Effect of Hippotherapy on Motor Control, Adaptive Behaviors, and Participation in Children With Autism Spectrum Disorder: A Pilot Study

Heather F. Ajzenman, John W. Standeven, Tim L. Shurtleff

OBJECTIVE. The purpose of this investigation was to determine whether hippotherapy increased function and participation in children with autism spectrum disorder (ASD). We hypothesized improvements in motor control, which might increase adaptive behaviors and participation in daily activities.

METHOD. Six children with ASD ages 5–12 participated in 12 weekly 45-min hippotherapy sessions. Measures pre- and post-hippotherapy included the Vineland Adaptive Behavior Scales–II and the Child Activity Card Sort. Motor control was measured preintervention and postintervention using a video motion capture system and force plates.

RESULTS. Postural sway significantly decreased postintervention. Significant increases were observed in overall adaptive behaviors (receptive communication and coping) and in participation in self-care, low-demand leisure, and social interactions.

CONCLUSION. These results suggest that hippotherapy has a positive influence on children with ASD and can be a useful treatment tool for this population.


Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social skills and communication, and repetitive and stereotyped behaviors (Tomchek & Dunn, 2007). Although subtle motor impairments are not considered an identifying factor (according to the Diagnostic and Statistical Manual of Mental Disorders, 5th ed. [DSM–5]; American Psychiatric Association, 2013) or a symptom of ASD, between 80% and 90% of children with ASD display these behaviors (Dziuk et al., 2007; Wiggins, Robins, Bakeman, & Adamson, 2009). These subtle motor impairments can affect children’s ability to initiate, effectively perform, and switch between goal-oriented movements and engage in developmentally appropriate activities, with the potential to affect communication, social interactions, and performance of daily activities (Dziuk et al., 2007; Hilton, Zhang, Whilte, Klohr, & Constantino, 2012; Leary & Hill, 1996).

Through exploration and engagement, children gain the skills necessary for motor control development. Initially, motor control requires cognitive awareness, in which skills are acquired through continued trial-and-error practice of new movements. Through continuous practice, past experiences are related to the current task, associating movements for higher efficiency. Motor skills eventually become autonomous for functional motor control (O’Brien & Williams, 2010). Learning is built from the development of these cognitive components, leading to acquisition of skills in multiple performance areas (Case-Smith, Law, Missiuna, Pollock, & Stewart, 2010).
Postural control becomes an integrative automatic response as children refine their abilities and learn to select appropriate postural strategies on the basis of anticipating consequences of movement (Assaiante, Mallau, Viel, Jover, & Schmitz, 2005). Fournier, Kimberg, et al. (2010) reported that children with ASD displayed decreased postural stability (independent of age) compared with typically developing (TD) children during a standing balancing task measured with a force plate and kinematic data, supporting the hypothesis that postural system development is delayed in children with ASD (Fournier, Kimberg, et al., 2010). Postural instability can have an impact on fine and gross motor abilities, hand manipulation skills, and planning and execution of motor sequencing (Minshew, Sung, Jones, & Furman, 2004). Views on the potential impact of disrupted motor control on occupational engagement vary; however, postural control is associated with language, social engagement, play skills, and academic abilities (Baranek, 2002). As a result, motor challenges can limit interactions with the physical and social world, reducing opportunities to acquire developmentally appropriate skills (Cosbey, Johnston, & Dunn, 2010; Fournier, Hass, Naik, Lodha, & Cauragrah, 2010) and possibly contributing to social isolation, anxiety, and emotional challenges for children with ASD and their families (Hilton et al., 2012).

Children with neurological disabilities can have reduced postural control during functional tasks, theorized as an improper interaction among the somatosensory, visual, and vestibular systems. Motor control and sensory processing theories suggest that children with ASD have decreased ability to regulate degree, intensity, and type of responses to sensory information, resulting in limited abilities to habituate and adapt during daily activities. Not only do sensorimotor impairments affect overall postural control but decreased proximal stability also influences upper-extremity stability and control during fine motor activities. These challenges influence motor coordination, body positioning, fine and gross motor skills, and complex hand skills, all of which are hypothesized to further disrupt occupational performance and participation (Gal, Dyck, & Passmore, 2010; Su, Wu, Yang, Chen-Sea, & Hwang, 2010).

