The Effect of Yoga Therapy for Children with Cerebral Palsy

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THE EFFECT OF YOGA THERAPY
FOR CHILDREN WITH CEREBRAL PALSY

A Masters Thesis presented to the Faculty of the
Graduate Program in Occupational Therapy
Ithaca College

In partial fulfillment of the requirements for the degree
Masters of Science

by
Alyson Lee
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Abstract

This single subject AB design was conducted to evaluate the effectiveness of yoga therapy on the motor skills, well-being, and attention for two 11 year old fraternal twins with cerebral palsy. The principal investigator collected baseline data five times over the course of one week, and once per week for 10 weeks during the intervention phase. During intervention, the children participated in a yoga program three times per week. Results of the study indicate that the yoga program produced significant improvements in active range of motion for both participants and postural stability for one participant. No significant differences were indicated for all other measurements; however non-significant improvements in motor skills, well-being, and attention are discussed.

Keywords: yoga, cerebral palsy, occupational therapy
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Lastly, I would like to thank my research assistants, Brenda Barber, Rebecca Lee, and Thomas Swink.
Dedication

I would like to dedicate my thesis to my mother for introducing me to yoga and guiding me to share yoga with others. Thank you for always believing in me and teaching me to open my heart.
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Chapter 1: Introduction

Yoga is an ancient Indian practice that connects the mind, body, and spirit through holding systematic poses and postures (Birdee, Yeh, Wayne, Phillips, Davis, & Gardiner, 2009). The tradition has circulated all over the world and has grown in popularity throughout western cultures. In recent decades, yoga has become useful in health professions due to its healing effects for various diseases and conditions. Some of the physiological benefits attributed to yoga include reduced levels of cortisol (McCall, 2009), increased conservation of energy (Peck, Kehle, Bray, & Theodore, 2005), and improved circulation, respiration, and sleeping patterns (Nayak & Shankar, 2004). Unofficially, yoga has been incorporated in many medicinal and therapeutic arenas through the use of extended stretches and breathing exercises. The establishment of the International Association of Yoga Therapists (IAYT) in 1989 has attracted yoga therapists, teachers, researchers, and health professionals to educate others about the use of yoga as an intervention strategy (IAYT, 2009).

The use of yoga as medicine and therapy has spread to people of all ages, including children. In children, yoga has been associated with improved physical, mental, psychosocial, and behavioral health (Birdee et al., 2009). There is research that supports the benefits of yoga for children’s neuromusculoskeletal functioning (Galantino, Galbavy, & Quinn, 2008; Tran, Holly, Lashbrook, & Amsterdam, 2001), respiratory functioning (Nagarathna & Nagendra, 1985; Telles, Reddy, & Nagendra, 2000), anxiety management (Case-Smith, Sines, & Klatt, 2010; Kirkwood, Rampes, Tuffrey, Richardson, & Pilkington, 2005), attention (Jensen & Kenny, 2004), and self-regulation (Garg, Buckley-Reen, Alexander, Chintakindi, Tan, & Koenig, 2009). Most of the literature regarding yoga for the pediatric population includes typically developing children. However, some studies include populations with special needs, such as children with
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attention deficits (Jensen & Kenny, 2004; Peck et al., 2005), autism (Radkarkrishna, Nagarantha, & Nagendra, 2010), learning difficulties (Chan, Cheung, & Sze, 2008), and psychological disorders (Birdee et al., 2009; Lavey, Sherman, Mueser, Osbourne, Currier, & Wolfe, 2005; Shannahoff-Khalsa, Ray, Levine, Gallen, Schwartz, & Sidorowich, 1999).

Although many people have examined the effects of yoga on children, there is limited research that supports yoga as a valid intervention strategy. Limitations of evidence include too few studies, methodological issues, and small sample sizes in existing studies (Birdee et al., 2009). There is a need for experimental research, including controlled studies, reliability and validity of measures, and quantitative data in order for yoga to be included as a therapeutic intervention (Wiart, Darrah, & Kembhavi, 2008).

One population that has not been studied as a potential beneficiary of yoga is children with cerebral palsy. Cerebral palsy (CP) is a non-progressive condition that results from injury to the central nervous system (Koman, Smith, & Shilt, 2004). Individuals with this condition may have abnormally high, low, or fluctuating levels of muscle tone. Muscle tone refers to a muscle’s response to resistance or stretch, and affects postural control and motor coordination (Reddihough, 2009). Individuals with CP may have limited abilities in maintaining postural control, thus limiting controlled, smooth movements. High muscle tone, or spasticity, frequently causes limitation in range of motion and flexibility in children with CP.

Although sources from books and the web suggest that yoga may help increase neuromusculoskeletal functioning and motor coordination in children with cerebral palsy (Sumar, 1998; University of Illinois at Chicago, 2011; Wenig, 2003; Yoga for the Special Child, 2009; Yoga Forums, 2010), no studies have documented the effect of yoga on children with
cerebral palsy. The purpose of this study was to evaluate the effect of yoga therapy in school-aged children with cerebral palsy. The following research questions were addressed:

- Will there be a significant increase in range of motion and motor coordination in children with cerebral palsy following a routine yoga program?
- Will yoga therapy produce a change in well-being in children with cerebral palsy?
- Will there be a significant difference in attention in children with cerebral palsy following a routine yoga program?
Chapter 2: Literature Review

History of Yoga

Yoga is an Indian philosophy developed between 1000 and 5000 B.C. as a form of spiritual growth (McCall, 2007). This ancient practice is a part of Indian science that focuses on connecting the mind, body, and spirit. The word yoga originates from the Sanskrit root yoke, meaning “harnessing oneself to a discipline or way of life” (Nayak & Shankar, 2004, p. 783). The practice is comprised of a system of breathing and mental techniques as well as postures and poses that are designed to target specific energy systems in the body that are important for health and well being (Chandler, 2001). Many variations of yoga exist; however, most practices incorporate “body scanning, pranayama (breathing techniques), asanas (stretches and physical exercises), relaxation techniques, dhyana (meditation), and visualization” (Kluge, 2004, p. 22).

Yoga has traveled from the East Asia region around the world and has taken on new meanings, especially for Western cultures. The earliest introduction of yoga to the United States is attributed to Hindu monk Swami Vivekananda by his address at the World’s Columbian Exposition in Chicago in 1893 (McCall, 2007). Although growing in popularity, yoga has been somewhat controversial in the United States. This may stem from the religious and spiritual implications of its origin. The emphasis on the mind-body complex differs from the mechanistic view of bodily functions in the West. The concrete split between science and religion in Western society contrasts with the connection of spirituality and healing in the Indian culture.

Historically, yoga’s primary goal in practice was based on spiritual growth and personal awareness (Kluge, 2004). Khalsa (2004) suggested that the physiological responses that are associated with yogic techniques would have been viewed as positive side effects of the practice. As a result, yoga as medicine did not begin to formulate until the 20th century.
Khalsa (2007) reported that the relationship between yoga and beneficial medical effects began to be recognized in 1918. The Yoga Institute at Versova near Mumbai, India gave rise to the Yoga Institute at Santa Cruz. By the 1920s, yoga was being integrated into hospitals and clinics throughout the country, and eventually on an international level (Khalsa, 2007). Yoga therapy has been termed as the intervention used to address health issues and medical conditions (Kluge, 2004). Unofficially, yoga has been incorporated in many medicinal and therapeutic arenas through the use of extended stretches and breathing exercises. The establishment of the International Association of Yoga Therapists (IAYT) in 1989 has attracted yoga therapists, teachers, researchers, and health professionals through the use of a journal, newsletter, and website (IAYT, 2009).

