# HHRF Research Grant Application Cover Page

Title of Project: **EFFECT OF HIPPOTHERAPY ON CHILDREN WITH AUTISM SPECTRUM DISORDERS** Submission Date: May 12, 2011

Principal Investigator Name and Title: Tim L. Shurtleff, OTD, OTR/L, Instructor in Program in Occupational Therapy, Washington University School of Medicine.

Contact Name and Title: Same

(NOTE: The contact person is the only person with whom HHRF will have direct contact. The contact person receives all letters and notification from the HHRF office.)

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Primary focus area of the investigation (i.e. mental health, physical therapy, speech therapy, occupational therapy, education, recreation, the horse-human relationship): Outcomes measured from Occupational and Physical Therapy using horse movement (Hippotherapy) for children with Autism Spectrum Disorder. .

Years and Titles of past HHRF Funding Applications:

2006 **Effect of Hippotherapy on Trunk/Head Stability and Upper Extremity Reaching**

2008 **Effects of Hippotherapy Dosage on Children with Cerebral Palsy**

2010 -- **The Long Term Effects of Hippotherapy on Children with Cerebral Palsy**

## Safety and quality standards for EAA/T:

Name(s) of personnel directly involved with any associated EAA/T:

- Therapeutic Horsemanship
  - Sandy Rafferty, MA, OTR/L, Program Director at Therapeutic Horsemanship, Wentzville, MO. NARHA #96 Level II Therapist
  - Melanie Wood, MS, OTR/L NARHA # 68445. Level II Therapist
  - Tim Shurtleff, OTD, OTR/L, NARHA#11453 Level II Therapist
  - (TH has several other occupational and physical therapists who may provide treatment, most are NARHA registered level II therapists (any who treat research participants will be Level II)
- Ride-On St. Louis, Kimmswick, MO
  - Marita Wassmann, Program Director, NARHA Certified Instructor: NARHA #37916
  - Anne Cochran, PT, Physical Therapist at Ride-on St. Louis, Kimmswick, MO, NARHA #55198, Level II therapist. AHA#79.

Are all listed personnel certified to provide the activities? Yes (If yes, please provide member numbers with each name)

Certifying organization's name, website and contact information, or evidence of equivalent standards adhered to (please attach explanation if necessary):

NARHA : www.narha.org: All treating therapists are registered Level II with NARHA.

AHA: www.americanhippotherapyassociation.org provides education to allow therapists to register with NARHA and all have taken level I and II courses from AHA.

## Site standards for EAA/T:

Is the site providing EAA/T programming accredited to do so? Yes Member Number: see below

Therapeutic Horsemanship: NARHA #1483

Ride-On St. Louis: NARHA # 45514

Accrediting organization's name, website address and contact information, or evidence of equivalent standards adhered to (please attach explanation if necessary):

All centers are premier accredited centers with NARHA. www.narha.org:

Will others collaborate or consult with you on this project? Yes

If yes, attach letters to you that state their agreement to do so.

Brief description of project (60 words or less):

15 children with Autism Spectrum Disorder will participate in 12 weeks of weekly hippotherapy sessions. Age/gender-matched children without disabilities will provide a neurotypical comparison. Kinematic and kinetic measurements be used to measure changes in static and dynamic stability. Social responsiveness, Sensory Processing, participation and occupational performance measures will integrate physical changes with changes in everyday life skills and participation in age appropriate activities with peers.

Pilot Studies Completed? Yes Completion Date: April 2008.

Is project Institutional Review Board approved? Pending

Please attach a copy of the IRB application.

We have prior IRB applications approved for two similar studies of children with cerebral palsy. Another study has just been approved for children with ASD. This study is very similar with more participants and adds a baseline measurement to factor out maturation and other ongoing therapies. IRB approval is therefore expected to be simple and will use an expedited format. Our IRB will not review projects that are not yet funded. IRB application to be submitted upon commitment for funding. Response from IRB expected within 30 days from funding commitment.

Start Date of Project: January 1, 2012 End Date of Project: December 31, 2012

Total Project Budget: $50,000 Amount Requested from HHRF: $50,000

**II. Scientific Abstract.**

**EFFECT OF HIPPOTHERAPY ON CHILDREN WITH AUTISM SPECTRUM DISORDERS**


Background: Autism Spectrum Disorders (ASD) affects 1 in 110 children and 80-90% have motor control impairments which impact their ability to participate in activities of childhood affecting their lifelong participation. No studies of Hippotherapy have been reported about children with ASD but many children with ASD participate in hippotherapy. Evidence is needed to support treatment planning, and to support reimbursement for intervention with children with ASD.

Participants: 15 children with ASD. 8-10 typically developing children to age match normative base for

- Inclusion: 5-12 yrs, no prior horse riding experience, no other neurodevelopmental impairments.
- An age/gender-matched group without disabilities provide a neurotypical comparison.

Intervention: 12 weekly 45 min PT/OT sessions using hippotherapy

Assessments: 12 weeks before the HPOT interventions, immediately before and after 12 wk set of HPOT treatments

- Precise kinetic measures using forceplates and video motion capture will track dynamic and static postural control.

Hypothesis/outcomes:

- Static and dynamic postural control will significantly improve over three months
- After 12 weeks, social responsiveness, sensory processing, occupational performance and participation in age-appropriate activities will be significant.

Potential impact of this study: Completion and publication of this study will provide evidence to support treatment funding for children with Autism.

IV. Need/Justification/Significance: ASD is a neurodevelopmental disorder characterized by impairments in social/communication skills, repetitive and stereotyped behaviors[1]. Motor impairments are frequently reported in this population, including clumsiness, motor planning and coordination problems, fine and gross motor impairments, and decreased static and dynamic postural control [2-6]. Impairments in response to sensory experiences are documented in individuals with ASD including hypersensitivity and under-responsiveness to auditory and visual stimuli (e.g. avoidance eye contact) and over- responsiveness to tactile sensation. Children with ASD show impairments in attention and arousal, impacting social competence, adherence to routines, and participation[1, 7].

The number of children diagnosed with Autism Spectrum Disorders (ASD) continues to rise. Currently, in the United States, 1 in 110 children are diagnosed with ASD each year[8]. Despite the increase in incidence, there is minimal systematic published research on appropriate interventions and rehabilitation techniques to address their social, motor, and participation challenges. Common interventions include dietary routines, applied behavioral analysis, sensory integration, relationship development intervention, hyperbaric oxygen therapy, and the Floortime program [9-12]. However, there are conflicting views on the effectiveness of these treatments and there is little evidence to support their use for children with ASD [13].

Between 80 to 90% of children with ASD display subtle motor impairments [14]. Motor abilities are an important component of performance, enabling a child to engage in developmentally appropriate activities with peers. Motor impairments can limit exposure to social experiences, potentially leading to isolation, anxiety, and emotional and/or social problems for both the child and his/her family [5]. Despite a high prevalence of motor impairments, children with ASD that display motor manifestations are not more likely to receive therapy services compared to children with ASD who do not have motor deficits [15]

Hippotherapy (HPOT) utilizes horse's movement as a tool to improve functional outcomes. Horse movement is modulated throughout the treatment session to address the client's needs as s/he works towards functional goals [16]. Anecdotal evidence suggests improvements in coordination, body awareness,

attention span, concentration, sensory processing, and motor skills in children with varied disabilities[17-19].

HPOT is commonly used for children with ASD[16]. However, no systematic evidence has been published on the impact of HPOT on children with ASD. Outcomes in children with ASD have been studies in adaptive horseback riding lessons. Results indicated that children with ASD displayed improvements in sensory processing, direct attention, and social motivation [20]. In addition to these findings, it would very valuable to determine if changes in motor functioning (e.g., postural control) might also occur as a result of HPOT. Recent results from Hilton et al. [5] suggest that interventions focusing on motor abilities, such as HPOT, can potentially result in increases in social competence and improve participation in children with ASD.

Our pilot studies on children with cerebral palsy (CP) demonstrated motor changes in dynamic head and trunk stability as well as functional reach after HPOT intervention [21]. Measures in this proposal use the same technology in different ways with the ASD population. Since most children with ASD also have stability issues our objective measurement technology can also determine if using HPOT can improve motor performance and possibly enable social competence, adaptive behaviors, and participation in children with ASD.

Innovation; Past research has explored motor impairments in children with ASD. However, there is little evidence for rehabilitation therapies to improve motor abilities. Studies exploring motor challenges in children with autism typically use qualitative standardized clinical scales rather than objective quantitative data collection. These studies have noted decreased social competence, sensory processing, adaptive behaviors, and engagement in activities for children with ASD but none of them addressed potential interventions to improve motor performance [5, 22]. Fournier, et al. (2010b), found that children with ASD displayed decreased postural stability during a standing task measured with force plate and kinematic data. Children with ASD also showed difficulties transitioning from static balance to a dynamic phase of gait initiation. This supports the notion that postural system development is delayed in children with ASD compared to typically developing children. Furthermore, while previous studies have examined difficulties in social competence, sensory processing, adaptive behaviors, and participation in children with ASD, none have explored the

possible impact of an intervention addressing a broad variety of functional skills. We have piloted a new measure of static balance and gait initiation using our video motion capture and force-plate instrumentation to develop an objective measure to assess gross motor performance for this population. By examining the effect of HPOT on children with ASD, this study objectively quantifies subtle changes in motor performance/postural control and links assessment of sensory processing, social competence, adaptive behaviors, and participation that are difficult to measure in this population.

IV. RESEARCH NARRATIVE: The long-term goal is to increase function and participation in children with ASD. The expected long term outcomes of HPOT are improvements in motor control and sensory processing which may be mechanisms to improve social responsiveness, adaptive behaviors, and participation in children with ASD. The current project goal is to determine if changes in motor control, social competence, sensory processing, adaptive behaviors result in increased participation in children with ASD after HPOT. The impact of this work will be to demonstrate the effectiveness of HPOT to facilitate greater participation in daily activities for individuals with ASD.