Hippotherapy (HPOT) is a treatment strategy that uses the horse’s movement as a tool to affect functional outcomes. In HPOT, an occupational therapist, physical therapist, or speech–language pathologist continually modifies the horse’s movement throughout the session to address clients’ needs as they work toward functional goals (American Hippotherapy Association, 2010). HPOT is a unique treatment strategy for children with disabilities because it considers the context of the therapy session while offering support necessary to challenge the cognitive–sensorimotor systems (Engel, 2007). Active engagement in therapy activities has been shown to lead to improvements in adaptation and increased willingness to participate in everyday activities (Brown & Dunn, 2010), and using the horse’s movement as a treatment tool is theorized to have similar influences.

Because each step of the horse is a challenge to stability, HPOT provides a unique opportunity to challenge and improve postural control. At a working walk, the horse takes approximately 100 steps per minute (Clayton, 2002). Thus, in one 45-min HPOT session, the horse takes approximately 4,500 steps. As a result, children must repeatedly respond to the variability in the horse’s movement to maintain stability (Shurtleff, Standeven, & Engberg, 2009).

In children with cerebral palsy, improvements in reaching were observed after HPOT and ascribed to improved stabilization of the trunk and reduced use of upper-extremity support, freeing the hands for everyday functional activities (Shurtleff et al., 2009). The research has suggested that children with ASD also have a slower development of the postural control system, leading to reliance on external support such as stabilizing on a table during writing tasks (Pehoski, Henderson, & Tickle-Degnen, 1997). Thus, it is possible that with similar improvements in trunk stability, children with ASD could improve distal control after HPOT, enabling more functional gross upper-extremity movement and fine motor hand use. Additionally, performance of goal-oriented motor and imitation activities in children with ASD is typically more meaningful in purposeful situations, promoting willingness to engage in motor-based activities with peers (Baranek, 2002). HPOT has been suggested to have similar effects, where increased motivation during therapy activities influenced by the horse’s movement can affect the generalization of newly acquired motor skills to other daily activities.

The purpose of this investigation was to determine whether HPOT increased function and participation in children with ASD. Specifically, we explored the impact of using the horse’s movement during therapy activities on postural control and parent reports of adaptive behaviors and engagement in age-appropriate activities. We hypothesized that improvements in motor control might enable improved adaptive behaviors and increased participation in daily activities of children with ASD after HPOT.
Method

Research Design

This pilot study was a single group pre–post design involving a 12-wk HPOT intervention for children with ASD. Data were collected 1 wk before and 1 wk after completion of the intervention. Institutional review board approval was obtained from the Washington University in St. Louis, School of Medicine. Parents and guardians completed and signed an approved consent form. HPOT safety was ensured by following Professional Association of Therapeutic Horsemanship International (PATH) HPOT standards.

Participants

Participants were recruited from local school districts and government agencies. Inclusion criteria were a diagnosis of ASD according to the DSM–IV–TR (APA, 2000), ages 5–12 yr, full-term birth, and ability to independently ambulate and follow a one-step direction. Parental compliance for the child’s participation in premeasurements, HPOT, and postmeasurements and approved consent from the child’s primary physician were also required. Exclusion criteria were a physician diagnosis of severe sensory impairment, cerebral palsy, epilepsy, or any other neurological or psychiatric conditions; severe behavioral issues that resulted in physical harm to others; physical limitations restricting the ability to sit unaided; serious health conditions stated on PATH’s list of contraindications; and previous exposure to any type of equine-assisted activities or therapies.