Khalsa (2004) suggested that the lag in evidence-based research regarding yoga as a therapeutic intervention is attributed to the majority of publications in Indian journals. For example, *Yoga Mimamsa*, a yoga specialty Indian journal, is not consistently reviewed or cited due to its inaccessibility from most mainstream databases. In more recent decades, research has been published in journals in the U.S. and England. Khalsa conducted a bibliometric analysis of published articles pertaining to yoga and its use in medicine. Results showed that 181 publications in 81 different journals in 15 different countries contain articles about yoga for medical or psychiatric conditions. Journals with the most publications included *Yoga Mimamsa*, *Indian Journal of Physiology and Pharmacology*, and *Journal of the Association of Physicians of India*. Khalsa found that 48.1% were uncontrolled studies with small sample sizes performed in India. Khalsa suggested that the peer review process in India may not be as rigorous as in Western journals, further weakening the results of the study.
Medical Benefits of Yoga

Researchers have recorded the physical responses that are associated with the mental components of the yoga practice. The coordination of a psychophysiological response when doing yoga poses produces a decrease in cognitive and somatic arousal through modified activity in the hypothalamic pituitary axis and autonomic nervous system (Khalsa, 2004). Studies have shown that yoga techniques are associated with reduced cortisol and catecholamine secretion, which are related to the stress response. The sympathetic nervous system, or arousal control center, becomes less involved as complimentary parasympathetic activity increases (McCall, 2007). These factors combined with metabolic rate and oxygen consumption reduction contributes to the relaxation response (Ghoncheh & Smith, 2004; Khalsa).

Kluge (2004) indicated that pranayama, or breathing techniques, is a central aspect of the yoga practice. In a study of 40 male volunteers, Telles et al. (2000) compared the effects of cyclic meditation, yoga that included calming and stimulating poses, and shavasana, relaxation in the supine position. Results indicated that cyclic meditation, which emphasizes concentration on breathing with movement, produced more significant decreases in oxygen consumption and breath rate, and increases in breath volume. The authors postulated that control of the breath reduces muscular effort, contributing to the relaxation response. In a study of 106 individuals diagnosed with bronchial asthma, Nagarathna and Nagendra (1985) found significant decreases in numbers of asthma attacks and drug treatments in the 53 randomly assigned individuals who participated in a yoga program for 150 minutes per day for two weeks compared to the control group. The yoga program consisted of yoga poses, breathing exercises, relaxation, meditation, and lectures on the philosophy of yoga.
**Populations Served.** Khalsa’s (2004) results indicated that most published studies on yoga have been used for psychiatric conditions, cardiovascular disorders, and respiratory disorders. More specifically, Chandler (2001) suggested that yoga postures and breathing techniques improve circulation, respiration, and heart function. Other populations that have been shown to benefit from yoga are people with chronic pain, carpal tunnel syndrome, asthma, diabetes, and hypertension (Chandler). Nayak & Shankar (2004) reported that yoga helps regulate sleeping, breathing, and bowel patterns. Mailoo (2005) gathered studies indicating that individuals with chronic hemiparesis, multiple sclerosis, low back pain, and depression have had positive results with yoga. It is evident that the use of yoga as a way to promote healing has spread to many populations.

**Yoga for Children**

Yoga has been practiced by individuals of a wide range of age and level of functioning. McCall (2007) outlined the widespread practice of yoga among children, adults, and senior citizens with typical and abnormal developmental abilities. Studies of the effect of yoga on the pediatric population is a newer area of research. Birdee et al. (2009) reported that in 2007, there were over 1.5 million children in the United States who practiced yoga. The authors reviewed 26 controlled studies of yoga for children and nine controlled studies for young adults. The authors found that yoga has been studied for children with typical development, attention deficit hyperactive disorder (ADHD), learning disabilities, irritable bowel syndrome, depression, eating disorders, visual perceptual impairments, intellectual disability, and other physical, cognitive, and social problems. They found that like in adults, yoga produces improved cardiovascular effects, such as decreased blood pressure, heart rate, and respiratory rate, in children. Another common theme among these studies was increased physical fitness in children who participated
in yoga programs. Birdee et al. suggested that these studies should be improved and repeated because many of them were conducted in India, limiting their generalizability across contexts and cultures.

One study has evaluated the effect of yoga on the motor functioning of children. Telles, Hanumanthaih, Nagarathna, & Nagendra (1993) examined static motor performance in two groups of 45 typically developing children ages 9 to 13. The experimental group, which participated in a 10-day yoga training demonstrated a significant decrease in errors on a steadiness test. The steadiness test consisted of maintaining forearm extension while holding a metal stylus inside the decreasing sizes of holes of a metal plate without touching the sides of the plate. No studies have been identified that examine the effect of yoga on children with motor dysfunction. However, yoga has been promoted as a beneficial practice for children with diagnoses related to motor challenges, such as microcephaly, Down syndrome, and cerebral palsy (Sumar, 1998).

Cerebral Palsy

Cerebral palsy is a term used to describe the range of syndromes affecting posture and motor control caused by impairment of the central nervous system (Reddihough, 2009). Koman et al. (2004) reported that CP is the most common physical disability for children, affecting 2.4 per 1000 children aged 3-10 years old worldwide. Injury to the developing central nervous system most often occurs during pregnancy, delivery, or the first two years of life (Koman et al.), but can also result from meningitis infection and traumatic brain injury (Yoga for the Special Child, 2009). The spectrum of cerebral palsy can range from subtle motor impairment to severe dysfunction, dependent upon the magnitude, extent, and location of brain injury (Koman et al.). The most common type, spastic cerebral palsy, results in tense and contracted muscles.
Dyskinetic cerebral palsy affects only motor centers of the brain and is characterized by fluctuating tone that causes involuntary movements, such as twisting, and facial grimacing. Damage to the cerebellum impairs balance and coordination and is the prime characteristic of ataxic cerebral palsy, the least common type of CP (Reddihough).

Cerebral palsy is a non-progressive disorder resulting from a permanent static lesion of the cerebral motor cortex. The resulting injury to upper motor neurons produces abnormal muscle control, weakness, incoordination, dystonia, and spasticity (Flett, 2003). Spasticity, or inappropriate muscular activity or resistance to stretch, results from increased excitability of gamma and alpha neurons. Patterns of spasticity can lead to joint contracture, bony deformity, and or joint subluxation or dislocation (Koman et al., 2004). Spasticity manifests as an increase in muscle tone with exaggerated tendon jerks. The most recent treatment of spasticity focuses on both abnormalities in muscle tone and bone growth to address both neurophysiological and musculoskeletal components (Flett).

The level of functioning of patients with CP relies on the location and impact of injury to different parts of the brain. Koman et al. (2004) reported that more than half the CP population can walk independently, 25% cannot walk, and 30% also encounter mental disabilities. DiMario & Sladky (1989) stated that more than 70% of children with cerebral palsy have additional neurological problems, including seizures, sensory impairment of the arms, hydrocephalus, autonomic dysfunction, impaired visual perception, speech difficulties, intellectual disability, and learning disabilities. Management of these problems typically addresses spasticity and its related consequences.
Yoga and Cerebral Palsy

Because yoga therapy is considered a newer and more alternative medicine, its inclusion as a rehabilitative technique is not widely recognized. However, yoga workshops have been designed for occupational and physical therapists that are geared toward children with special needs. Designers of these workshops have based their routines of poses on the anatomical abnormalities of individuals with cerebral palsy.

Marsha Wenig's (2003) book illustrated a sequence of yoga poses that can be adapted for children ages two to eleven with various abilities. The yoga poses are described by animal and other childlike references to engage the children in a physical activity that is fun, enjoyable, and therapeutic. Wenig developed the YogaKids program based on Howard Gardner's theory of multiple intelligences, focusing on the eighth addition to the list of intelligences: naturalist intelligence. This level involves awareness with personal and environmental nature. Wenig built upon this inner body and outer connection when establishing the elements of YogaKids.

Sonia Sumar is credited with the spread of yoga for children with disabilities. Her international program, Yoga for the Special Child, is a therapeutic program that targets individuals with Down syndrome, cerebral palsy, microcephaly, autism, and other developmental disabilities (Yoga for the Special Child, 2009). Sumar claimed that yoga helps in areas of coordination, muscle development, body awareness, concentration, and hyperactivity reduction.

Physical implications of yoga therapy for children with cerebral palsy. Limited range of motion is a commonly reported problem in children with CP. Stretching has been recommended as treatment to manage spasticity and maintain range of motion (Tremblay, Malouin, Richards, & Dumas, 1990). However, for the CP population, it is difficult to prove the effectiveness of stretching because the structural anatomy of muscle contractures in these
individuals is not fully understood. As a result, there is limited research on the efficacy of stretching techniques with children with CP that can be used as evidence for clinical practice (Wiart et al., 2008). Children with spastic cerebral palsy exhibit rigid muscles. Pin, Dyke, & Chan (2006) reviewed seven studies that measured the effectiveness of passive stretching on children with spasticity. Results from the analysis showed that there is limited evidence that passive stretching can reduce spasticity, increase range of movement, or improve walking efficiency for this population. The researchers drew the conclusion that stretching that was sustained for longer periods of time on each occasion showed significant improvements in range of motion compared to stretches of briefer time spans. Wiart et al. reported that stretching programs are thought to increase the extension of muscles, facilitate joint range of motion for desired movement patterns, and reduce the need for orthopedic surgery.