Objective 1: Compare static and dynamic postural control before and after HPOT in children with ASD and age-matched children without disabilities. Kinematic (Video Motion Capture) and kinetic (force plate) data will be collected from participants with ASD and age-matched typically developing (TD) children during an integrated functional task composed of quiet stance and gait initiation. We hypothesize improvements in postural sway during quiet stance and in gait initiation after HPOT.

Objective 2: Compare social competence, sensory processing, and adaptive behaviors before and after HPOT in children with ASD. Social competence, sensory processing, and adaptive behaviors will be measured through parent and/or teacher report using the Social Responsiveness Scale (SRS), the Sensory Processing Measure (SPM), and the Vineland Adaptive Behavior Scales (Vineland-II) in participants with ASD. Measures address social skills, sensory functioning, expressive communication, daily living skills, interpersonal relationships, play, leisure, and coping skills. We hypothesize improvements in social

competence, sensory processing, and adaptive behaviors after HPOT.

Objective 3: Determine what changes in participation occur after HPOT in children with ASD. Changes in motor function, daily living skills, and participation will be analyzed through the Life Outcomes of Hippotherapy (LOH) and the Child Activity Card Sort (CACS). The LOH measures parent perceptions of participation in age-typical activities as a result of HPOT. The CACS is a child self-report validated to identify changes in participation in age typical activities [23]. We hypothesize increases in participation after HPOT.

METHODS:

Research Design: This study is a prospective cohort study[24] using a baseline-pre-post design involving a 12-week HPOT intervention for children with ASD (Fig 1). Participants will receive HPOT for one 45-minute session per week with an occupational therapist (OT). Strict inclusion and exclusion criteria will ensure homogeneity. Participants will be assessed 12 weeks prior to beginning treatment, then immediately prior to and following 12 weekly HPOT treatment sessions. Baseline, Pre and post HPOT static and dynamic balance will be recorded using video motion capture (VMC) and force plates. The outcomes (Obj. 1) will be postural stability during a quiet stance and gait initiation tasks measured by postural sway, the displacement of center of mass (COM) from center of pressure (COP). Social competence, sensory processing, and adaptive behaviors will be measured using standardized assessments at the three time points: the Social Responsiveness Scale (SRS) [25], Sensory Processing Measure (SPM)[26], and Vineland Adaptive Behavior Scales (Vineland-II)[27] (Obj. 2). Changes in Occupational Performance and Participation will be further examined using the LOH questionnaire[28] and an the Child Activity Card Sort[23] to determine impact of HPOT treatment on participation and Occupational Performance (Obj.3). This design allows participants to be their own controls. Post intervention results are compared to a baseline which allows changes due to maturation and other ongoing interventions to be factored out of the analysis. Participants will continue any ongoing interventions or therapies.

Participants: A convenience sample of 15 children with ASD (age 5-12 years old) will be recruited through

networking with families, referrals from local health professionals, waitlists or new clients at collaborating riding centers or from previous motor-function studies on children with ASD (Hilton, et. al., in press). After initial recruitment, participants will receive an evaluation by an occupational therapist to ensure they qualify for the study. Inclusion criteria include a diagnosis of ASD, chronological age of 5-12 years, and full-term birth. Inclusion criteria will also include consent from child's primary physician, parental agreement for the child's participation in baseline-measurements, the HPOT intervention and pre and post HPOT measurements. Participants will be able to follow a one-step direction and independently ambulate without the use of assistive devices. Participants will have a T-score of 60 or above on the Social Responsiveness Scale (SRS) indicating cutoff for moderate to severe autism.

Exclusion criteria include a physician diagnosis of severe sensory impairment (e.g. vision, hearing, vestibular), or other major neurological or psychiatric conditions. Children will be excluded who demonstrate behaviors that might result in physical harm during the intervention or during testing, who have physical limitations restricting ability to sit unaided or who cannot abduct hips preventing sitting on a horse. Children will also be excluded with other serious health conditions on the NARHA list of contraindications. Previous experience with equine-assisted activities or a history of informal horse riding experiences (more than three lifetime horse rides) will exclude them. Participants with dual diagnosis associated with ASD, such as ADHD, will not be excluded if they meet all other inclusion and exclusion criteria.

After the ASD group is recruited, up to10 typically developing (TD) children will be recruited to ensure that our normative sample remains age matched. They will be tested once for stability/gait initiation. They will provide a typically developing movement comparison to children with ASD and their changes after HPOT.

Theories /Principles supporting the HPOT intervention for ASD: Motor Learning is based on repetitive practice of a skill that can lead to permanent changes in performance. Motor learning theory suggests that both massed and variable practice promote learning. Massed practice occurs when the amount of practice during a treatment session is greater than the amount of rest. In Variable practice, tasks are performed in a

variety of conditions to promote generalization of learning [29]. HPOT follows the constructs of motor learning as the horse's movement is variable, rhythmic, and repetitive and challenges postural control as both massed and variable practice. Horses average 100 steps per minute [30] resulting in 3-5000 steps or repetitions of a trunk challenge and recovery exercise in a 45 minute mounted HPOT session, an order of magnitude greater than the amount of repetition in a clinical motor rehabilitation setting [31]. The child must repeatedly respond to the horse's three-dimensional rhythmic movement while multiple motor units are challenged with variability in gait (e.g. walk vs. trot, start/stop, half-halts) and movement patterns, ( speed and direction). Changes in mounted position and school figures require the child to problem solve and respond appropriately to varying challenges. Most importantly the child must develop automatic postural responses to maintain postural stability and position. The variability is intentionally and continuously adjusted by the therapist who uses HPOT to address the needs and challenge the skill level of the child [21].

HPOT is also grounded in a cognitive behavioral frame of reference. The child's reaction to the horse and the social context of the HPOT session challenges both cognitive and behavioral responses. Social learning theory is based on how the child manipulates his/her surroundings combined with how the social and supportive environment impacts the child [32]. Social responses are challenged, as the child learns appropriate self-control and regulation while interacting with the horse and other people in the therapy environment. Overall, motivation to ride and move becomes an underlying theme of this intervention approach. The use of a horse potentially increases interest and involvement in the treatment session, which may ultimately broaden the child's choices of activity and participation in daily life [33].

Evidence Guiding this Study: A previous study evaluated postural control in children with ASD using force plate data [3]. Participants stood on two force plates during a quiet stance phase and then walked off the force plates during the gait initiation task. Typically, during static standing, an individual's center of mass (COM) remains within their base of support. To do so, the COM is coupled with the center of pressure (COP) to minimize sway (Figure 2). During dynamic postural control, the COM separates from the COP as one moves

from one position to the next.

Fournier, et al. found that children with ASD had decreased postural stability compared to TD children [3]. During the quiet stance, postural sway was greater in children with ASD than TD children in both anteroposterior and mediolateral directions. The larger distance between the COP and COM the less stable the child is, requiring the need for a more active postural control system. In the gait initiation task, children with ASD were found to maintain stability in the anteroposterior direction compared to TD children. It is theorized that the anteroposterior displacement of the COP from the COM moves the body forwards during gait initiation. However, changes in COP-COM displacement in the mediolateral direction were significantly smaller for children with ASD, suggesting greater instability and the need for greater postural control in this direction. Stance-side momentum is needed to move the COP towards the swing limb. In children with ASD it is possible that there is decreased uncoupling of the COM-COP, so the child cannot shift COM towards the stance limb leading to decreased postural stability [3].

Figure 2 shows the general center of pressure (COP) and center of mass (COM) of a typical developing (TD) individual. The COP (solid line) and COM (dotted line) movement was plotted in a 20 second time frame. The average X and Y coordinates for COP and COM were determined to get a centroid COP (circle) and centroid COM (star). The distance (in cm) between the two is measured, labeled by the COP-COM distance (arrow). The hypothesis of this study suggests that with children with ASD, COP-COM distance will decrease as their stability increases as a result of HPOT.

LOCATIONS: Baseline, pre-and post- intervention outcome measurements will take place at the Human Performance Laboratory (HPL), of the Washington University Program in Occupational Therapy. The HPOT intervention will take place at two sites with which we have previous research experience, Therapeutic Horsemanship, Wentzville, MO, or Ride-on-St Louis, Kimmswick, MO. both accredited by NARHA.

The HPOT intervention: Horses, their movement and the HPOT social support environment are the main treatment tools and strategies for the intervention. Each participant will be matched with a horse by a

licensed Level-II therapist and NARHA registered instructor. Horses will be assigned to participants based on size, width, movement characteristics, horse's response to participant's functioning level, and overall horse demeanor. The same horse will be used over the entire 12-week session unless it becomes injured or sick. In this case, a best-matched horse will replace the assigned horse.

Additional equipment used during the intervention will be chosen by the therapist to meet treatment goals. Tack and equipment can increase function by providing support or to grade the challenge to the individual. In most sessions, the horse wears a saddle pad and surcingle (to hold the saddle pad and provide support and stabilization for the client's upper extremities). Small toys may be used to challenge attention, cognition, balance and coordination. A horsehandler will control the horse from the ground. Sidewalkers will ensure safety and provide verbal direction and cueing for therapeutic activities and positions.

Intervention Personnel/ Training: Therapists will be state licensed, Level II occupational or physical therapists or speech language pathologists working with a NARHA certified instructor. Level II therapists have participated in a series of training workshops provided by American Hippotherapy Association (AHA) and recognized by NARHA (Formerly known as North American Riding for the Handicapped, Assoc.). The same therapist will work with the participant throughout the intervention. Horsehandlers and sidewalkers, will be experienced volunteers with training provided by the NARHA accredited riding center prior to intervention.