Intervention

The HPOT sessions consisted of 45 min mounted on a therapy horse, 1x/wk for 12 wk. Therapists were state-licensed occupational therapists or certified occupational therapy assistants working with a PATH-certified instructor. Because all the participants were enrolled in school and many had an individualized education program, they continued to receive school-based therapies during the 12 wk of HPOT intervention.

An HPOT treatment progression strategy was developed and used for the intervention. This strategy was based on five domains (motor control, functional communication, cognition, social skills, and interactive play), ranging from basic to more advanced activity participation while on the horse. Various mounted positions, schooling figures performed by the horse, and functional skills were used as treatment activities to promote motor planning and sequencing. Functional positions on the horse included forward sitting (astride), prone, supine, backward astride, side sit, kneeling, quadruped, and standing. Schooling figures included straight lines, circles, and weaving through cones to challenge postural stability. Intermittently stopping and starting, changing speed within the walk, and using half halts further challenged trunk stability and attentional skills.

Functional activities challenged attention, cognitive skills, functional communication, social skills, and interactive play. Activities included following complex directions through changes in positioning, obstacle courses, and tasks and games requiring use of the upper extremities. Children participated in turn taking, planning, and sequencing activities with therapists or with other children who were receiving treatment at the same time in the arena. Interactive play and social activities were graded from solitary up to cooperative levels of play with exploratory and symbolic components. Activities addressed basic cause–effect to more complex tasks with initiation, sequencing, and problem-solving components with a variety of transitioning components overlaid on the activity to challenge adaptive behaviors. For example, a ball playing activity was suggested while on the horse, starting off at the basic level of simply holding the ball, moving to playing a basic catch game with the therapist, and grading up to adding social exchange components, such as requiring the child to attend to a direction and playing the ball game with another peer who was also on a horse. More complex motor planning tasks were added in which children had to complete one to two simple to complex motor plans after catching the ball (requiring periods of waiting and appropriately reacting to therapist directions), all while postural control was challenged by varied horse movement (e.g., therapist-directed abrupt changes within or between gaits to grade the challenge up or down). This progression strategy was created as a guideline and to suggest options for intervention therapists for this pilot study, thus methods to measure treatment fidelity were not used.

Data Collection and Processing

Participants came to the Human Performance Laboratory for initial assessments of postural control. Structured self-report assessments and interviews were given to the participants’ parents: the Vineland Adaptive Behavior Scales–II (VABS–II) and Child Activity Card Sort (CACS). After 12 wk of HPOT intervention, participants returned for reevaluation of postural control variables and parent-report measures. Because of the length of parent-report measures, the VABS–II was completed at home and returned within 1 wk. The primary investigator was the only person who collected those data and was trained...
in the administration of these two measures by well-qualified therapists in the field. Other therapists provided the intervention.

**Force Plates and Video Motion Capture.** To measure changes in postural control, we used an eight-camera video motion capture (VMC) system (using Cortex software, Version 1.0.0.198; Motion Analysis Corporation, Santa Rosa, CA) and one 50-cm \( \times \) 50-cm force plate (Kistler; Winterthur, Switzerland). The three-dimensional force plate measures ground reaction forces in X, Y, and Z dimensions. Twenty-five reflective markers (5 mm) were placed on bony landmarks of the participants’ head, trunk, and lower extremities. Typically, surface markers are placed on skin for accurate bony landmark location; however, because of the anticipated tactile sensitivity or defensiveness of children with ASD, markers were placed on tight-fitting clothing that covered all bony landmarks (except the head).

Each participant stood on the force plate for 20 s. The force plate captured center-of-pressure (COP) data simultaneously with center-of-mass (COM) data, which were captured by the VMC system. After 20 s, the participant stepped off the force plate. The force plate recorded at 300 samples/s with camera data at 60 frames/s. Each five force-plate samples were averaged to synchronize force plate and camera data at 60 frames/s.