Sustained stretching is a major component of yoga. Different yoga poses, called asanas, target areas of high and low muscle tone. Holding an asana relaxes the muscles and tendons, releasing the stress around the joints that is present for an individual with cerebral palsy with high or rigid tone (University of Chicago at Illinois, 2011). Based on conclusions drawn from Telles et al. (2000), increased breath volume caused by yoga is likely to affect spastic muscles by reducing muscular tension in children with cerebral palsy. Likewise, the physical demands of specific postures will facilitate strengthening of muscle groups that have low tone. This dual effect of yoga provides stretch and strength for targeted muscles (Wenig, 2003).

Some asanas may specifically target the misalignment of the spinal column in individuals with cerebral palsy. Since CP is a brain abnormality, the execution of movements is compromised due to impaired nerve function. Many advocates of yoga for children with CP suggest that yoga poses that focus on realignment of the spine may not only reduce muscle
tension but also enhance overall nerve function (University of Chicago at Illinois, 2011; Sumar 1998; Wenig, 2003; Yoga for the Special Child, 2009). Each series of poses includes a stretch and counter-stretch to create a balance of muscle contracture on both sides of the body. Movement in this fashion creates more space between the vertebrae, alleviating pressure on the intervertebral disks. Zipkin (2001) summarized that the relaxing nature of yoga facilitates reduction in muscular tension. Wenig (2003) suggests that this release in muscular tension and increase in nerve function allows the child to have more control over movement and coordination while increasing flexibility of joints. In a review of the literature, Zipkin reported that yoga increases body awareness, balance, and laterality in children, which may be areas of concern for children with cerebral palsy. However, the articles reviewed derive from the 1970s.

The structure of many yoga programs for children with cerebral palsy is based on these widely held assumptions. Such programs include the following: National Center on Physical Activity and Disability (University of Chicago at Illinois, 2011), Yoga for the Special Child (Sumar, 1998), and YogaKids (Wenig, 2003).

The philosophy behind this anatomical perspective is that yoga poses realign the spine to reduce muscle tension, a prime feature of spasticity. Through stretching, individuals with CP may gain more control over motor movements. Wenig (2003) suggested that more accurately planned motor movements may contribute to increased coordination and independence.

McCall (2007) suggested that a yoga practice should include a series of poses that involve backbends, forward bends, and twists. Poses that elongate the spine prevent breakdown of the intervertebral discs by providing a cushioning. By lengthening and twisting the spine, individuals with cerebral palsy may be able to alleviate the compression and impingement on the
nerves in the spinal column. The disks can then provide support for shock absorbance when moving for everyday functions.

**Psychological implications of yoga therapy for children with cerebral palsy.**

Research has indicated that children with physical disabilities, including cerebral palsy, experience high levels of stress and anxiety (Zipkin, 2001). Yoga is a form of relaxation therapy that affects mood and mental states (Carmody & Baer, 2008; Kirkwood et al., 2005; Lavey et al., 2005). Embedded in yoga practice are breathing techniques and meditation. In a systematic review of the literature on yoga for anxiety, Kirkwood et al. found eight controlled trials, six of which were randomized. All eight studies demonstrated significant improvement in anxiety management in the yoga groups compared to the control groups, most notably for populations with obsessive compulsive disorder (OCD). Of importance in the review was the study conducted by Shannahoff-Khlasa et al. (1999) due to its rigorous methodological process for data collection and analysis.

Slovacek, Tucker, and Pantoja (2003) studied the effect of 60-120 minutes of yoga on 405 inner-city students in Los Angeles, CA over the course of the 2002-2003 academic year. Results indicated significant improvements in students' self-perception, in-class behaviors, physical health, and academic performance as demonstrated by grade point averages, attendance, discipline referrals, standardized test scores, physical fitness scores, and student and teacher report; students' attendance perceptions of school were not affected, possibly due to high scores in these areas prior to the start of the study.

Studies and reviews have reported that children who do yoga show increased concentration at school (Parnes & Dagan, 2005). Peck et al. (2005) conducted a multiple baseline design designed to improve attention to task on 10 individuals with attention problems
and found that effect sizes ranged from 1.5 to 2.7 as a function of the intervention of yoga. Jensen and Kenny (2004) conducted a study of boys aged 8-13 with ADHD who were divided into a control group and a yoga group that practiced respiratory, postural, relaxation, and concentration training. Results showed that boys in the yoga group demonstrated significant improvements on 8 subscales of the Conner Parent Rating Scales compared to the control group.

Uma, Nagaratha, Vaidehi, & Seethalakshmi (1989) studied 90 children in Bangalore, India with mild, moderate, and severe intellectual disability, ages 6-16, half of which underwent yogic training for 10 months. Results indicated significant improvement in IQ and social adaptation in the yoga group compared to the control group for individuals with mental retardation according to scores on the Binet Kamat, an Indian intelligence scale. Stueck & Gloeckner (2005) developed the Training of Relaxation with Elements of Yoga for Children technique and performed 15 sessions on 48 fifth graders with abnormal examination anxiety. Post-test versus pre-tests results show increased emotional balance and static balance and decreased aggression and helplessness in school. Carryover of the techniques learned in this program are indicated by continued use of yoga and relaxation strategies in and out of school after the intervention phase had ended.

Lavey et al. (2005) studied the effect of yoga on 133 psychiatric inpatients at New Hampshire Hospital who voluntarily participated in a yoga program, which had been established at the hospital for eight years, as frequently as they desired. Using the Profile of Mood States assessment, the researchers found significant improvements on all five of the negative emotion factors: tension, depression, anger, fatigue, and confusion. Other mindfulness and mind-body programs, which incorporate yoga principles, have manifested promising results. Carmody and Baer (2008) reported significant improvements in well-being as measured by the Scales of
Psychological Well-Being in 174 adults who participated in a Mindfulness-Based Stress Reduction program. Likewise, in a study of 60 children who were randomly assigned to a mind-body training group or a control group, the experimental group showed significant reduction in some behavioral problems as well as improvement in academic performance (Chan et al., 2008).

While the studies mentioned do not pertain solely to the CP population, many of the psychological and psychosocial components of stress and anxiety are generalized across the disability population. It is possible that stress levels in children with CP can be lowered as a result of yoga intervention in the same way that it has been shown to affect children and adults with other diagnoses. More evidence-based research is needed to support this hypothesis.

Qualifications for Yoga Therapists

The routine of yoga poses can be done independently as well as with assistance from the therapist. It is important for yoga therapists to have adequate training as yoga instructors as well as knowledge of the cerebral palsy condition. Isaacs (2007) noted that there are no national credential requirements to become a yoga therapist. Certificates may be obtained through various training programs that are not necessarily standardized worldwide. Birdee et al. (2009) added that certification for teaching yoga to the pediatric population is less standardized than for adults. Integrative Yoga Therapy is an organization that offers multi-level training programs for health professionals who are interested in bringing yoga in their practice (Integrative Yoga Therapy, 2010). Sonia Sumar offers a developmental 7-day training around the world called *Yoga for the Special Child*, beginning with early intervention and continuing to adolescence (Yoga for the Special Child, 2009).
Yoga and Occupational Therapy

As cited by Chandler (2001), Scholar Georg Feuerstein is noted for drawing inferences between yoga and therapeutic interventions in stating that the emphasis on proper alignment and positioning exemplifies therapeutic strategies. While many studies have been conducted, the need for more quantitative evidence is essential for the establishment of yoga as a justifiable modality. The use of longitudinal studies pertaining to specific medical conditions is needed to show evidence of long-term benefits. Among the health professionals who have used yoga as a form of intervention are occupational therapists. Occupational therapy focuses on engagement in occupations or activities that bring meaning to a client’s everyday life (AOTA, 2010).

Occupational therapists may incorporate yoga into therapy as a preparatory method or intervention strategy in order to reduce symptoms that may interfere with the client’s normal functioning. Specific yoga postures can be targeted to influence certain groups of muscles and bodily functions. Postures can also be adapted or modified to maximize the client’s potential at various stages in the rehabilitation process. In contrast to basic stretching, yoga incorporates mental components, and their related physical responses, into the therapeutic intervention.