Intervention Protocol: The HPOT intervention will consist of 45 minutes mounted on the therapy horse for 12 weekly sessions. HPOT will be performed with participants matched with a therapy horse, a therapist, sidewalkers, and horse handlers. A HPOT treatment progression strategy has been developed for this intervention (Appendix A). It is based upon five domains (balance, speech, cognition, social skills, and interactive play), and three skill levels (basic, intermediate and advanced). This protocol defines level of assistance needed for stabilization on the horse, time in positions, school figures and movements, and mounted activities. Treatment progresses from greatest assistance and easier tasks to independence and most difficult tasks. Though each intervention plan will be unique to the client, this framework will guide the

therapist with a progression of treatment that can enhance uniformity across participants. Participants will be placed in an initial stage based on their treating therapist's evaluation. Each level can be completed over several treatment sessions. A participant can move to the next level when all components at the prior level are completed. Though sessions are one-on-one, other treatment teams will likely be present in the arena during these HPOT sessions. Social skills and peer interaction will be promoted as described in Appendix A.

A treatment planning worksheet will enable the therapist to identify impairments, priorities, and goals for each treatment session and specify mounted activities. A variety of positions, figures, and skills may be used as treatment activities. Mounted positions may include forward astride, prone, supine, backwards astride, side sit, tall kneel, stand, and quadruped. Various school figures will grade challenge to the client, including straight lines, circles, and weaving through cones, challenging postural stability and providing additional lateral challenge. Trunk stability and attentional skills may be further challenged with halts and half-halts as well as changing cadence (speed) within the walk or trotting. Vestibular response may be challenged by weaving on sidehills during trail rides. Functional activities (e.g. catch and throw games, bilateral and bimanual upper extremity tasks, communication and memory games) will be incorporated into various mounted positions to promote motor planning and sequencing, as well as challenging attention, focus, and cognitive abilities integrated with school figures and the rhythmic movement of the horse (Appendix C).

Quality Assessment/ treatment fidelity: The HPOT treatment progression strategy (Appendix. A) and treatment planning worksheet (Appendix C) will ensure consistency between sessions for each participant and among therapists treating different participants. Completed activity checklist/progress notes (Appendix D) will be faxed or emailed to the investigators after each session to ensure that therapists are following the study protocols. Discrepancies will be noted and the therapist will be coached toward consistency as needed.

Missed HPOT Sessions: Participants will commit to attend all 12 weeks of HPOT. If a participant is unable to continue for any reason, including unanticipated allergies or fear of horses, the child will be removed from the study. Absences will be rescheduled within before the study ends. If participants are unable to make up a

session, completing 11 out of 12, their results will remain in the main analysis. If a child is uncooperative or misses more than two sessions, he/she will be terminated. Children dropped who do not complete at least 10 sessions will be placed in a secondary "intent to treat" analysis if they return for the post HPOT measures.

Participant Safety: Parents will sign a consent form approved by the Human Research Protection Office (Institutional Review Board at Washington University in St. Louis). Safety will be ensured by following NARHA/AHA standards. Standards include use of trained therapy horses with a quiet temperament which range in height from 11hh (44'') to 18hh (68"). NARHA registered instructors will partner with therapists to ensure safety of equipment and respond to the needs of the horse if a situation occurs. Participant safety is ensured with trained leaders and side walkers providing physical and any other needed support. Therapy sessions will be performed in an enclosed or covered arena or in a controlled outdoor environment.

Compliance: To facilitate compliance during HPOT sessions, rewards will be customized to each child's typical motivators. Various cognitive strategies will be employed including cueing, prompting, and demonstration of a variety of functional tasks throughout HPOT sessions [34]. Changes of gaits (going from walk to trot (slow jog)) can also be used to motivate participants and keep them compliant during a session.

VARIABLES/OUTCOME MEASURES: The independent variable in this study is the HPOT intervention itself. Objective dependent variables include changes in postural sway, weight shift stability during quiet stance, and gait initiation. Other dependent variables include changes in social competence (ASD severity), sensory processing, adaptive behaviors, and participation, detailed in Table 1.

Sequence of Events: Participants will be tested three times, baseline, pre-HPOT and Post-HPOT. At each testing time parents will complete caregiver-report assessments while the participants are performing postural control/gait measures.

*Social Responsiveness Scale (SRS):* The SRS is a 65-item questionnaire measuring severity of ASD used to assess interpersonal behavior, communication, and repetitive/stereotyped behaviors characteristic of ASD. There are five subscales: social awareness (ability to pick up on social cues), social motivation (extent to

which a respondent is generally motivated to engage in social-interpersonal behavior), social cognition, (expressive social communication), social communication, and autistic mannerism. It is given to parents and teachers, rating participants on a 4-point Likert scale (0-never true, 3-almost always true). Reliability and validity of the SRS are well documented (e.g. Inter rater = 0.75 to 0.91, cronbach's α=0.93-0.97)[35].

*Sensory Processing Measure (SPM):* The SPM is 62 to 75-item parent report measuring sensory processing.. Seven subscales include social participation, vision, hearing, touch, body awareness, balance and motion, and planning and ideas. Validity and reliability of the SPM are well documented (e.g. α=0.78 to 0.94, test-retest r=0.94 to 0.98, content/construct validity is detailed in the cited manual) [26].

*Vineland Adaptive Behavior Scales (V-II):* The Vineland-II is a 297-item semi-structured interview measuring one's adaptive behavior and performance of daily activities for personal and social competency. The eleven subscales include receptive communication, expressive communication, written communication, personal daily living skills, domestic daily living skills, community daily living skills, interpersonal relationships, play and leisure time, coping skills, gross motor skills, and fine motor skills as well as an optional maladaptive. Due to overlap of some motor and social skills subscales, selected subscales will be used in the SRS, SPM and V-II. These subscales include: expressive communication, personal daily living skills, community daily living skills, interpersonal relationships, play and leisure time, coping skills, and the optional maladaptive behavior subscale. These subscales are validated to use as stand-alone measures [35].

*Child Activity Card Sort (CACS):* The CACS is an adaptation (in collaboration with the author) of the preschool and adolescent activity card sorts for the ASD population[23]. It contains 135 activities in 7domains. Children (with parent assistance if needed) sort picture cards of activities into piles to indicate current participation and assist needed to participate in the activity. They then sort those activities in which they do not participate into other categories (not interested, not able, parent or child choice, etc.). Reliability and validity of the Washington University card-sort methodology is well established [23, 36, 37].

*Life Outcomes of Hippotherapy (LOH):* The LOH is a qualitative questionnaire currently under

development and validation by this researcher (Cronbach's alpha for pilot α=0.978). The LOH quantifies caregiver's perception of change as a result of HPOT. It uses a 10-point semantic differential scale (0= child demonstrates minimal or no ability on characteristics in question, 10= child is now no different than a typical same-age child on the question). The seven subscales measure strength and stability, participation, effects on caregiver, speech, confidence, balance, and attitude/responsiveness [38]

*DATA PROCESSING/ANALYSIS*

*Force Plates and VMC:* Participants will stand for 20 seconds on the first forceplate and then step forward across two more forceplates. Data collection will be completed when the participants step off the last forceplate. The forceplates record at 300 samples/second with camera data at 60 frames/second. Every 5-forceplate samples will be averaged and consolidated to 60 frames/second to synchronize forceplate and camera data. Kinematic and kinetic data collected and integrated with software from Motion Analysis corporation (Cortex 1.0, 2008). The initial setup trial will be used to combine the forceplate corners (camera shot taken with marker's at each corner) with relation to camera placement. By the participant standing and then "dancing,"(move in place) to enable the computer to refine the collection template. Since the markers on the subject are placed on anatomical landmarks, using anthropometric table COM can be calculated based on the tracked location of the surface markers as well as participant's height, weight, and age in both the static and dynamic postural control tasks [39]. COP will be determined based on raw data collected from the force plate trials based on the center of each force plate in relation to the Lab Coordinate System (LCS) [40]. The COP location is then compared to the LCS and matched with the COM location from the camera data.

Postural control is evaluated comparing the COP and COM (Figure 2). During the quiet stance the participant's postural sway will be analyzed based on the relation of COM to COP. Postural sway and weight shift will be calculated as COM is displaced from COP, determined by the horizontal displacement between the centroids of COP and COM during collection. Shift from static to dynamic postural control during gait initiation will be examined based on horizontal COM displacement from the COP. Mean, standard deviation,

and minimum and maximum range using the corresponding COP-COM and COP-COM horizontal displacement will be calculated. The ratio of the size of the 2D COM and COP scatterplots (Range of motion and Standard deviation) is calculated as another stability variable.

*SRS, SPM, Vineland-II, and LOH:* Subscores will be calculated for each domain. For the SRS and SPM a total score will be determined from the subscales whereas with the Vineland-II specific subscales scores will also be used independently of each other. The LOH identifies changes in multiple dimensions of participation and performance of activities in everyday life that occurred after HPOT intervention.

DATA MANAGEMENT

*VMC and Force plate data:* The collected data will be reduced into mean COP, COM, and COP-COM horizontal displacement for each participant with ASD pre-and post HPOT and will be entered into a spreadsheet. The same methods will be used for the TD group. Summary data will be analyzed using PASW Statistics V. 18 (previously known as SPSS) to determine significance of any measured changes. Dr. Standeven and Dr. Shurtleff will oversee and manage the data entry and analysis accuracy.

*SRS, SPM, Vineland-II, LOH and CACS;* Baseline and Pre and post HPOT scores will be analyzed in a spreadsheet to determine domain and change scores and entered into PASW Statistics to determine significance.. Baseline, pre and post scores will be compared using either parametric or non-parametric tests appropriate to the measurement level of each assessment. Our TD sample receives no HPOT intervention and will not complete these assessments since they already have TD norms established, are only validated for children with ASD or are focused only on outcomes from HPOT.

STATISTICAL ANALYSIS.

Objective 1: Compare mean, standard deviation, and minimum and maximum range using the corresponding COP, COM. COP-COM displacement repeated measures Analysis of Variance (RM-ANOVA) will be used to compare static/dynamic postural control before and after HPOT. ASD-TD comparisons will only be performed for Obj. 1. This group will only be tested to enhance our normative sample and keep it

age/gender matched to this group with ASD. For the ASD-TD comparison, the mean COP, COM, and COP-COM displacement at each test time will be compared to the single TD test using paired T-tests.