Because of difficulty attending to and following directions, most participants required more than four trials to meet the required protocol for accurate data acquisition. As a result, multiple trials (typically eight or more) were performed, and four trials were selected for analysis on the basis of adherence to data acquisition protocols, before any data analysis.

The Cortex software integrated kinematic and kinetic data. Using anthropometric tables, we calculated COM in the static postural control task on the basis of the tracked location of the trochanter and acromion markers as well as the participant’s height, weight, and age (Winter, 2005). COP was determined on the basis of the force plate trials related to the lab coordinate system (LCS) generated by Cortex. The COP location could then be matched with the COM location (using the camera LCS data) at any point in time, at 60 Hz (frames/second).

During the static postural control–quiet stance task, the participant’s postural sway was analyzed using COM and COP anteroposterior (AP) sway, mediolateral (ML) sway, area (rectangle created by min and max AP and ML sway), sway path length (total two-dimensional distance of movement), and movement variability (standard deviation) over time (1,200 observations for each 20-s trial) during quiet stance. Postural sway was calculated by the displacement of COM from COP, determined by the horizontal displacement between the centroids (two-dimensional averages) of COP and COM during the collection period.

**Vineland Adaptive Behavior Scales–II (Parent/Caregiver Rating Form).** The VABS–II is a 297-item parent report measuring children’s adaptive behavior and performance of daily activities. The four domains include communication, daily living skills, socialization, and motor skills with respective subdomains of 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, fine motor skills, and gross motor skills. Scoring is done on a 3-point Likert scale ranging from 0 (never) to 3 (usually) with an option of don’t know. For children ages 5–12, internal consistency is strong, with a correlation of .96–.97, strong mean domain and subdomain test–rest reliability of .85–.90, and good mean domain and subdomain interrater reliability of .71–.81. Content criterion-related validity has been established (Sparrow, Cicchetti, & Balla, 2005).

**Child Activity Card Sort.** CACS is a modified version of the Preschool Activity Card Sort (PACS; Berg & LaVesser, 2006) with a few questions modified in collaboration with the author of the PACS. The term preschool was removed from the evaluation form, and two questions were reworded to address the communication and schooling needs of this population (C. Berg, personal communication, May 28, 2011). The CACS is a semi-structured parent–guardian interview used to examine participation in typical age-appropriate activities through the use of picture cards. The parent or guardian rates 85 cards that display typical activities on the basis of whether the child participates in the activity (yes, yes with adult assistance, or yes with environmental assist) or not (no for child reasons, no for adult reasons, or no for environmental reasons). The responses are typically used to explore potential barriers to the child’s participation and help identify goals for therapy sessions. The CACS has seven domains: self-care, community mobility, high-demand leisure, low-demand leisure, social interaction, domestic, and education. Test–retest reliability is strong at .93, and interrater reliability is .91 (Berg & LaVesser, 2006).

Content validity has been established, and its authors are currently working on validating norms for TD children and children with ASD.

**Statistical Analysis**

We analyzed the results using IBM SPSS Statistics, version 20 (IBM, Armonk, NY). We used nonparametric statistics
because of the small sample size \((N = 6)\) and ordinal scales for parent-report measures. For motor control, we used a Wilcoxon signed-rank test for participants with ASD pre- and post-HPOT. An a priori \(\alpha\) level was set at \(p < .05\). Effect sizes (Cohen’s \(d\)) were calculated as the difference between means divided by a pooled standard deviation (of participants with ASD pre- and post-HPOT). An effect size of .02 indicates a small change; an effect size of .05, a moderate change; and an effect size >.08, a large change, indicating a clinical change (Portney & Watkins, 2009).

We used a Wilcoxon signed-rank test for the VABS–II and CACS. For the VABS–II, we compared the pre- and post-HPOT adaptive composite score, domains, sub-domains, and content categories for children with ASD. Change scores were calculated for each domain in the CACS using a coding process based on whether the child participated and what factors influenced participation. This method was developed in consultation with the CACS’ author. If a child participated in an activity independently (yes), a change score of 1 was given, whereas if a child participated in an activity with assist (yes with adult assistance), a change score of 0.5 was given. A change score of −1 was given if a child did not participate in an activity, whether the child chose not to participate (No child) or the parent chose not to offer that activity (No adult). We used these change scores to compare pre- and post-HPOT participation of children with ASD.