Thomas and Nelson (2000) argued that occupational embedded exercise versus non-occupational activity can be meaningful and purposeful, and produce a change in the developmental structure. Yoga is an occupational embedded exercise. Mailoo (2005) linked the two health practices by naming yoga as “an ancient occupational therapy” (p. 574) that could contribute to occupational science theory. The potential for yoga to be an integral part of occupational therapy practice relies on the need for greater evidence on the effect of breathing techniques and postures on desired physiological responses.
Conclusion

The availability and potential for yoga to be used in therapy is growing as yoga becomes more widespread in western culture. However, there is little research to support the effectiveness of specific yoga poses in reducing spasticity for children with cerebral palsy. If studies show that children who participate in yoga demonstrate increases in coordination and independence, it is possible that yoga therapy will be become more accepted and used in the therapeutic setting.

Limitations of evidence include limited studies, methodological issues, and small sample sizes in existing studies. Birdee et al. (2009) reported that a main obstacle in studies that have examined the effectiveness of yoga for the pediatric population is an inadequate description of the yoga intervention that was provided and too few details of the population tested. The authors also note that many studies used yoga therapy in conjunction with other studies, inhibiting the researchers to conclude the effectiveness of yoga therapy in isolation to other treatments.

There is a need for experimental research, including controlled studies, reliability and validity of measures, and quantitative data in order for yoga to be included as a therapeutic intervention. Wiart et al. (2008) suggested that future research should examine the effect of yoga on body structures and functions and participation in daily occupations. The researchers stated the importance of child engagement in physical activities to promote physical fitness.

Examining the relationship between yoga therapy and affect and well being may indicate if children will cerebral palsy are more able and likely to engage in social occupations with their peers. Kirkwood et al. (2005) added that yoga as therapy provides an alternative to pharmacological intervention and its associated side effects. Yoga therapy may provide an opportunity to minimize the negative effects of cerebral palsy and maximize coordination and independence in motor activities as well as overall positive well-being.
Chapter 3: Methodology

Study Design

This study was a single subject AB design. After receiving approval from the Human Subjects Review Board of Ithaca College (see Appendix A), the principal investigator recruited school-aged children with a diagnosis of cerebral palsy in the local area. Two children with cerebral palsy were involved in the study. The total study was 11 weeks in duration. Baseline phase was one week long and consisted of five data collection points; intervention phase was 10 weeks long and consisted of one data collection point per week. The participants had ongoing responsibilities throughout the week in addition to the one data collection point, as described in the methods.

Participants

The two 11-year old children who participated in this single subject design are fraternal twins with cerebral palsy. Each child was offered a $50 gift card as an incentive to participate in the study. The participants and their parents signed the Informed Consent forms (see Appendix B) and the details of the study were explained to them prior to its start. Both children were able to understand directions, could read and respond to study materials, and had adequate motor skills to participate in a yoga program. Pseudonyms have been assigned to each participant for the purposes of confidentiality.

Anna is a female who was born at 27 ½ weeks gestation, and weighed one pound five ounces and spent four months in the Neonatal Intensive Care Unit (NICU). She was ventilated for the first two months of life. After returning home for nine days, Anna was re-admitted into the hospital for two more months. Comorbid conditions include asthma, left exotropia, bilateral myopia, and retinopathy of prematurity.
Luke is a male who was born two pounds one ounce and was ventilated for the first week of life. He was on continuous positive airway pressure (CPAP) for one month and spent a total of three months in the NICU. Comorbid conditions include myopia, retinopathy of prematurity, and absence seizures.

Both children had bradycardia and apnea for the first year of life and were monitored at home at all times. They received occupational therapy, physical therapy, and speech therapy through Early Intervention until the age of three. The participants continued to receive services at home through a local education agency until the age of four when they began preschool. Both children went to Kindergarten for two years. They are currently attending regular education classes and have Individualized Education Plans. According to the Gross Motor Function Classification System for Cerebral Palsy (Palisano, Rosenbaum, Walter, Russell, Wood, & Galuppi, 1997), an ordinal scale that categorizes motor function, both participants are classified as level I. Anna and Luke are fully ambulatory indoors and outdoors; however, speed, balance, and coordination are reduced.

Anna receives occupational therapy and physical therapy once per week during the school year. Occupational therapy targets in-hand manipulation, visual motor coordination, bilateral hand use, and handwriting. Physical therapy focuses on Anna’s strength, balance, coordination, and flexibility, especially in her hamstrings and hip external rotators. She receives teacher support for math and support from an aide in the classroom as needed. Anna requires a 1:1 aide during recess, physical education, and art. She attends general physical education as well as adapted physical education once per week. Anna has corrected 20/30 vision in each eye.

Luke has a history of absence seizures and experienced two complex partial seizures during the year of 2010. He displays low tone in his lower extremities and wears orthotics in
both shoes; his left orthotic also provides ankle support. Luke attends general physical education as well as adapted physical education. He receives additional support in the classroom to maintain attention to task, organize materials and belongings, and manage frustrations. Luke has corrected 20/25 vision in his right eye and 20/50 vision in his left eye.

Independent Variable

Yoga program. The yoga program used for this study was a 15-minute DVD, titled Get Ready to Learn (GRTL), created by Anne Buckley-Reen, OTR/L, RYT (Garg et al., 2009). The GRTL DVD was designed for children in the New York City Department of Education public schools, to use with teacher supervision in the classroom (Garg et al.). The principal investigator received permission to use the GRTL DVD from its creator prior to the start of the study. The DVD incorporates a series of breathing, balancing, stretching, and strengthening postures as well as eye exercises and relaxation.

Dependent Variables

The principal investigator evaluated the effect of yoga therapy on motor skills, attention, and overall well-being.

Bruininks-Oseretsky Test of Motor Proficiency-2. On the first day of baseline and the last day of intervention, the principal investigator administered the Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2). The BOT-2 is a standardized assessment of motor skills (Bruininks & Bruininks, 2005). Boyce et al. (1991) indicated that not all the items of the comprehensive test are applicable to the CP population, but that it is applicable for evaluation of developmental delay and clumsiness. As a result, the Short Form was chosen to assess overall gross and fine motor function in this study. The Short Form is a screening tool that consists of 14 items, which represent items from all eight subtests of the full form of the test. Pearson
correlations for test re-test reliability and interrater reliability for the Short Form are .87 and .98, respectively (Bruininks & Bruininks, 2005).

**Motor coordination.** Central nervous system (CNS) damage, resulting in cerebral palsy, causes interference with the precise sequencing, timing, and degree of normal muscle activation, resulting in uncoordinated movement (Howle, 2002). Motor coordination is defined as the quality of the appropriate activation of multiple joints and muscles to produce a smooth, efficient, and accurate movement (Howle, p. 136). To assess motor coordinator, the principal investigator developed a measure that incorporated typical play activity. Motor coordination was assessed through the use of videotapes of a Twister game. The Twister game was played five times during baseline and once per week during intervention. During the administration of each Twister game the same six movements were scored and videotaped. Each of the six movements was scored on three different scales (see Appendices C, D, & E for descriptions of scoring), developed by the principal investigator. These included: Speed to Target, Smoothness of Movement, and Postural Stability. When reviewing the video files to score Smoothness of Movement and Postural Stability, the principal investigator used iMovie video software to slow the videos down to 25% of normal speed. This allowed for better analysis of the movements. The principal investigator was blinded to the date of each video to ensure impartial coding of data between baseline and intervention phases. She established interrater reliability with a research assistant on approximately 20% of the data for each of the three scales, and then scored the remaining videos.

**Administration of measures of motor coordination.** Six consistent movements were called during each Twister game. The six movements were called in the beginning, middle, or...
end of the game sequence, alternating their position in the game each week to reduce the effect of learning by the participants.

**Speed to Target.** Speed to Target in the Twister game was measured on a four point Scale, with a score of zero indicating the slowest speed to target and a score of three indicating the fastest speed to target (see Appendix C). The principal investigator started a stopwatch at the end of each verbal cue of each movement and stopped the stopwatch when the participant reached the target. A score of zero was indicated when the participant did not reach the target at all. Pearson correlation for interrater reliability of the Speed to Target scale was .96; percent agreement was 88.9%.