Objective 2: Compare social competence, sensory processing, and adaptive behaviors before and after HPOT in children with ASD. Scores will be determined according to published protocols and compared baseline-pre-post-HPOT with Friedmanns Analysis of Variance (F-ANOVA), a non-parametric repeated measures test of significance..

Objective 3: Determine if changes in occupational performance and participation occur after HPOT in children with ASD. The LOH uses an ordinal semantic differential scale. Participation/function before and after HPOT will be compared to baseline using non-parametric F-ANOVA..The CACS uses frequency counts yielding ratio level data so a RM-ANOVA can be used for three test times.

Treatment Notes (Appendix D) Treatment notes will be used to explore which activities in HPOT may have greater performance outcomes. These data will be covariates in a statistical analysis (ANCOVA) by analyzing the frequency of activities of the children who showed greater improvement compared to children who showed less improvement. This may indicate which treatment activities are more effective.

V. PROPOSED TIME LINE. One year, Jan – Dec, 2012. Additional details in Table 2 in appendices.

VI. INTENT TO PUBLISH: Progress reports will be sent to HHRF at the completion of each phase of the study. After completion of the post-HPOT measures and analysis, results and conclusions will be consolidated and reported to HHRF in a summary form which they can report in press releases without violating opportunities to publish. A peer reviewed journal with a high impact factor will be selected and results will be formatted into an article meeting the journal publication guidelines and submitted reporting the main outcomes of the study. This study is designed to address several dimensions of outcomes of HPOT for children with ASD. Given the limitations most journals place on topical focus and word count, we anticipate that up to four focused publications may result and be placed in journals read by various specialties to inform their understanding of HPOT outcomes.

**References:**


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## VII. Budget Justification

Personnel **$XXXXXX in year 01**

Tim L. Shurtleff, OTD, OTR/L: Dr. Shurtleff will devote XX% (X.XX CY months) of his time on this project as principal investigator. He will be responsible for designing, adapting and implementing experimental methods and protocols, performing the statistical analysis, interpreting data, and authoring papers for scientific journals. Dr. Shurtleff is an instructor in the Program in Occupational Therapy and participates in grant-funded research projects within the Human Performance Laboratory. He mentors masters (MSOT) and doctoral (OTD) students who may work on this project as degree requirements. Dr. Shurtleff is a NARHA certified therapeutic riding (1996) instructor and Level II carriage driving (2001) instructor. He is also a Level II therapist with 19 years experience in therapeutic riding, hippotherapy and in the development of positioning aids for HPOT. He is on the Board as Research Chair of the American Hippotherapy Association (AHA) and on the scientific advisory board for the Horses and Humans Research Foundation (HHRF). He received a grant from AHA for the pilot project cited in this grant and was the first recipient of a HHRF research grant (2006) cited in this grant application (Shurtleff, Engsberg, & Standeven, 2009). The pilot study was published in May 2010. As an OT he uses HPOT on a part time basis and his clients have included many with cerebral palsy. Salary and benefits equivalent to percent time and effort at $XXXXX and $XXXX respectively is requested for Dr. Shurtleff.

Jack R. Engsberg, Ph.D: Dr. Engsberg will devote up to X% (.XX CY months) of his time to this project as Co-Investigator. Dr. Engsberg will advise Dr. Shurtleff including designing and implementing variations in experimental methods and protocols, performing the statistical analysis, interpreting data, and authoring papers for scientific journals. Dr. Engsberg mentored Dr. Shurtleff in the preliminary work described in the narrative. Dr. Engsberg has been studying mechanics of patients with for over 20 years. Salary and benefits equivalent to percent time and effort at $XXXXX and $XXX is requested for Dr. Engsberg.

John W. Standeven, E.E., Ph.D. Dr. Standeven will devote X% (0.x CY months) of his 50% part-time position to this project as Engineer Dr. Standeven is an electrical engineer and will analyze COP and COM of participants and force plate data for the postural control portion of this study. He has 30 plus years of experience working in biomedical engineering with different capacities including working in the Human Performance Lab. Dr. Standeven will troubleshoot and operate data collection equipment. He will collaborate with Dr. Shurtleff in developing outcome data collection and analysis methods. He will assist with collecting the VMC study measurements. He will be responsible for data entry, management, and screening. He will also collaborate in authoring manuscripts. Salary and benefits equivalent to percent time and effort at $XXXX and $XXX is requested for Dr. Standeven.

A research assistant, (To be named) will be a graduate student in the Program in Occupational Therapy at Washington University. This RA will average six hours per week over the life of this project. The RA will assist in the testing process and administer standardized assessments. He/She will process raw video motion capture data, summarize and score assessments perform preliminary analysis and statistical analysis under the direction of Dr. Shurtleff. She/he will likely be completing her/his doctoral research project as a part of this study and in addition to paid RA duties listed above will assist in all aspects of the project, including site visits and caregiver/client interviews. Stipend of $3600 is requested for this RA.

Holly Hollingsworth, PhD, while not paid from the grant, is on the faculty of the Washington University School of Medicine, Program in Occupational Therapy and as such is available on a consulting basis for all department projects as biostatistician to assist in the development of appropriate methods to structure, analyze and interpret outcome data. Less than 1% effort is anticipated.

Supplies **$461 in year 01**

Supplies will include purchasing sufficient outcome assessment tests which are not public domain for three administrations for 15 participants as described in the narrative above including:
SRS = $90, SPM = $210, Vineland II = $161 for a total of $460 for published standardized assessments. Two of the assessments mentioned in the narrative above (CACS and LOH) are in-house developed at Washington University and can be used free of charge.

Other Expenses **$16,800 in year 01**

The standard treatment cost per weekly HPOT session with local treatment sites of is $85 per session or 1020 for the 12 treatments for each participant. Fifteen participants who will participate in 12 weeks of treatment each will cost $15,300. Because participants are receiving this benefit by participating in the study, we will not pay an additional mileage or incentive to them to come for testing. It has been our experience with prior studies that the treatment itself is sufficient incentive to participate in the testing process.

An updated computer workstation is needed in the laboratory with the capacity to capture and process video motion capture data for use by the Research Assistant and investigators. We request $1500 to purchase a computer and software which will be used to complete the project.

Travel **$650 in year 01**

To ensure compliance to treatment protocols as well as to monitor progress and commitment to the project, personal contact with parents/caregivers, participants and treating therapists is critical. To monitor treatment progress and to encourage continued participation (between testing times in the laboratory) we plan to visit the treatment sites and meet with the therapists, the families and the participants twice during the three months of the study for each participant. Since multiple participants will be treated at each site, we will coordinate visit schedules to meet with more than one family for each trip allowing more than two contacts with each family. The treatment sites average 42.5 miles away from the Human Performance Laboratory. Travel to treatment sites for Dr. Shurtleff and/or research assistant is therefore requested for two round trips for each of 15 participants plus one additional trip to meet with administration and therapists to initiate the project (85 miles each @.51 per mile would cost $ 650.00 for travel over the life of the grant. During these visits, we will follow-up on parent/caregiver journals and review treating therapists treatment notes to enhance the qualitative data collection for Aim 3.

**Space Rental $2,400 in year 01**
Space Rental $2,400 for year 01 has been allocated for the Human Performance Laboratory, which is leased from Paraquad, Inc., an independent living center. This rate is based upon the percent effort of personnel working on the project relative to the $14 per square foot annualized rental rate in effect. The Human Performance Laboratory occupies 1,915 square feet as part of Washington University in St. Louis at Paraquad. Total space rental is estimated at $2,400.

department projects as biostatistician to assist in the development of appropriate methods to structure, analyze and interpret outcome data. Less than 1% effort is anticipated.

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Travel $650 in year 01

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## VIII. LAY LANGUAGE ABSTRACT

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social/communication skills, repetitive and stereotyped behaviors[1]. Motor impairments are frequently reported in this population, including clumsiness, motor planning and coordination problems, fine and gross motor impairments, and decreased static and dynamic postural control. 1 in 110 children are diagnosed with ASD each year and 80-90% of them have motor impairments limiting their static and dynamic postural control, fine and gross motor planning and coordination resulting in clumsiness and limitations in participation. In hippotherapy horses and horse movement is often used for children with ASD in physical, occupational and speech therapy. It is widely reported anecdotally by parents and therapists to be effective. However, there is no published systematic evidence in the medical literature supporting the use of hippotherapy for children with ASD. In this era of evidence based practice, this seriously limits the opportunity for patients to receive funding to support hippotherapy as treatment for ASD.

This study is designed to answer the question about whether hippotherapy makes a difference for children with autism so they can participate better in age appropriate activities. Fifteen children between 5 and 12 years old with ASD will be recruited for this study. It will compare static and dynamic postural control of a typically developing group of children with 15 children with ASD who participate in 12 weekly treatments during which they will ride a horse under the direction of a therapist. They will ride forward, backward, sit sideways and in other positions. They will not be getting a riding lesson, the horse and its movement will be the treatment strategies to help them to build their balance and stability. The investigators will use very precise video motion capture, the same technology used to animate video games and movies. This is combined with force plate instrumentation to measure static and dynamic postural control before and after a baseline period which will determine any background improvements that are already occurring as a result of maturation and other ongoing therapies. In addition they will measure social responsiveness, sensory processing and participation in everyday activities of childhood to learn if 1: motor control improves and 2: if improvements in many other impairments characteristic of ASD also improve. At the end of the study we will be able to say whether hippotherapy improves basic skills which enable children to participate in everyday activities of typical childhood.