Results

Seven children with ASD completed the HPOT intervention (ages 5–12 yr, 4 boys, 3 girls, mean age = 8.4 yr, standard deviation = 2.5), but 1 child was dropped from the analysis because of the development of aggressive behaviors and inability or unwillingness to perform the requested tasks. One participant completed only 10 of 12 sessions and was included in the analysis.

**Motor Control and Postural Stability (Force Plates and Video Motion Capture)**

When pre- and post-HPOT results were compared, we found a significant improvement in postural stability in children with ASD. COM and COP showed significant changes with moderate to large effect sizes (Figure 1). Significant decreases were observed in movement variability of sway area for COP (12% change, \(p = .028, d = 0.1999\), COM mean AP velocity (102% change, \(p = .046, d = 1.316\), and COM ML velocity (20% change, \(p = .046, d = 0.845\)). We observed no significant reduction in COP AP (\(p = .600\)) and ML (\(p = .600\)) velocity and COM movement variability for sway area (\(p = .600\)). COM normalized area of sway (40% change, \(p = .046, d = 0.702\)) and sway path length (7% change, \(p = .028, d = 0.499\)) and COP normalized area of sway (48% change, \(p = .046, d = 0.990\)) and sway path length (24% change, \(p = .028, d = 1.259\)) also significantly decreased post-HPOT (Figure 2). The mean displacement (33% change, \(p = .028, d = 1.799\)) and minimum displacement (77% change, \(p = .028, d = 1.912\)) between COM and COP significantly decreased, with a large effect size post-HPOT (Figure 3).

**Adaptive Behaviors (Vineland Adaptive Behavior Scales–II)**

We saw significant changes in the overall adaptive behavior composite score (which improved from the low-functioning category to the moderately low-functioning category) post-HPOT for children with ASD with a small effect size (Table 1). We also saw significant increases with small effect sizes within the communication and socialization domains. We observed significant changes

![Figure 1. Mediolateral (ML) sway velocity, sway path length, and sway area of children with autism spectrum disorder before and after hippotherapy (HPOT).](https://example.com/image1.png)
in specific subdomains post-HPOT with improvement from low functioning to moderately low functioning in receptive communication with a large, clinically significant effect size and in coping with a small effect size.

Large, clinically significant improvements were observed in the receptive communication content categories of (1) listening and attending and (2) following instructions. Specifically, significant changes occurred in attending or listening for 5 min, following two-step directions, and following if–then instructions. For coping, significant improvements were seen in appropriate social caution, specifically avoiding dangerous activities. We found no significant differences in the daily living and motor skills domains, including their respective subdomains: personal daily living, domestic daily living, community daily living, fine motor, and gross motor. In the communication and

Figure 2. Postural sway comparison of children with autism spectrum disorder (ASD) pre- and posthippotherapy (HPOT). Pre-HPOT children with ASD had a large sway area and a great degree of movement variability. Post-HPOT children with ASD had a significantly decreased sway area with less variability in postural sway.

Note. AP = anteroposterior; COM = center of mass; COP = center of pressure; ML = mediolateral.

Figure 3. Quiet stance: Depicting differences in displacement of COP–COM pre- and post-HPOT for a participant with ASD. Pre-HPOT, a great amount of sway (approximately 1 cm) is present in both the AP and ML directions because of the inability to couple COM and COP to remain stable during quiet stance. Post-HPOT, the overall area created by the AP and ML directions is greatly reduced (approximately in half) with coupling of COM and COP. The COM stays directly within the COP sway path.