**Smoothness of Movement.** Children with cerebral palsy have difficulty producing smooth movements (Kluzik, Ferrels, & Coryell, 1990). Smoothness was defined as the fluidity of movement from start to finish. Three components of smoothness were assessed: initiation, fluidity, and accuracy on achieving target (see Appendix D for a more detailed summary of the scoring system). Each scale is a four point Scale, with a score of zero being the lowest and a score of three being the highest. The sum of each of the three scales was used as the total smoothness score (TSS). Pearson correlation for the interrater reliability of the initiation subscale was .92; percent agreement was 84.4%. Interrater reliability of the fluidity subscale was .96; percent agreement was 93.8%. Interrater reliability for the accuracy on achieving target subscale was .97; percent agreement was 93.8%. Interrater reliability for the TSS was .95; percent agreement was 67.7% for exact accuracy. Because the TSS represents sums of the component scores, the total maximum score is 12 points. For interrater reliability, agreement between raters was established when scores were within one point. Percent agreement with one degree of freedom for the TSS was 100%.
Postural Stability. Westcott, Lowes, and Richardson (1997) defined postural stability as "the ability to maintain or control the center of mass (COM) in relation to the base of support (BOS) to prevent falls and complete desired movements," (p. 630). The authors noted that children with cerebral palsy may have dysfunctional postural stability, which interferes with motor abilities.

Postural stability was assessed on a five point scale, with a score of zero indicating the lowest level of postural stability and a score of four indicating the highest level of postural stability (see Appendix E). Pearson correlation for interrater reliability for postural stability was .97 and percent agreement was 90.6%.

Range of motion (ROM). Fosang, Galea, McCoy, Reddihough, and Story (2003) indicated that passive range of motion (PROM) using a goniometer is a common outcome measure in children with CP. Active range of motion (AROM) was assessed using a goniometer to evaluate the participants' range independent of external manipulation. The principal investigator followed the procedures for assessing AROM outlined by Reese and Bandy (2002). The principal investigator measured AROM joints bilaterally while the participants were lying in prone or supine on a mat. Ankle dorsiflexion and plantarflexion were assessed while the participant was seated in a chair with the feet resting 1 foot above the floor. Wrist flexion and extension were assessed with the participants' forearm supported on a table and hand resting three inches off the surface of the table allowing mobility of the wrist.

The participants also performed the active 90-90 Straight Leg Raising Test on each leg. Fasen et al. (2009) demonstrated intrarater reliability when using this test as one of four methods to evaluate hamstring flexibility. Flexibility is defined as ROM available in one or more joints (Magee, 2008). The participants were instructed to lie in supine with one hip and knee flexed.
about 90°. While clasping the hands around the back of the thigh, the participant was instructed to actively straighten the leg, with the foot reaching toward the ceiling as far as he or she could. The principal investigator used a goniometer to measure the popliteal angle, the angle between the femur and tibia, at the participant’s greatest point of flexibility. Including the 90-90 Straight Leg Raising Test, 13 measurements were taken on each side of the child’s body, totaling to 26 measurements (see Appendix F for full list of AROM measurements).

Prior to the start of the study, the principal investigator established interrater reliability with a second research assistant for AROM measurements. AROM was assessed on a 12-year old male volunteer with cerebral palsy who was not part of the study. Ankle measurements were not included due to lack of cooperation by the volunteer. Pearson correlation was .99 for AROM measurements. The students were 86.4% accurate within five degrees accuracy for all AROM measurements.

Well-being. Well-being, as defined by Law, Steinwender, and Leclair (1998), is “the integration of a person’s physical, mental, emotional, spiritual, and social characteristics” (p. 83). Liptak, O’Donnell, Conaway, Chumela, Worley, and Henderson (2001) argued the need for understanding well-being and health-related quality of life in the CP population. In the current study, well-being was assessed using a four question survey that the principal investigator created, the Well-Being Scales (WBS) (see Appendix G). The first question evaluated the participants’ moods; the second question assessed how the participants’ bodies felt on that particular day. Both questions were evaluated by the use of a Smiley Face Assessment Scale. The scale included five faces with written descriptions of “poor,” “ok,” “fair,” “good” and “great.” The last two questions of the WBS were four point scales that evaluated the participants’ energy and stress levels. Prior to the study, the principal investigator described the WBS to
ensure comprehension by the participants. After the participants verbally expressed comprehension of the questions, the principal investigator was confident that the participants understood the assessment tool.

Attention. Children with CP tend to exhibit comorbid conditions, such as behavioral, cognitive, and learning disabilities. Behavioral symptoms, such as attention deficits and impulsivity, often present similarly to those displayed by children with ADHD. Power, Werba, Watkins, Angelucci, and Eiraldi (2006) indicated that children with attention deficits demonstrate difficulty completing homework assignments.

To measure attention, the principal investigator and research advisor developed a three question survey, the Attention to Homework Scale (ATHS) (see Appendix H). The ATHS evaluated each of the participants’ attention to homework on that day based on level of assistance, neatness, and accuracy. In this study, attention was measured by the participants’ mother.

Procedures

Yoga program. The participants performed a 15-minute yoga routine three times per week following the GRTL DVD. The participants performed the yoga routine in their home. The principal investigator was present for two of the three yoga sessions each week. During those sessions, the principal investigator performed therapeutic handling to facilitate specific poses. The participants independently performed yoga on the third day of the week under the supervision of a parent. The participants chose to use yoga straps to modify poses that were too challenging for them. For example, during the forward bend hamstring stretch, the participants wrapped the loop of the strap around the sole of the foot and pulled the strap toward the body to compensate for the inability to touch the toes.
Responsibilities of the principal investigator. The principal investigator facilitated the children’s participation in the yoga program two days per week. On one of the two days, immediately after the yoga program, the principal investigator led and videotaped the Twister game. Following the Twister game, the principal investigator assessed active range of motion (AROM) on each of the participants. Each week the participants alternated who was measured first.

Responsibilities of the participants and caregivers. The participants were responsible for performing the yoga program under the supervision of a parent one additional day per week, totaling to three yoga sessions per week. Before and after each yoga session, the participants completed the WBS (Appendix G). On all the days that the children performed yoga, the participants’ mother completed the ATBS (Appendix G) when homework was assigned.
Chapter 4: Results

Data Analysis

Data analysis was performed through the two standard deviation method. In this method, ratings were plotted through baseline and intervention for each variable. The mean and standard deviation were calculated at baseline and a band was drawn two standard deviations above the mean to extend through the intervention phase. Two consecutive data points that were above the two-standard deviation band during the intervention phase indicated a significant difference.

BOT-2

Anna. The BOT-2 was administered on the first day of baseline. Anna’s pre-test standard score was 31, which placed her performance in the third percentile for her age group, indicating that her motor proficiency was below average. The BOT-2 was administered again on the last data collection point of the intervention phase. Anna’s post-test standard score was 36, placing her performance in the eighth percentile for her age.

Luke. The BOT-2 was administered on the first day of baseline. Luke’s pre-test standard score was 37, which placed him in the eighth percentile rank for his age, indicating that his motor proficiency was below average. The BOT-2 was administered again on the last data collection point of the intervention phase. Luke’s post-test standard score was 39, placing him in the 10th percentile rank for his age.

Motor Coordination

Anna. Anna demonstrated significant improvement on the postural stability scale (Figure 1) from baseline to intervention. There were no significant differences for speed to target and smoothness.

AROM

For both children, the principal investigator analyzed AROM baseline means that indicated limited range. Limited AROM was defined as greater than 10° from the normative values for AROM outlined by Norkin and White (2009). Magee (2008) indicates that a normal score on the active 90-90 Straight Leg Raising Test for an individual above the age of six is approximately 155°. Measurements less than 145° on the 90-90 Straight Leg Raising Test were considered limited for this study.

Anna. Anna demonstrated limited AROM during baseline in the following 14 measurements: right shoulder extension, left shoulder extension, right elbow flexion, right wrist flexion, left wrist flexion, right wrist extension, right hip flexion, left hip flexion, right hip extension, left hip extension, right ankle dorsiflexion, left ankle dorsiflexion, right 90-90 Straight Leg Raising Test, and left 90-90 Straight Leg Raising Test.

Of the 14 limited measurements identified in baseline, Anna demonstrated statistically significant increases in AROM during intervention phase in all of the measurements except for left hip extension and right 90-90 Straight Leg Raising Test (Table 1). A graphical representation of increased AROM in right elbow extension is shown in Figure 2.