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## IX. BIOGRAPHICAL SKETCH

| NAME | POSITION TITLE |
|---|---|
| Tim L Shurtleff | Instructor, Occupational Therapy<br>Investigator, Human Performance Laboratory |
| eRA COMMONS USER NAME (credential, e.g., agency login)<br>Timothy L Shurtleff | |

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | MM/YY | FIELD OF STUDY |
|---|---|---|---|
| Brigham Young University, Provo, Utah | BA | 1974 | German, Psychology |
| Brigham Young University, Provo, Utah | MA | 1976 | Organizational Behavior |
| Columbia University, NYC, New York | Certificate | 1992 | Organization Development & Human Resource Mgmt. |
| Washington University in St. Louis, MO School of Medicine, Program in OT | OTD | 2006 | Occupational Therapy |

### A. Personal Statement

The purpose of this project is to develop understanding of the effect of hippotherapy treatment and how it affects participation in age-appropriate activities of everyday life of children with Autism Spectrum Disorder. To do this, the specific area of investigation is to understand some of the underlying mechanisms that support participation, e.g. static and dynamic postural control, sensory processing and social responsiveness. We will also investigate outcomes and changes in occupational performance and participation in everyday activities of childhood as outcomes of changes in motor control and stability gained through hippotherapy intervention. This is the real bottom line and may answer the critical question about why or whether therapists should use HPOT for children with ASD.

I am qualified to investigate this area because of my history in therapeutic riding and hippotherapy and my prior research in that area. I have been involved with therapeutic riding and NARHA since 1990. I became certified as a registered instructor with NARHA in 1996 and as a driving instructor in 2001. In 2003 I entered the occupational therapy graduate program and pursued an Occupational Therapy Doctorate degree graduating in 2006. As part of that educational process, I completed a pilot study of the efficacy of hippotherapy for children with cerebral palsy using very sophisticated motion capture technology. Using the results of that study, I applied to HHRF for a grant to extend the study. I received that grant in 2006 and completed the project in 2007. Both studies have been published in high level medical journals and I have presented results in numerous professional conferences, listed below. These studies have made a difference in the understanding that physicians and therapists have about the effect of hippotherapy on the motor control of children with cerebral palsy. I regularly receive requests from students, researchers and professionals for copies of the articles from the US and as far away as France, Brazil, China, and Poland. These articles are now being cited in current scientific publications about the efficacy of hippotherapy. However, most of the literature supporting the use of hippotherapy focuses only on children with cerebral palsy and there are many other conditions being treated which need to be studied in this context.

This study takes that same measurement technology to a different population which is growing in need and is becoming very prevalent in centers where therapists use horse movement as a treatment strategy in occupational, physical and speech therapy. Many children with Autism Spectrum Disorder participate in hippotherapy and anecdotal evidence is mounting. However, there are no published studies of the efficacy of Hippotherapy for children with Autism, only for therapeutic riding, a very different process with different goals and approach. Physicians, therapists and third party funders need systematic evidence to support decisions to

consider hippotherapy a viable and efficacious means to improve the lives of children with autism and to justify paying for HPOT treatment to meet their commitments to their clients who qualify for PT, OT or Speech therapy. This study is designed to meet that need in this new population and inform decision making of physicians, therapists and those who write the insurance checks.

### B. Positions and Honors

Instructor, Washington University School of Medicine, Program in Occupational Therapy, Human Performance Laboratory, July. 08 to present
Staff Scientist, Washington University School of Medicine, Program in Occupational Therapy, Human Performance Laboratory, July. 07 to present
Research Associate, Saint Louis University, Department of Physical Therapy, Motion Analysis Laboratory Feb 07-June 07.
Occupational Therapist, Therapeutic Horsemanship, Wentzville, MO. 2006-present.
OTD Student, Program in Occupational Therapy, Washington University School of Medicine, 2003-2006.

Prior Career Summary, 1976 - 2003: Internal and external organization development/organization effectiveness consultant

TL Shurtleff, LLC, independent external consulting practice, based in Villa Ridge, MO. 1993 to 2003
Monsanto Company, St. Louis, MO, 1989-1993, entrepreneurial internal consultant, competing with external consulting companies to keep consulting fees and expertise in-house.
Tenneco Oil Exploration and Production, Houston, TX; 1981-1989, internal team and organization effectiveness consulting,
Solar Turbines International, San Diego, CA; 1977-1981, Organization Effectiveness consulting in research and engineering units, supervisor and management Training
Unites States Steel, Geneva Works, Orem, Utah; 1976-1977, Team building, supervisory training efforts.

Common Features of positions listed in this section:

- Facilitated strategic planning and organization design/redesign efforts for internal and external clients. Teams ranged from groups of as few as five employees, to the National Governors Association, several not-for profit organizations, Operating division redesign for a major oil company plus facilitating a design team for a new $20 billion company.
- Developed and conducted “team skills” as well as supervisory, middle and upper management development programs.
- Designed and conducted survey-feedback organization diagnosis, facilitated feedback and change efforts at all levels.
- Initiated and/or facilitated employee involvement efforts, total quality processes and self-directed teams.
- Conducted team-building, problem solving and issue identification/resolution/action-planning processes at all levels.

### C. Selected Peer-reviewed Publications

Shurtleff, T. Engsberg, J. Standeven, S. (2009). Changes in Dynamic Trunk/Head Stability and Functional Reach after Hippotherapy. Archives of Physical Medicine and Rehabilitation, 90(7), 1185-1195.
Shurtleff, T.L. and J.R. Engsberg. “Trunk and Head Stability Changes after Hippotherapy, A Pilot Study.”, (2009) Physical and Occupational Therapy in Pediatrics, in Press for Spring 2010.
Engsberg, J.R., J.W. Standeven, T.L. Shurtleff, J.M. Tricamo, W.M. Landau. (2009) “Spinal cord and brain injury protection: testing concept for a protective device”. Spinal Cord, 47, 634-639

**Presentations:**

Shurtleff, T. L. (2009) Research Report: Changes in Trunk/Head stability and Functional Reach After Hippotherapy, American Occupational Therapy Association, April 2011, Philadelphia, PA

Shurtleff, T. L. (2009) Research Report: Changes in Trunk/Head stability and Functional Reach After Hippotherapy, American Hippotherapy Association, May 2009, Atlanta, GA

Shurtleff, T. L., Cook, Rebecca, (2009), Measuring Equine Movement: Introduction to the Accelerometer , American Hippotherapy Association, May 2009,Atlanta, GA.

Shurtleff, T. L. (2009) Research Report: Changes in Trunk/Head stability and Functional Reach After Hippotherapy, NARHA Region 7, Feb. 2009, Chicago, IL.

Shurtleff, T. L., (2009) Research Report: Equine Movement Measurement Workshop:, NARHA Region 7, Feb. 2009, Chicago, IL.

Shurtleff, T. L. (2008) Research Report: Changes in Trunk/Head stability and Functional Reach After Hippotherapy, HHRF Final Report in Research Track, NARHA (North American Riding for the Handicapped Association), Annual Meeting, Hartford, CT.

Shurtleff, T. L ,( 2008) Research Report - Changes in Trunk and Head Stability after Hippotherapy, A Pilot Study, Gait and Clinical Movement Analysis Society Conference, Richmond, VA:

Shurtleff, T. L., Casady, R., (2008), Designing Research Projects – half day workshop, North American Riding for the Handicapped Association, Region 4 conference.

Shurtleff, T. L ,( 2007), North American Riding for the Handicapped Association, National Conference, Anaheim, CA., Horses and Humans Research Foundation 2006 Grant - Preliminary Project Report, presented to general meeting.

Shurtleff, T. L ,( 2007), HHRF 2006 Grant: Preliminary Project Report, presented Horses and Humans Research Foundation Board Meeting at NARHA National Conference.

Shurtleff, T. L, (2007), Changes in Head/Trunk Stability after Hippotherapy, a Pilot Study – Poster Presentation at: American Occupational Therapy Association National Conference, St. Louis, MO,

Shurtleff, T. L, (2007), Changes in Head/Trunk Stability after Hippotherapy, a Pilot Study – Poster Posted at: American Hippotherapy Association Conference, Atlanta, GA

Shurtleff, T. L, (2007), Changes in Head/Trunk Stability after Hippotherapy, a Pilot Study-Research Report, NARHA Region 4 conference presentation

Shurtleff, T. L, (2006), Changes in Head/Trunk Stability after Hippotherapy, a Pilot Study-Research Report, NARHA national Meeting, 2006 presented pilot project summary and HHRF grant plan to general meeting upon receipt of HHRF2006 grant

Shurtleff, T. L, (2006), Changes in Head/Trunk Stability after Hippotherapy, a Pilot Study-Research Report, NARHA national Meeting

Shurtleff, C., Jensen, L., Shurtleff, T. L., Grading the Therapy Horse's Movement with Effective Leading, NARHA Region 7 conference, 2005,

Shurtleff, C., Jensen, L., Rafferty S., Shurtleff, T. L., Grading the Therapy Horse's Movement with Effective Leading, NARHA National Meeting, 2004,

Shurtleff, T. L, Cramer, T., (2005), Therapeutic Driving techniques - Half day hands-on workshop, NARHA Region 7 Conference, Omaha, NE

Shurtleff, T. L, Balding, L., (2004), Using Horse drawn Vehicles for therapeutic benefit, 2HR Seminar, NARHA Region 7 Wentzville, MO

Shurtleff, T. L., Vittert, C., Rafferty, S., Shurtleff, C., & Perrino, L. (2003). Low-tech, high impact equipment for hippotherapy, Paper presented at the North American Riding for the Handicapped Association, National Conference, Washington, DC.

Shurtleff, T.L., Mullins, P., Shurtleff, C., Strategic Planning for Therapeutic Riding Programs: "Where are we going and Why am I in a Handbasket?" one day preconference workshop for center administrators. NARHA National Meeting, 2002.

Shurtleff, T.L., (2001) Strategic Planning for Therapeutic Riding Programs, 2hr seminar, at NARHA national meeting,.

**D. Research Support**

Horses and Humans Research Foundation, 2006 Grant, Changes in Dynamic Trunk/Head Stability and Functional Reach after Hippotherapy. (With Jack R. Engsberg, PhD),

American Hippotherapy Association, 2005 Research Grant, for Occupational Therapy Doctorate project: Changes in Head/Trunk Stability after Hippotherapy, a Pilot Study, conducted at Washington University School of Medicine, Program in Occupational Therapy.