Note. AP = anteroposterior; ASD = autism spectrum disorder; COM = center of mass; COP = center of pressure; HPOT = hippotherapy; ML = mediolateral.
social skills domains, we observed no significant changes in expressive communication, written communication, interpersonal skills, and play and leisure time.

**Participation in Daily Activities (Child Activity Card Sort)**

We observed significant increases in change scores in participation in daily activities for children with ASD post-HPOT (Table 1). Moderate to large clinically significant daily participation increases were seen in self-care, low-demand leisure, and social interaction. Children with ASD showed no significant participation changes in community mobility, high-demand leisure, domestic, and education.

**Discussion**

These results suggest that postural control, adaptive behaviors, and participation in everyday activities improved for children with ASD after involvement in a 12-wk HPOT intervention. Improvements in postural control may provide children with ASD with more opportunities or increased willingness to participate in self-care, low-demand leisure, and social interactions. Increased engagement in daily activities could potentially lead to improvements in receptive communication and socialization (coping).

We measured significant changes in multiple postural control variables after HPOT for participants with ASD. This reduced postural sway, displayed in components such as decreased movement variability, velocity, area of sway, and sway path length, may have resulted from an improved coupling of the COM and COP. During HPOT, the horse moved through space and performed a variety of figures as participants concurrently changed to different functional positions and engaged in therapeutic activities. This sensorimotor experience has the potential to continuously provide postural challenges to which participants