Luke. Luke demonstrated limited AROM during baseline in the following 15 measurements: right shoulder flexion, left shoulder flexion, right shoulder extension, right elbow flexion, left elbow flexion, right wrist flexion, left wrist flexion, right wrist extension, right hip flexion, left hip flexion, left hip extension, right ankle dorsiflexion, left ankle dorsiflexion, right 90-90 Straight Leg Raising Test, and left 90-90 Straight Leg Raising Test.
Of the 15 limited measurements identified in baseline, Luke demonstrated statistically significant increases in AROM during intervention phase in all the measurements except right wrist flexion, right ankle dorsiflexion, and left ankle dorsiflexion (Table 2). A graphical representation of increased AROM in right shoulder flexion is shown in Figure 3.

Well-Being

Because yoga has been promoted as a practice to increase well-being, the principal investigator compared baseline and intervention means at the end of each session to determine change over time. In addition, the investigator compared the number of sessions when each child rated his or her well-being higher at the end of the session during baseline and intervention to attempt to determine the short term effects of yoga on well-being.

Anna. There were no significant differences on well-being scores collected at the end of each session between baseline and intervention. However, Anna reported higher well-being scores on two out of six (33%) baseline dates vs. 18 out of 31 (58.1%) intervention dates.

Luke. There were no significant differences on well-being scores collected at the end of each session between baseline and intervention. However, Luke reported higher well-being scores on zero out of six (0%) baseline dates vs. seven out of 28 (25.0%) intervention dates. Because Luke did not complete the WBS on three dates, his well-being data consists of three less points than Anna's.

Attention

Anna. Anna demonstrated no significant differences in attention between baseline and intervention.

Chapter 5: Discussion

Summary of Results

Results from the single subject AB design indicate that the yoga program produced statistically significant improvements in AROM for both children. Anna demonstrated statistically significant improvement in postural stability. No statistically significant improvements were demonstrated in well-being and attention for either participant. However, both participants demonstrated a greater percentage of sessions during the intervention phase than during baseline when their well-being scores increased from the beginning of the session to the end of the session, suggesting that yoga may have affected their well-being positively. Results from the pre-post administration of the BOT-2 do not indicate significant improvements; however, both participants demonstrate increases in standard scores and percentile ranks following the yoga program.

Motor Coordination. The only improvement in motor coordination, as measured by the Twister game, was Anna’s postural stability. It is possible that the scales developed to evaluate this construct were not sensitive enough to detect subtle changes in speed to target, smoothness of movement, and postural stability. Written report from the participant’s mother indicates that the yoga program contributed to her children’s balance and strength, demonstrated by improved performance in other physical activities, such as karate and skiing.

AROM. Anna demonstrated significantly increased AROM in 12 out of 14 limited measurements determined at baseline. Luke demonstrated significantly increased AROM in 12 out of 15 limited measurements determined at baseline. The results of these measurements indicate that the yoga program may have contributed to increased
flexibility in both participants. For the measurements that did not show statistical significance, further data analysis indicates that these measurements had begun to increase toward the end of the study. Had the intervention phase been longer, it is likely that statistical significance may have been shown for all AROM measurements. Both participants verbalized that they were more inclined to participate in the yoga program rather than basic stretching due to the relaxing and comfortable nature of the yoga DVD.

**Well-being.** No significant differences were demonstrated in well-being between baseline and intervention. This may be partly due to unexpectedly high scores on the WBS during baseline with little room for improvement during intervention. If the study were to be repeated, the principal investigator would increase the number of points on the WBS to allow for greater variability. Anna and Luke did demonstrate increases in well-being immediately following the yoga program compared to the beginning of the session, demonstrating the short-term effects of yoga for children with cerebral palsy. Further research is needed to evaluate the long-term benefits of yoga for this population. Written report by the participants' mother explains her observation of increased well-being by examples of stress reduction in daily living throughout the intervention phase.

**Attention.** No significant differences were demonstrated in attention to homework. During the intervention phase, attention was measured only on days that the children performed the yoga program. Results indicate that Anna completed homework on 10 out of the 30 yoga days and Luke completed homework on 14 out the 30 yoga days. As a result, the ATHS was not a valid tool to evaluate ongoing attention skills over time. However, the participants' mother indicated that both children demonstrated improved time management skills throughout the intervention phase. The mother
reported that the routine yoga program established structure, commitment, and personal accountability for her children.

Limitations

Limitations of the study include small sample size and single subject AB design. It is possible that a return to baseline phase, or ABA design, would produce more concrete results. Due to the lack of a control group, results of the study cannot be generalized for all children with CP. Scales for motor coordination, well-being, and attention were developed by the principal investigator. If the study were to be repeated, it would be useful to reexamine the reliability and validity of these measures in order to determine whether it would be possible to achieve consistency with parent report. In order to fully evaluate the effectiveness of yoga therapy for the CP population, more rigorous research is needed.

Conclusion

This is the first report that documents the effect of yoga therapy for the select population of children with cerebral palsy. This single subject AB study was conducted to evaluate the effectiveness of yoga therapy on the motor skills, well-being, and attention for two 11 year old children with cerebral palsy. Results of the study suggest that yoga may be an appropriate intervention technique to increase AROM in children with cerebral palsy. Further research is needed to evaluate the effect of yoga therapy on motor coordination, well-being, and attention for children with cerebral palsy.
Table 1. Anna’s mean degrees of limited AROM.

<table>
<thead>
<tr>
<th>Limited Range</th>
<th>Baseline $M$</th>
<th>Intervention $M$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Shoulder Flexion</td>
<td>171.6</td>
<td>173.1*</td>
</tr>
<tr>
<td>Left Shoulder Extension</td>
<td>42.6</td>
<td>58.8*</td>
</tr>
<tr>
<td>Right Elbow Flexion</td>
<td>145.2</td>
<td>150.4*</td>
</tr>
<tr>
<td>Right Wrist Flexion</td>
<td>68.8</td>
<td>82.1*</td>
</tr>
<tr>
<td>Left Wrist Flexion</td>
<td>65.4</td>
<td>79.4*</td>
</tr>
<tr>
<td>Right Wrist Extension</td>
<td>57.2</td>
<td>68.7*</td>
</tr>
<tr>
<td>Right Hip Flexion</td>
<td>101.8</td>
<td>123.0*</td>
</tr>
<tr>
<td>Left Hip Flexion</td>
<td>100.8</td>
<td>121.9*</td>
</tr>
<tr>
<td>Right Hip Extension</td>
<td>17.2</td>
<td>22.0*</td>
</tr>
<tr>
<td>Left Hip Extension</td>
<td>22.0</td>
<td>21.1</td>
</tr>
<tr>
<td>Right Ankle Dorsiflexion</td>
<td>2.2</td>
<td>7.5*</td>
</tr>
<tr>
<td>Left Ankle Dorsiflexion</td>
<td>5.2</td>
<td>10.9*</td>
</tr>
<tr>
<td>Right 90-90 Straight Leg Raising Test</td>
<td>139.8</td>
<td>155.0</td>
</tr>
<tr>
<td>Left 90-90 Straight Leg Raising Test</td>
<td>140.4</td>
<td>157.3*</td>
</tr>
</tbody>
</table>

*Significantly increased AROM during intervention.
Table 2. Luke’s mean degrees of limited AROM.

<table>
<thead>
<tr>
<th>Limited Range</th>
<th>Baseline $M$</th>
<th>Intervention $M$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Shoulder Flexion</td>
<td>160.8</td>
<td>174.5*</td>
</tr>
<tr>
<td>Left Shoulder Flexion</td>
<td>162.8</td>
<td>171.8*</td>
</tr>
<tr>
<td>Right Shoulder Extension</td>
<td>43.6</td>
<td>75.3*</td>
</tr>
<tr>
<td>Right Elbow Flexion</td>
<td>138.4</td>
<td>145.9*</td>
</tr>
<tr>
<td>Left Elbow Flexion</td>
<td>134.0</td>
<td>143.8*</td>
</tr>
<tr>
<td>Right Wrist Flexion</td>
<td>64.0</td>
<td>78.1</td>
</tr>
<tr>
<td>Left Wrist Flexion</td>
<td>58.6</td>
<td>79.6*</td>
</tr>
<tr>
<td>Right Wrist Extension</td>
<td>59.2</td>
<td>75.6*</td>
</tr>
<tr>
<td>Right Hip Flexion</td>
<td>94.2</td>
<td>112.0*</td>
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<tr>
<td>Left Hip Flexion</td>
<td>91.8</td>
<td>112.5*</td>
</tr>
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<td>Left Hip Extension</td>
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<td>23.9*</td>
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<tr>
<td>Right Ankle Dorsiflexion</td>
<td>12.4</td>
<td>13.3</td>
</tr>
<tr>
<td>Left Ankle Dorsiflexion</td>
<td>9.2</td>
<td>10.7</td>
</tr>
<tr>
<td>Right 90-90 Straight Leg Raising Test</td>
<td>139.4</td>
<td>155.2*</td>
</tr>
<tr>
<td>Left 90-90 Straight Leg Raising Test</td>
<td>137.2</td>
<td>154.5*</td>
</tr>
</tbody>
</table>

*Significantly increased AROM during intervention.
Figure 1. Anna's scores on postural stability during baseline and intervention.