Missouri Spinal Cord Injury Foundation 03/01/05-06/30/07( co-investigator)
*Development and Testing of a Device for Spinal Cord and Brain Impact Protection*
The purpose of this pilot investigation is to develop a device that can protect both the head and the neck from injury due to acute impact.

Missouri Spinal Cord Injury Foundation 03/01/05-06/30/07(as co-investigator)
*Development and Testing of a Device for Spinal Cord and Brain Impact Protection*
The purpose of this pilot investigation is to develop a device that can protect both the head and the neck from injury due to acute impact.

## XI. Research Grant Conditions of Award

1. At least one member of the research team must be fluent in English and published in peer-reviewed English language journals.
2. No institutional overhead or other indirect costs will be paid and should not be included as part of any grant request. A letter to your institution explaining this condition can be requested if needed. Beware that substantive equipment costs could work against the success of the grant request.
3. All funds awarded shall be used in accordance with the submitted and approved proposal and accompanying budget. Any unused portion thereof shall be returned to the Horses and Humans Research Foundation (HHRF). If an unforeseen problem occurs with the study design, notify HHRF immediately. Potential changes to the study design with additional financial assistance from HHRF may be considered to salvage the study and still lead to a favorable outcome.
4. Grant awards will be made in US dollars. Fifty percent will be awarded after the midpoint report is accepted and the remainder will be awarded when the project is fully completed, unless other arrangements have been specified and agreed to. The value of the grant will not be adjusted for inflation, cost over runs, or foreign exchange rate fluctuations. It is the responsibility of the recipient to manage these potential variables (example: if grant budget deals in euros, a loan could be purchased at the time of award, in US dollars, against the euro).
5. At the midpoint of the grant period a progress report and financial report must be submitted. A final report must be submitted within 60 days of the completion of the project. The final report shall include a scientific abstract, summary data tables, a financial report, and a less-technical lay language article (400 words) to potentially be used in HHRF and related publications as determined by HHRF. Confidential data that could jeopardize formal publication in a peer-reviewed journal should not be disclosed in the lay articles. If a delay in project completion of more than 3 months duration is anticipated, HHRF must be notified promptly with a brief explanation and a request for extension. All investigators are encouraged to communicate and work with HHRF for the best possible outcome of their study. Failure to comply with the above conditions may result in revoking of all award funding.
6. The Principal Investigator must assure HHRF of his or her intended work location. HHRF must be advised at the time of application of all moves, contemplated or real. Changes of address, phone number, fax number and email *within the same institution* must be promptly conveyed to HHRF. Changes in site location during a funded period must be approved by HHRF.
7. All publications (including poster abstracts at medical conferences) resulting from HHRF-funded research must include HHRF in a footnote/credit line/disclosure, and copies of such publications must be provided to HHRF. All publicity and information disseminated about such research must acknowledge HHRF support. This is an essential part of HHRF's conditions of award. Publicity or information about the project is used to keep supporters to HHRF informed about how their donations are being spent. This condition of award does NOT involve disclosure of any information that might jeopardize the applicant's ability to formally publish their findings.
8. The recipient of any research grant awarded must certify that any research, including work involving human and/or animal subjects, will be conducted according to the rules and regulations of the United States Department of Health and Human Services. The recipient must agree to hold HHRF harmless from any and all claims which may arise from any associations/issues related to such research.

9. All studies involving therapeutic riding horses must comply with accepted industry standards for care, treatment, and humane work load. All mounted work must comply with accepted industry standards for safety – including a certified instructor/therapist or evidence of equivalent standards. Therapeutic riding program sites must be accredited by or provide evidence of equivalent standards for facility safety.
10. A one-year grant period is assumed. HHRF may approve the funding of a multi-year project, with funding of subsequent years pending the successful completion of the initial year. Applicants must consult HHRF prior to submitting a multi-year application.
11. Recipients of HHRF grants will be committed to a serious effort to publish resulting research findings in a peer-reviewed journal. HHRF will be kept informed of publication efforts.
12. All grant applicants must include one signed copy of this "Research Grant Conditions of Award" as a necessary part of their grant application to HHRF.
13. The Foundation reserves the right to terminate an award if the grant holder or staff funded by the grant is in breach of any of the conditions of award or becomes unfit or unable to pursue the work funded by the grant.

*I have read and understood HHRF's "Research Grant Conditions of Award" and my signature below signifies that I agree to abide by all conditions specified.*

Principal Investigator's signature: Date: _5/6/11_

Principal Investigator's name and title (please print)
Tim L. Shurtleff, OTD, OTR/L. Instructor in the Program in Occupational Therapy, Washington University in St. Louis, School of Medicine

## XII. Attachments

**Table 2. Timeline for project completion: Duration (months) to perform tasks for a 12 month project but expecting analysis and publication to continue beyond data gathering period of the grant.**

| Assume November 2011 announcement of grant | Dec-Jan | Feb-April | May June | July-August | Sept-Nov- | Dec-March. |
|---|---|---|---|---|---|---|
| | 1-2 | 3-4 | 5-6 | 7-9 | 10-12 | 13-16 |
| IRB/HRPO | x | | | | | |
| Recruit Participants | | x | x | | | |
| Baseline Assessments | | x | x | x | | |
| Pre-intervention Assessments | | x | x | x | | |
| HPOT Intervention | | x | x | x | x | |
| Post HPOT Outcome Assessments | | | x | x | x | |
| Process Data | | | | x | x | x |
| Statistical Analysis | | | | | x | x |
| Submit/Publish Results | | | | | | x |

***Table 1.*** **Variable Table**

| Dependent Variables | Measurements |
|---|---|
| Postural Sway: Static standing task<br>Weight Shift: Dynamic/Gait initiation task<br>(Kinematic [Video Motion Capture]<br>and kinematic [Force plates] data analysis) | COM M±SD<br>COP M±SD<br>COM-COP horizontal displacement<br>COM-COP minimum and maximum<br>ASD: Paired-T test/Wilcoxon Signed Ranked Test<br>ASD & TD: Unpaired T-test/Mann-Whitney U Test |
| Social Competence<br>(Social Responsiveness Scale - SRS) | Mean score pre-and post with SD<br>Paired-T test/Wilcoxon Signed Ranked Test |
| Sensory Processing<br>(Sensory Processing Measure - SPM) | Mean score pre-and post with SD<br>Wilcoxon Signed Ranked Test |
| Adaptive Behaviors<br>(Vineland-II – V-II) | Mean score pre-and post with SD<br>Paired-T test/Wilcoxon Signed Ranked Test |
| Participation and Occupational Performance<br>(Life Outcomes of Hippotherapy - LOH) | Mean score pre-and post with SD<br>Paired-T test/Wilcoxon Signed Ranked Test |
| Participation<br>(Child Activity Card Sort – CACS) | Number of current activities<br>Number of activities - Desired to participate<br>Reasons for participation, no participation = (parent, child, environmental barrier, child's capability) |