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**Table 1. Adaptive Behaviors and Daily Participation of Children With ASD Pre- and Post-HPOT**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-HPOT</th>
<th>SD</th>
<th>p</th>
<th>Post-HPOT</th>
<th>SD</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VABS–II</strong></td>
<td>M Score/Total</td>
<td></td>
<td></td>
<td>M Score/Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptive Composite Score</td>
<td>64.00 (86–114)</td>
<td>15.30</td>
<td>.027</td>
<td>70.67 (86–114)</td>
<td>18.50</td>
<td>0.393</td>
</tr>
<tr>
<td>Communication</td>
<td>65.00 (86–114)</td>
<td>18.54</td>
<td>.042</td>
<td>74.00 (86–114)</td>
<td>19.52</td>
<td>0.473</td>
</tr>
<tr>
<td>Receptive</td>
<td>7.50 (13–17)</td>
<td>2.35</td>
<td>.026</td>
<td>10.33 (13–17)</td>
<td>2.42</td>
<td>1.189</td>
</tr>
<tr>
<td>Listening 5 min</td>
<td>1.17/2</td>
<td>0.41</td>
<td>.046</td>
<td>1.83/2</td>
<td>0.41</td>
<td>1.618</td>
</tr>
<tr>
<td>Following 2-step directions</td>
<td>1.00/2</td>
<td>0.63</td>
<td>.046</td>
<td>1.67/2</td>
<td>0.52</td>
<td>1.092</td>
</tr>
<tr>
<td>Following if–then instructions</td>
<td>1.00/2</td>
<td>0.63</td>
<td>.046</td>
<td>1.67/2</td>
<td>0.52</td>
<td>1.092</td>
</tr>
<tr>
<td>Expressive</td>
<td>8.16 (13–17)</td>
<td>—</td>
<td>.157</td>
<td>9.00 (13–17)</td>
<td>—</td>
<td>—</td>
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<td>Written</td>
<td>10.33 (13–17)</td>
<td>—</td>
<td>.059</td>
<td>11.50 (13–17)</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Daily living skills</td>
<td>68.50 (86–114)</td>
<td>—</td>
<td>.093</td>
<td>73.83 (86–114)</td>
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<td>—</td>
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<tr>
<td>Personal</td>
<td>9.50 (13–17)</td>
<td>—</td>
<td>.131</td>
<td>10.67 (13–17)</td>
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<tr>
<td>Domestic</td>
<td>10.50 (13–17)</td>
<td>—</td>
<td>.334</td>
<td>11.17 (13–17)</td>
<td>—</td>
<td>—</td>
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<td>.102</td>
<td>8.83 (13–17)</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Socialization</td>
<td>61.00 (86–114)</td>
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<td>.027</td>
<td>68.17 (86–114)</td>
<td>21.52</td>
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<td>Interpersonal</td>
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<td>.197</td>
<td>8.00 (13–17)</td>
<td>—</td>
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<tr>
<td>Play and leisure</td>
<td>6.84 (13–17)</td>
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<td>.109</td>
<td>9.00 (13–17)</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Coping</td>
<td>9.33 (13–17)</td>
<td>3.08</td>
<td>.038</td>
<td>10.50 (13–17)</td>
<td>3.56</td>
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<tr>
<td>Avoid dangerous activities</td>
<td>0.33/2</td>
<td>0.51</td>
<td>.046</td>
<td>1.00 2</td>
<td>0.63</td>
<td>1.162</td>
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<tr>
<td>Motor skills&lt;sup&gt;a&lt;/sup&gt;</td>
<td>79.67 (86–114)</td>
<td>—</td>
<td>.600</td>
<td>82.67 (86–114)</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Fine</td>
<td>11.67 (13–17)</td>
<td>—</td>
<td>.892</td>
<td>11.83 (13–17)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Gross</td>
<td>11.67 (13–17)</td>
<td>—</td>
<td>.399</td>
<td>12.50 (13–17)</td>
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<td>—</td>
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**CACS**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-HPOT</th>
<th>SD</th>
<th>p</th>
<th>Post-HPOT</th>
<th>SD</th>
<th>d</th>
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<tr>
<td>Self-care</td>
<td>7.58/14</td>
<td>4.95</td>
<td>.027</td>
<td>10.17/14</td>
<td>3.13</td>
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<td>Community mobility</td>
<td>11.92/15</td>
<td>—</td>
<td>.335</td>
<td>12.42/15</td>
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<td>—</td>
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<tr>
<td>High-demand leisure</td>
<td>5.25/10</td>
<td>—</td>
<td>.588</td>
<td>6.25/10</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Low-demand leisure</td>
<td>8.00/11</td>
<td>1.76</td>
<td>.042</td>
<td>9.58/11</td>
<td>1.80</td>
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<td>Social interaction</td>
<td>6.08/12</td>
<td>2.33</td>
<td>.027</td>
<td>8.25/12</td>
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<td>Domestic</td>
<td>3.42/11</td>
<td>—</td>
<td>.173</td>
<td>5.50/11</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Education</td>
<td>4.92/9</td>
<td>—</td>
<td>.115</td>
<td>7.00/9</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note. Dashes indicate results that were not significant (p > .05). Standard deviation (SD) and d not reported on non-findings. CACS = Child Activity Card Sort; HPOT = hippotherapy; VABS–II = Vineland Adaptive Behaviors Scale–II.  
<sup>a</sup>Motor domain was given to all participants for consistency purposes, irrespective of age (>6 yr old).
learned to respond. Postural control was further challenged because the horse took several thousand steps during each treatment session. We theorize that the participants had to repeatedly respond to the variability in the horse’s movement, promoting learned righting and equilibrium reactions to remain stable to perform activities during therapy (Shurtleff et al., 2009). Involvement in HPOT thus has the potential to enable children with ASD to use newly improved automatic postural mechanisms to improve stability while standing and performing functional tasks.

Decreased cognitive–sensorimotor abilities are commonly reported in children with ASD, for whom motor control deficits are believed to result in decreased flexibility and inability to adapt to tasks and environmental demands (Leary & Hill, 1996). Poor motor control is theorized to account for the social, communication, and behavioral characteristics seen in ASD (Dziuk et al., 2007). It is possible that involvement in HPOT enabled improvement in sensorimotor functioning, allowing for children to further explore and engage in opportunities, as evidenced by specific domain and subdomain changes in adaptive behaviors and participation measures.