Anna's Postural Stability

Score
Baseline Mean
+2SD

Postural Stability Score

Date
Figure 2. Anna’s AROM for right elbow extension during baseline and intervention.

Anna's Right Elbow Extension

![Graph showing Anna's right elbow extension over time with baseline and intervention data.](image-url)
Figure 3. Luke’s AROM for right shoulder flexion during baseline and intervention.

Luke's Right Shoulder Flexion

![Graph showing Luke's right shoulder flexion over time with baseline and intervention data points.]
References


YOGA FOR CEREBRAL PALSY

Surgery, 6(4), 761-790.


Integrative Yoga Therapy. (2010). IYT training programs. Retrieved from
http://www.iayt.org/training.php


AM=&Ds=&CI=&AT=&Return=

Attention-Deficit/Hyperactivity Disorder. *Journal of Attention Disorders, 7*(4), 205-216. doi:
10.1177/108705470400700403


doi:10.1136/bjsm.2005.018069


effects of neurodevelopmental treatment on reaching in children with cerebral palsy.

*Physical Therapy, 70*(2), 65-76.


*Canadian Journal of Occupational Therapy, 65*(2), 81-91.

Liptak, G.S., O'Donnell, M., Conaway, M., Chumela, W.C., Worley, G., & Henderson,


Patterns of parent-reported homework problems among ADHD-referred and non-

Rakdakrishna, S., Nagarantha, R., & Nagendra, H.R. (2010). Integrated approach to yoga therapy and
autism spectrum disorder. *Journal of Ayurveda and Integrative Medicine, 1*(2), 120-124. doi:
10/4103/0975-9476.65089

Reddihough, D. (2009). Medical aspects of cerebral palsy: Causes, associated problems and
management. In E. Bower (Ed.). *Finnie’s handling the young child with cerebral palsy at home*


Shannahoff-Khalsa, D.S., Ray, L.E., Levine, S., Gallen, C.C., Schwartz, B.J., Sidorowich, J.J.
(1999). Randomized controlled trial of yogic meditation techniques for patients with
obsessive-compulsive disorder. *CNS Spectrums, 4*(12), 34-47.

*the accelerated school*. Unpublished manuscript, Program Evaluation and Research
Collaborative, California State University at Los Angeles.

spectrum and practice fields in the training of relaxation with elements of yoga for


YOGA FOR CEREBRAL PALSY


September 17, 2010

Alyson Lee, Graduate Student
Department of Occupational Therapy
School of Health Sciences and Human Performance

Re: The Effect of Yoga Therapy on Children with Cerebral Palsy

Thank you for responding to the stipulations made on September 13, 2010 by the All-College Review Board for Human Subjects Research (HSR). You are authorized to begin your project at any time. This approval will remain in effect for a period of one year from the date of authorization.

After you have finished the project, please complete the enclosed Notice-of-Completion Form and return it to my office for our files.

Best wishes for a successful study.

Sincerely,

Carol G. Henderson, Associate Provost for Academic Policies & Administration
All-College Review Board for Human Subjects Research

/mat

Enc.

Cc: Carole Dennis, Associate Professor

Ref: HSR 0910-03
INFORMED CONSENT FORM
For Children Ages 8-12
The Effect of Yoga Therapy on Children with Cerebral Palsy

1. Purpose of the Study
This study is an evaluation of the effect of yoga therapy on muscle tone, range of motion, and motor coordination in children with cerebral palsy. This study will also examine the effect of yoga on affect and well-being.

2. Benefits of the Study
This study will help contribute to a research base for the role of yoga therapy for children with cerebral palsy. We hope that you will experience improved motor skills and enhanced well-being following the yoga program.

3. What You Will Be Asked to Do
You will be asked to participate in a 25-minute yoga program three times per week for ten weeks. The researcher will assess your muscle tone, range of motion, and motor coordination on 6 occasions before you begin the yoga program and 1 time per week during the program. In addition, the researcher will assess your overall motor skills using a standardized assessment at the beginning and end of the yoga program. You will complete a Smiley Face Assessment Scale following each yoga session. The entirety of the program will occur in your home.

4. Risks
It is possible that you may experience soreness or stiffness following the program. However, we believe that such discomfort is unlikely due to the elementary nature of the yoga program. If you experience any unusual symptoms at any time, you will be able to withdraw from the study, as described in Section 7 below.

5. Compensation for Injury
If you suffer an injury that requires any treatment or hospitalization as a direct result of this study, the cost for such care will be charged to you. If you have insurance, you may bill your insurance company. You will be responsible to pay all costs not covered by your insurance. Ithaca College will not pay for any care, lost wages, or provide other financial compensation.

6. If You Would Like More Information about the Study

| Dr. Carole White Dennis, ScD, OTR/L | Alyson Lee, OTS |
| School of Health Science and Human Performance | School of Health Science and Human Performance |
| Department of Occupational Therapy | Department of Occupational Therapy |
| 206 Smiddy Hall | 953 Danby Road |
| Ithaca, NY 14850 | Ithaca, NY 14850 |
| (607) 274-1057 | (718) 986-1854 |

7. Withdraw from the Study
At any point throughout the study, you have the opportunity to withdraw from the program without penalty.

Parent’s initials
8. How the Data will be Maintained in Confidence

No identifying information will be used in any reports or publications that arise from this work. Photos or videographic material, if used, will not provide any reference to identifying information. Research records and any photographic or videographic materials will remain securely in the Ithaca College Occupational Therapy Department. At the conclusion of the study, all videotapes will be returned to you and your parents for protection of identifiable information. Dr. Carole White Dennis and Alyson Lee will be the only viewers of the videographic material.

Parent’s or Guardian’s Consent: I have read the above and I understand its contents. I give permission to my son or daughter, ______________, to participate in this study. I acknowledge that I am 18 years of age or older.

________________________________________
Parent’s Name (please print or type)

________________________________________
Parent’s Signature

________________________________________
Date

I give permission to my son or daughter, ______________, to be videotaped for the purposes of this study.

________________________________________
Parent’s Name (please print or type)

________________________________________

Child’s Consent: I have read the above and I understand its contents, or my parents or guardians have explained this to me. I agree to participate in this study.

________________________________________
Child’s Name (please print or type)

________________________________________
Child’s Signature

________________________________________
Date

I give permission to be videotaped for the purposes of this study.

________________________________________
Child’s Name (please print or type)

________________________________________
Child’s Signature

________________________________________
Date
INFORMED CONSENT FORM
For Parent or Guardian
The Effect of Yoga Therapy on Children with Cerebral Palsy

1. Purpose of the Study
This study is an evaluation of the effect of yoga therapy on muscle tone, range of motion, and motor coordination in children with cerebral palsy. This study will also examine the effect of yoga on affect and well-being.

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This study will help contribute to a research base for the role of yoga therapy for children with cerebral palsy. We hope that your child will experience improved motor skills and enhanced well-being following the yoga program.

3. What You Will Be Asked to Do
You will be asked to supervise your child’s participation in a 25-minute yoga program three times per week for ten weeks. The researcher will assess your child’s muscle tone, range of motion, and motor coordination on 6 occasions before he/she begins the yoga program and 1 time per week during the program. In addition, the researcher will assess your child’s overall motor skills using a standardized assessment at the beginning and end of the yoga program. Your child will complete a Smiley Face Assessment Scale following each yoga session. The entirety of the program will occur in your home.

4. Risks
It is possible that your child may experience soreness or stiffness following the program. However, we believe that such discomfort is unlikely due to the elementary nature of the yoga program. If you are uncomfortable with your child’s participation in the study at any time, you may choose to withdraw your child from the study, as described in Section 7 below.