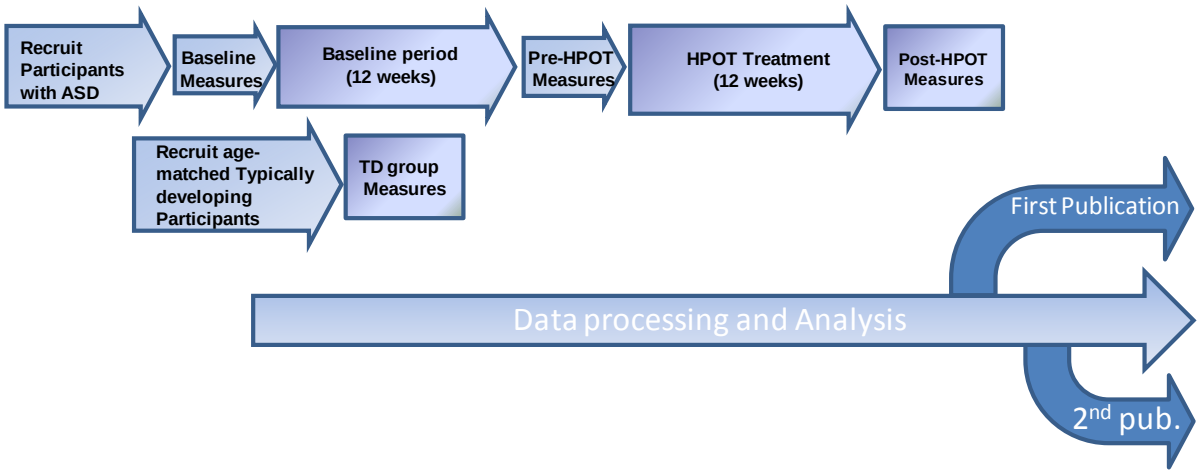


**Figure 1. Research Design and Process.**

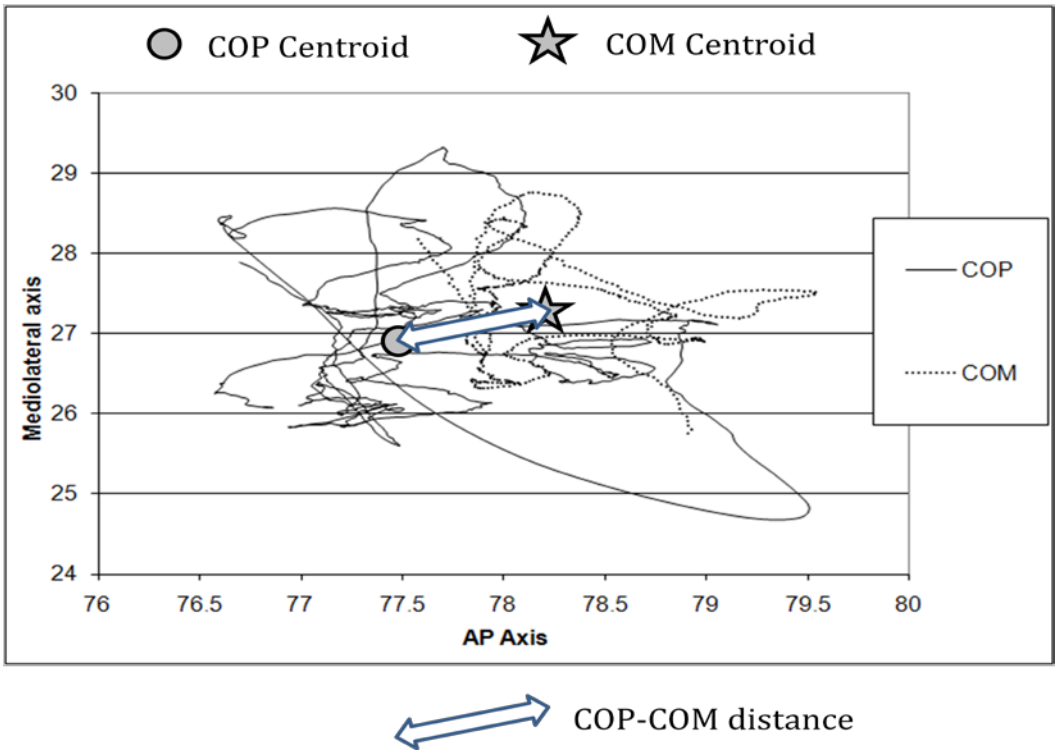


***Figure 2*. Scatterplot of COM and COP during Quiet Stance**

**This figure shows the general center of pressure (COP) and center of mass (COM) of a typical developing (TD) individual. The COP (straight line) and COM (dotted line) movement was plotted in a 20 second time frame. The average X and Y coordinates for COP and COM were determined to get a centroid COP (circle) and centroid COM (star). The distance (measured in centimeters) between the two is measured, labeled by the COP-COM distance (arrow). The hypothesis of this study suggests that children with ASD COP-COM distance will decrease as their stability increases as a result of HPOT.**

**Appendix A:** HPOT Treatment Progression Strategy: Five domains with progression levels from basic to advanced: Each HPOT participant will be slotted into their own beginning point determined at initial evaluation. Each level may be completed over several treatment sessions.

At each of three levels, activities in the following categories are defined for five domains
.

**Treatment Strategy categories**:
**A.** = % Assistance required
**B.** = Movement/Figures Schooled
**C.** = Positions/Transitions
**D.** = Mounted game

| | **Three Levels of performance/treatment** | | |
|---|---|---|---|
| **Domains (below):** | **Basic** | **Intermediate** | **Advanced** |
| **Balance & Stability** | **A. ***2 SW, full hold w partial support (A=75%)<br>**B. ***Free walk<br>*Weave cones (shallow and gentle)<br>*Groomed surface<br>**C.** *Forward, side sit, backwards<br>* Position changes performed by participant with mod. verbal cues<br>* Max. (75%) verbal cues for righting and centering<br>**D.** Reach/place objects in all planes and elevations<br>Catch/throw target games | **A.** 2 SW, ankle hold, (A=25%) for walk<br>Full hold for trot and on trail (A=50%)<br>**B.** *Working walk, trot down long side<br>*Deep weave with energetic turns, for lateral challenge<br>* Forward, astride trot<br>* Side hill serpentines and trails with even surface<br>**C. ***Previous positions as well as quadraped, airplane, and helicopter at walk, and trotting down the long side of arena<br>* Min. (25%) verbal cues for righting and centering<br>**D.** *Hands free catch and throw/target games<br>* Games for trunk-free (no handhold) sitting | **A. ***SW- SBA, no contact needed at walk<br>* Ankle hold at trot and on trail (A=25%)<br>**B.** * Medium walk, trot whole arena<br>*Any figures, e.g. abrupt turns, sharp weaving through cones, driven/led trot on circle or through cones<br>* Uneven terrain, trail, hillside,<br>**C.** * All positions as well as kneel, stand with "water ski handle, vaulting positions, 2 pt- trot down long side of arena<br>* Self initiated righting and centering<br>**D.** * Any activities in positions listed above<br>* Reins allowed at this level as a meaningful UE bilateral task to integrate gross and fine motor coordination development (horse handler still leaders or drivers horse for movement/safety) |
| **Communication** | **A. ***2 SW, full hold w partial support (A=75%)<br>**B. ***Free walk<br>* Ask horse to halt and walk with max. (75%) therapist assist (verbal command) based on preferred verbal/non-verbal communication methods<br>**C.** *Halt/walk in forward, side sit, backwards positions<br>**D. ***Color game- Red plate used to tell horse to halt; Green Plate used to tell | **A.** 2 SW, ankle hold, (A=25%) for walk<br>Full hold for trot and on trail (A=50%)<br>**B.** *Working walk, trot down long side<br>* Ask horse to halt and walk with min. (25%) therapist assist (verbal command) based on preferred verbal/non-verbal communication methods<br>* Performed in various marked sections of arena | **A. ***SW- SBA, no contact needed at walk<br>* Ankle hold at trot and on trail (A=25%)<br>**B.** * Medium walk, trot whole arena<br>* Self-initiate verbal commands for halt/half-halts/walks in marked areas or when horse handler changes the horse's tempo or gait as directed by therapist.<br>*Perform uneven terrain |

| | | | |
|---|---|---|---|
| | horse to go | **C.***Halt/walk in previous positions as well as quadraped, airplane, and helicopter at walk, and trotting down the long side of arena<br>**D.** * Color game- Red and green plates place in different sections of the arena | **C.** * Halt/walk/trot in all positions as well as kneel, stand with "water ski handle, vaulting positions, 2-pt<br>**D.** *Color game- Red, green, and blue (meaning to trot) objects placed throughout arena to verbally tell horse to do specific gaits |
| **Cognition** | **A. ***2 SW, full hold w partial support (A=75%)<br>**B and C. ***Free walk<br>* One-step direction with indicated movements/positions for balance and speech domains, e.g. therapist asks to weave through cones<br>**D.** *Ask to follow one step obstacle course, e.g. shoot basketball into the hoop | **A.** 2 SW, ankle hold, (A=25%) for walk<br>Full hold for trot and on trail (A=50%)<br>**B and C.** *Working walk, trot down long side<br>* Two-step directions direction with indicated movements/positions for balance and speech domains, e.g. therapist asks to 1st weave through cones, then 2nd trot down long side<br>**D.** *Obstacle course with two step directions | **A. ***SW- SBA, no contact needed at walk<br>* Ankle hold at trot and on trail (A=25%)<br>**B and C.** * Medium walk, trot whole arena<br>*Three step directions direction with indicated movements/positions for balance and speech domains, e.g. 1st get into kneel position from letter K to H, 2nd 2-pt trot down next long side, 3rd halt with the use of the rein next to blue block.<br>**D.** * Obstacle course with three step directions |
| **Social Skills** | **A. ***2 SW, full hold w partial support (A=75%)<br>**B,C, D. ***Free walk; in positions described above<br>* Turn taking activity between therapist and participant | **A.** 2 SW, ankle hold, (A=25%) for walk<br>Full hold for trot and on trail (A=50%)<br>**B,C, and D.** *Working walk, trot down long side, in positions described above<br>* Turn taking activity between participant and one other rider | **A. ***SW- SBA, no contact needed at walk<br>* Ankle hold at trot and on trail (A=25%)<br>**B, C, and D.** * Medium walk, trot whole arena, in positions described above<br>* Turn taking activity between participant and two other riders requiring both sequencing and longer waiting time<br>* Verbal/non-verbal communication required |
| **Interactive Play** | **A. ***2 SW, full hold w partial support (A=75%)<br>**B, C, D. ***Free walk; in positions described above<br>*Role play (TBD) between therapist and participant | **A.** 2 SW, ankle hold, (A=25%) for walk<br>Full hold for trot and on trail (A=50%)<br>**B, C, D.** *Working walk, trot down long side; in positions described above<br>*Role play (TBD) between participant and one other rider | **A. ***SW- SBA, no contact needed at walk<br>* Ankle hold at trot and on trail (A=25%)<br>**B, C, D.** * Medium walk, trot whole arena; in positions described above<br>* Role play (TBD) between participant and two other riders, requiring communication in participant's preferred method |

## Appendix A(pg3):

| Abbreviations in Treatment Progression Strategy | Glossary |
|---|---|
| A – Assist from therapist or sidewalker. Can be expressed as a percent<br>AP – Anterior/Posterior movement<br><br>SBA- Stand By Assist<br>LE – Lower Extremity<br>2PT – "Two Point" position<br>SBA (Stand by assist, no contact)<br>SW – Sidewalker<br>UE – Upper extremity<br>WB – Weightbearing<br><br>Note: Any stage in Appendix A may include any activities from prior stages integrated into a treatment plan, which includes new activities in the higher stage. | * Airplane – Riding position with arms out at sides<br>* Helicopter – "Airplane" position with repeating trunk rotation in both directions.<br>* Equine – a pony (<14.2hh), horse (≥14.2hh), or mule<br>* Girth, a strap with buckles, goes under the girth area (under the horse's chest) to hold a surcingle and pads on the horse's back.<br>* Surcingle – an overgirth which buckles tightly around the horse's barrel (chest behind withers) -- used to hold pads on the horse. A surcingle often has rigid or flexible handles or rings attached but can also be smooth, no handles.<br>* Groomed Surface – level smoothed arena surface, vs. trail or side hill with elevation changes and surface irregularities<br>* Impulsion – Forward/vertical energy produced by the horse at the walk or trot, felt at the saddle or pad by the rider.<br>* Two Point – an astride riding position with UE weight-bearing on neck or pommel, LE weightbearing in stirrups<br>* Vaulting positions: advanced gymnastic positions (stand, quadruped, tall kneel, flag, crab, etc) performed on horseback with minimal SW support except SBA.<br>* "Water-ski handle" – neoprene-grip covered wooden handle (broomstick) with adjustable length straps with snaps on each side to attach to a surcingle for UE holds to facilitate wide base of UE support to balance while standing or in tall kneel position.<br>* Weave cones – The horse walks a serpentine (sine wave) around a line of cones. Can be done shallowly (less lateral challenge) or deeply and energetically (more lateral challenge)<br><br>Grades of Walk (four beat lateral gait with easy forward thrust, lateral roll and minimal upward movement:<br>* Free walk – Easy relaxed walk with low impulsion,<br>* Working Walk - more energy, more impulsion<br>* Medium Walk – very energetic walk, high impulsion.<br>Grades of Trot: (two beat gait with energetic bounce and forward thrust.<br><br>Sidewalker Holds to assist HPOT client:<br>* Full Hold – Sidewalkers hold surcingle or pad with hand with forearm across client's thigh.<br>* Partial hold – SW holds surcingle with forearm across lower leg.<br>* Ankle hold – SW keeps hand lightly on ankle, "just in case", outside hand can be on surcingle to keep SW attached to horse and client in case horse jumps, or transitions to trot.<br>* Contact Guard (CG) -- Light hold without support, ready to help if needed.<br>* Standby assist – Sidewalker walks alongside, (may hold surcingle) ready to help without touching client. |

