout routine that includes developing balance? (e.g., palates, balance board, balance ball, etc.)
   No ☐   Yes ☐   If yes, what kind? _____
   For how long (in months or years)? _____
   Are you currently doing a balance practice? No ☐   Yes ☐
   Check your level of ability on a scale of 1 to 9

     1   2   3   4   5   6   7   8   9
   ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
   (beginner)   (expert)

9. Do you experience hot flashes?   No ☐ Yes ☐

Do you have experience in:
10. Skiing   No ☐   Yes ☐
    If yes, for how long? (in months or years) _____

Are you currently skiing? No ☐   Yes ☐
Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

11. Snowboarding   No ☐   Yes ☐
If yes, for how long? (in months or years) _____
Are you currently snowboarding? No ☐   Yes ☐
Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

12. Surfing   No ☐   Yes ☐
If yes, for how long? (in months or years) _____
Are you currently skateboarding? No ☐   Yes ☐
Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

13. Skateboarding   No ☐   Yes ☐
If yes, for how long? (in months or years) _____
Are you currently skateboarding? No ☐   Yes ☐
Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

14. Gymnastics   No ☐   Yes ☐
If yes, for how long? (in months or years) _____
Are you currently involved in gymnastics? No ☐   Yes ☐
Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

15. Diving   No ☐   Yes ☐
If yes, for how long? (in months or years) _____
Are you currently diving? No ☐   Yes ☐
Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

16. Ice Skating/   No ☐   Yes ☐
    Hockey   If yes, for how long? (in months or years) _____
                   Are you currently skating? No ☐   Yes ☐
                   Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

                   (beginner)   (expert)

17. Roller Blading   No ☐   Yes ☐
                   If yes, for how long? (in months or years) _____
                   Are you currently roller blading? No ☐   Yes ☐
                   Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

                   (beginner)   (expert)

18. Dance   No ☐ Yes ☐ If yes, What kind? _____
                   For how long? (in months or years) _____
                   Are you currently involved in dance? No ☐   Yes ☐
                   Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

                   (beginner)   (expert)

19. Flying   No ☐   Yes ☐
   (pilot)   If yes, for how long? (in months or years) _____
                   Are you currently flying? No ☐   Yes ☐
                   Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

                   (beginner)   (expert)

20. Motorcycle riding   No ☐   Yes ☐
                   If yes, for how long (in months or years) ?_____
                   Do you currently ride a motorcycle? No ☐   Yes ☐

21. Bicycle riding   No ☐   Yes ☐
                   If yes, for how long (in months or years) ?_____
                   Do you currently bicycle? No ☐   Yes ☐

22. Other sport/activity involving balance

What kind? _____
If yes, for how long? (in months or years) _____
Are you currently involved in this practice? No ☐   Yes ☐

Check your level of ability on a scale of 1 to 9

1	2	3	4	5	6	7	8	9
☐	☐	☐	☐	☐	☐	☐	☐	☐

(beginner)   (expert)

PLEASE SAVE DOCUMENT BEFORE CLOSING

E-MAIL AS ATTACHMENT TO
sechand@qwest.net