5. Compensation for Injury
If your child suffers an injury that requires any treatment or hospitalization as a direct result of this study, the cost for such care will be charged to you. If you have insurance, you may bill your insurance company. You will be responsible to pay all costs not covered by your insurance. Ithaca College will not pay for any care, lost wages, or provide other financial compensation.

6. If You Would Like More Information about the Study

| Dr. Carole White Dennis, ScD, OTR/L | Alyson Lee, OTS |
| School of Health Science and Human Performance | School of Health Science and Human Performance |
| Department of Occupational Therapy | Department of Occupational Therapy |
| 206 Smiddy Hall | 953 Danby Road |
| Ithaca, NY 14850 | Ithaca, NY 14850 |
| (607) 274-1057 | (718) 986-1854 |

7. Withdraw from the Study
At any point throughout the study, you have the opportunity to withdraw your child from the program without penalty.

Initials
8. **How the Data will be Maintained in Confidence**

No identifying information will be used in any reports or publications that arise from this work. Photos or videographic material, if used, will not provide any reference to identifying information. Research records and any photographic or videographic materials will remain securely in the Ithaca College Occupational Therapy Department. At the conclusion of the study, all videotapes will be returned to you for protection of identifiable information. Dr. Carole White Dennis and Alyson Lee will be the only viewers of the videographic material.

I have read the above and I understand its contents. I give permission for my son or daughter, ________________________________, to participate in this study. I agree to supervise my child during the yoga program at all times. I acknowledge that I am 18 years of age or older.

______________________________________________________________
Parent's Name (please print or type)

______________________________________________________________  ________________
Parent's Signature                                      Date
Appendix C
Speed to Target Scale

0 = did not achieve target at all
1 = achieved target between 4 and 6 seconds
2 = achieved target between 2 and 4 seconds
3 = achieved target within 2 seconds
Appendix D
Smoothness Scale

Initiation of Movement
0 = not ready for movement
  - needs to readjust positioning of “moving limb” before moving (e.g., switches feet or repositioning limb)
  - initiates with inaccurate limb
1 = “moving limb” ready for movement (and begins to move) but rest of body is not
  ready and must adjust to compensate for poor balance
  - noticeable accessory movements
  - difficulty distinguishing right or left (e.g., looks back and forth at right and left hand to decide which to move)
2 = “moving limb” and rest of body ready for movement
  - very slight readjustments prior to moving (e.g., curling toes or fingers, minimal signs of imbalance)
3 = smoothly lifts limb and begins moving toward target
  - no noticeable readjustment or indications of poor balance
  - smooth weight shift
*moving limb = limb cued to move by verbal command
  Ex: Right foot blue □ moving limb = right foot

Fluidity of Movement
0 = very indirect movement to target (unsmooth trajectory)
  - excessive shakiness or
  - inaccurate limb
1 = somewhat indirect movement to target
  - moderate shakiness
  - realizes that motor planning was incorrect before touching target and replans motor sequence (e.g., reaches over leg, realizes this won’t work, and then reaches under leg to complete movement)
  - noticeable hesitation at beginning or end of movement
2 = somewhat direct movement to target
  - minimal shakiness
  - very slight (barely noticeable) hesitation at beginning or end of movement
3 = moves directly to target (smooth trajectory)
  - no shakiness

Accuracy on Achieving Target
0 = complete miss of target
  - needs to readjust positioning (i.e. lift and replace limb) in order to achieve target
  - may be from overshooting or undershooting
  - mostly hits white area or
  - inaccurate limb
1 = partial miss of target
  - achieves target but then needs to reposition limb by lifting off target and replacing (changing color spaces)
2 = partial achievement of target
  - achieves target but then needs to reposition limb by maintaining limb on target (e.g. sliding limb over
  or putting more of limb on target > fingers to whole hand)
3 = complete achievement of target
  - entire limb is on target on first attempt
  - mostly hits colored circle
Appendix E
Postural Stability Scale

Postural stability was measured in between the time the child achieved the target and when the principal investigator verbally called the next movement. If a child never achieved a target, postural stability was assessed from the time that the child altered the base of support to compensate for postural instability.

0 = Very Unstable
- unable to achieve target due to lack of balance
- unable to maintain COM over BOS
- drops knees, elbows, or butt to mat (proximal)
- significant amount of rocking

1 = Somewhat unstable
- changes “moving limb” of previous movement to different space or white space because cannot maintain COM over BOS with demands of maintaining position
- replaces “non-moving” foot or hand to mat (distal)

2 = Somewhat stable
- replaces (previous) “moving limb” limb on same space smoothly and to adaptively maintain COM over BOS (makes corrections to increase balance)

3 = More stable
- maintains all limbs on space but wiggles to maintain COM over BOS
- rocking

4 = Very stable
- child is able to completely maintain COM over BOS
- no unnecessary rocking or replacing of limbs
- minimal weight shifting

Definitions
- rocking: swaying or shaking
  - can’t stay still because not strong enough □ instability
- “moving limb”: limb that is supposed to move according to verbal cue
- “non-moving” limb: 1 of 3 limbs that are not supposed to move according to verbal cue
- COM = center of mass
- BOS = base of support
### Appendix F
AROM Measurements

#### Supine Measurements

<table>
<thead>
<tr>
<th>Right Shoulder Flexion</th>
<th>Left Shoulder Flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Elbow Flexion</td>
<td>Left Elbow Flexion</td>
</tr>
<tr>
<td>Right Elbow Extension</td>
<td>Left Elbow Extension</td>
</tr>
<tr>
<td>Right Hip Flexion</td>
<td>Left Hip Flexion</td>
</tr>
<tr>
<td>Right Knee Flexion</td>
<td>Left Knee Flexion</td>
</tr>
<tr>
<td>Right Knee Extension</td>
<td>Left Knee Extension</td>
</tr>
<tr>
<td>Right 90-90 Straight Leg Raising Test</td>
<td>Left 90-90 Straight Leg Raising Test</td>
</tr>
</tbody>
</table>

#### Prone Measurements

<table>
<thead>
<tr>
<th>Right Shoulder Extension</th>
<th>Left Shoulder Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Hip Extension</td>
<td>Left Hip Extension</td>
</tr>
</tbody>
</table>

#### Seated Measurements

<table>
<thead>
<tr>
<th>Right Ankle Plantarflexion</th>
<th>Left Ankle Plantarflexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Ankle Dorsiflexion</td>
<td>Left Ankle Dorsiflexion</td>
</tr>
<tr>
<td>Right Wrist Flexion</td>
<td>Left Wrist Flexion</td>
</tr>
<tr>
<td>Right Wrist Extension</td>
<td>Left Wrist Extension</td>
</tr>
</tbody>
</table>
Appendix G
Well-Being Scale

BEFORE

Circle the face that matches your mood right now.

Circle the face that matches how your body feels right now.

Circle the number that matches how stressed you feel right now.

0 = not stressed at all
1 = slightly stressed
2 = moderately stressed
3 = very stressed

Circle the number that matches how energetic you feel right now.

0 = very tired (not energetic at all)
1 = slightly tried
2 = slightly energetic
3 = very energetic (not tired at all)
AFTER

Circle the face that matches your mood right now.

Circle the face that matches how your body feels right now.

Circle the number that matches how stressed you feel right now.

0 = not stressed at all
1 = slightly stressed
2 = moderately stressed
3 = very stressed

Circle the number that matches how energetic you feel right now.

0 = very tired (not energetic at all)
1 = slightly tried
2 = slightly energetic
3 = very energetic (not tired at all)
Please circle the selection that most closely describes how much help your child needed to complete their homework:

<table>
<thead>
<tr>
<th>How much help did your child need to complete their homework?</th>
<th>None</th>
<th>1-3 verbal cues</th>
<th>Verbal and tactile cues (pointing)</th>
<th>Verbal, tactile, and physical cues (modification of task or environment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>How neat was your child’s homework?</td>
<td>Neat</td>
<td>Somewhat neat</td>
<td>Somewhat messy</td>
<td>Very messy</td>
</tr>
<tr>
<td>How accurate was your child’s homework?</td>
<td>Accurate</td>
<td>Somewhat accurate</td>
<td>Somewhat inaccurate</td>
<td>Mostly incorrect</td>
</tr>
</tbody>
</table>