**Appendix B**: **INCLUSION/EXCLUSION CRITERIA REFERRAL FORM**

**THE EFFECT OF HIPPOTHERAPY ON CHILDREN WITH AUTISM SPECTRUM DISORDERS**

PARTICIPANT'S NAME: _____ DATE: _____

PARTICIPANT'S DOB: _____

PARENTS NAMES: _____

ADDRESS: _____

PHONE: _____

DIAGNOSIS: _____ PHYSICIAN NAME: _____

**Inclusion Criteria**

_____Yes _____No - Age: 5-12 years, full term birth

_____Yes _____No - Dx: ASD, T-Score 60 or above on SRS

_____Yes _____No - Parental compliance for child's participation in HPOT and pre-and post-measurements

_____Yes ____No - Approved consent from primary physician

_____Yes _____No - Cognitive Status: Follow one-step direction.

_____Yes _____No - Independently ambulate with no use of assistive devices

**Exclusion Criteria**

____Yes _____No - Physician diagnosis of severe sensory impairment (e.g. vision, hearing, vestibular), cerebral palsy, epilepsy, or any other neurological or psychiatric conditions

____Yes _____N0 - Severe behavioral issues: self-injurious and outward physical aggressive behaviors

____Yes _____No - Severe physical limitations: Unable to sit unaided

___Yes _____No - Unable to abduct hips preventing them from sitting on a horse

_____Yes _____No - Serious health conditions on NARHA's list of contraindications

____Yes _____No - Previous exposure to any type of equine-assisted activities

Tim Shurtleff, OTD, OTR/L, Program in Occupational Therapy, Washington University School of Medicine, 4444 Forest Park Ave, St. Louis MO. 63108, (tshurtleff@wustl.edu)

**Appendix C: The Effect of Hippotherapy on Children with ASD Treatment planning Worksheet**
**Date** _____ **Session**: Spring Summer Fall Winter

| Client Name: | | Impairment level: mild…mod ...severe impairment |
|---|---|---|
| DOB: | | Other ongoing therapies/Medications: |
| Diagnosis: | | Precautions: |
| Client/Parent Priorities | 1. | 2. |

**Initial treatment level on study treatment protocol**._____

- Impairments: Please list up to three impairments from OT/PT evaluation that might be addressed during HPOT treatment.
- Objectively describe (measures, observations) current level of ability/impairment. Prioritize by allocating ten points between them indicating percent of effort that will be spent on strategies to address them during 12 wk HPOT treatment session.
- Write 12 wk goal for each impairment indicating how you will measure outcome, e.g. what evidence will indicate success.

| Impairment 1: | Impairment 2: | Impairment 3: |
|---|---|---|
| | | |
| | | |
| 12 wk Goal: | 12 wk Goal: | 12 wk Goal: |
| | | |
| | | |
| Outcome measure: | Outcome measure:: | Outcome measure: |
| | | |
| | | |

**Treatment activities: Check all that may apply to meet goals**

| Position/Gross motor activities | √ | Rationale/ description | UE/Functional Activities | √ | Rationale/ description | School figures/ Mounted Mvmts | √ | Rationale/ Description |
|---|---|---|---|---|---|---|---|---|
| Forward | | | Bear weight | | | Straight /smooth turns | | |
| Backward | | | Gross Grasp | | | Lg (20M) circles | | |
| Side-sit ( R L ) | | | Fine Motor | | | Circles | | |
| Quadruped (F R) | | | Reaching all planes | | | Weave cones / shallow | | |
| Prone – spine | | | Catch/throw/target | | | Weave Cones / deep | | |
| Prone – barrel | | | Cross Midline | | | Slow walk only | | |
| Supine | | | Interactive games | | | Energetic walk | | |
| Flag | | | Airplane/Helicopter | | | 3-4 stride trot | | |
| Tall kneel | | | Use reins for UE tx | | | Surprise halt/half halts | | |
| Stand | | | Scan/track exercise | | | Walk/halt/trot | | |
| Two Point | | | Cognitive tasks: | | | Long side straight trot | | |
| Other: | | | Cognitive tasks: | | | Hill/serpentine up down | | |
| Other: | | | | | | Other: | | |

**Tack:**

**Select Tack/Support Equipment: Explain why choices are appropriate to client and goals:**

| √ | Tack/Equipment: | Rationale: | √ | Tack/Equipment: | Rationale: |
|---|---|---|---|---|---|
| | Sticky pad | | | Western Saddle | |
| | Smooth pad | | | English Saddle | |
| | Stirrup strap (for standing) | | | Two handle surcingle | |
| | Neck Strap | | | Casting collar | |
| | Standing Handle | | | Smooth O'Girth | |
| | Other: | | | Spring handle | |
| | Other: | | | Other: | |
| | Other: | | | Other: | |
| | Other: | | | Other: | |
| | Other: | | | Other: | |

**Horse Selection / Horse Handling / Therapy Support Required**:

| | | | |
|---|---|---|---|
| Prefer: Small Pony…….Draft<br>Circle ideal size 11 12 13 14 15 16 17 18 hh | | Horse should:<br>lead…….Ground Drive…….Longe……Long Line | |
| Slow walk ……Fast walk, Why? | | Horse responsiveness to rider input:<br>Responsive……Dull | |
| Short stride……Long Stride, Why? | | Lateral movement at walk: Little……Lots, Why? | |
| Flat Trot……..Springy trot, Why? | | Vertical or AP rotation at walk Little……..Lots, Why? | |
| Walk: Soft ……Concussive Why? | | Sidewalkers needed: 1 or 2 (Circle one) | |
| Horse shape: Narrow ……Wide, Why? | | Other support requirements: | |
| Other Horse requirements: | | Handler skilled to:<br>lead…….Ground Drive…….Longe……Long Line | |
| Name up to three preferred horses for this client in priority order: | 1. | 2. | 3. |

Any other considerations in the treatment of this therapy client:

Date: _____

Evaluating Therapist: _____

Treating Therapist: _____

Please fax or email after initial evaluation to Tim Shurtleff, OTD, OTR/L at Washington University Program in Occupational therapy: tshurtleff@wustl.edu or 314-2879-4701 (fax)

**Appendix D: The Effect of Hippotherapy on Children with ASD**

**PT/OT Treatment note: Tx Number (1-24) _____ Date: _____**

| Client Name: | | **Assist Code** | **Assist definition** |
|---|---|---|---|
| DOB: | | **Dep - Dependent** | **75% + support** |
| Diagnosis | | **Max - Maximum** | **50-75%** |
| Impairments | | **Mod - Moderate** | **25-49%** |
| TX level (1-8) | | **Min - Minimum** | **<25%** |
| Precautions: | | **SBA - Standby** | **Supervise, cues** |
| 12 wk Goal: | | **Ind - Independent** | **No assist needed** |

Objectives:_____

_____

Tx plan: _____

_____

Tack:_____ Horse: _____ **L**ead or **D**rive #

SW **1 2**

## Treatment activities: Check all that were performed during HPOT treatment

| Position/Gross motor activities | √ | Notes/ Assist: | UE & Functional Activities | √ | Notes/ Assist: | School figures & Mounted Movements | √ | Notes/ Assist: |
|---|---|---|---|---|---|---|---|---|
| Forward | | | Bear weight | | | Straight /smooth turns | | |
| Backward | | | Gross Grasp | | | Lg (20M) circles | | |
| Side-sit ( R L ) | | | Fine Motor | | | Small Circles | | |
| Quadruped (F R) | | | Reaching all planes | | | Continuous Circles | | |
| Prone – spine | | | Catch/throw/target | | | Weave cones / shallow | | |
| Prone – barrel | | | Cross Midline | | | Weave Cones / deep | | |
| Supine | | | Airplane/Helicopter | | | Slow walk only | | |
| Flag | | | Groom/Tack/lead | | | Energetic walk | | |
| Tall kneel | | | Use reins | | | 3-4 stride trot | | |
| Stand | | | Scan/track exercise | | | Surprise halt/half halts | | |
| Two Point | | | Interactive games | | | Walk/halt/trot | | |
| Other: | | | Cognitive tasks | | | Long side straight trot | | |
| Other: | | | Cognitive tasks | | | Trot entire arena 1X, 2X… nX ? ____ | | |
| Other: | | | Other: | | | Hill/serpentine up down: | | |

**Treatment (SOAP) note**:

| | |
|---|---|
| **S:** | **O:** |
| **A:** | **P:** |

Treating Therapist:_____ OTR COTA PT PTA SLP NCI (as therapy aide)

Treating Therapist Signature: _____ Date: _____

Supervising Therapist _____ Date: _____

Please fax or email weekly to Tim Shurtleff, OTD, OTR/L at Washington University Program in Occupational therapy: tshurtleff@wustl.edu or 314-2879-4701 (fax)