Changes in postural control may possibly have affected the improvements observed in participation in everyday activities. As children experience improved sensorimotor function, they may be more willing to engage in everyday activities that have been challenging in the past. With increased motor abilities, children have increased opportunity to engage in self-care activities such as shoe tying or dressing, participate in leisure activities including cutting or coloring, and socially interact with other children (Hilton et al., 2012). Although no significant changes in performance of play and leisure activities, personal daily living tasks, and overall socialization were observed specifically on the VABS–II, increased participation in these daily activities still occurred, as was evident in the CACS results. This increased participation suggests that improved postural stability gained after HPOT may allow children with ASD to perform new motor patterns necessary for task engagement, even if initially not achieved at an efficient performance level (O’Brien & Williams, 2010).

Increased participation in low-demand leisure activities and social interaction in the CACS may result from improved postural stability. With the suggested correlation between postural control and distal upper-extremity use, improved stability possibly provided opportunities for better targeting and effective hand use, such as the object manipulation and material management skills required in low-demand leisure activities (Minshew et al., 2004). Increased social interaction can also be explained by improvements in motor control. Participants had many opportunities to interact and engage with others during the HPOT experience (therapist, horse, volunteers), providing opportunities to practice these skills (Hilton et al., 2012). Despite improved stability, we observed no significant changes in participation in high-demand leisure, domestic tasks, and education. Because learning and motor control are built on development of a variety of cognitive components (O’Brien & Williams, 2010), we hypothesize that no observable improvements in participation occurred because these activities require a larger repertoire of complex skills that were not specifically targeted or inadvertently affected as part of the intervention. However, the observed improvements in participation in activities suggest that through continuously responding to the horse’s movement during functional tasks in HPOT, children may develop a variety of new skills as they increase their ability to effectively use their improved postural stability. These newly developed skills are common in everyday activity and could support the increase in daily activity participation observed in our study.

Improvements in coping, particularly participants’ ability to react with appropriate social caution, may be explained by increased participation in social interactions, which are specifically targeted in the intervention. Motor challenges can have an impact on children’s ability to regulate goal-oriented movements, thus affecting communication, social relations, and participation with others (Leary & Hill, 1996). With improved postural control and resultant increased social participation, children with ASD could more effectively cope in restrictive, frustrating, or novel social situations (Hilton et al., 2012). The movement input during HPOT could have provided participants with ASD the cognitive arousal to and an engaging context that encouraged attending to and socially engaging in a variety of tasks.

Improvements in receptive communication, specifically in listening and following two-step and if–then instructions, may have resulted from an integrative connection between improved postural control and social interactions. The social opportunities provided in the HPOT setting could enhance receptive communication, because participants practiced attending, comprehending, and completing instructions provided by their therapists during turn taking, planning, and sequencing activities. Improved postural control, as suggested by Leary and Hill (1996), can also influence communication and social interaction abilities. With improved postural responses, children have the potential to effectively attend to tasks as motor responses become more automatic for functional engagement (Baranek, 2002; O’Brien & Williams, 2010).
With increased postural stability and practice in listening, understanding, and completing multistep directions, children with ASD may begin to engage in many tasks requiring these skills outside of the HPOT setting.

Nonsignificant findings in the motor skills portion of the VABS–II seem contradictory to the findings of improved postural control with use of the VMC system and force plate. However, we must note that the fine and gross motor subscales were used for data collection consistency purposes despite the sample’s mean age of 8.4 yr, which was beyond the norms of <6 yr. It is possible, as a result of age, that many of the participants, despite motor impairments, were functioning close to the norms reported for the VABS–II. Similarly, nonsignificant changes in participation in community mobility in the CACS could result from a ceiling effect because they were participating at an age-appropriate functional mobility level before intervention (Table 1).

Thus, improved coping abilities and communication skills evident after HPOT could also positively influence participation in self-care, low-demand play activities, and social interaction for children with ASD. As parents begin to observe improvements in these skills, they may begin to offer their children the opportunity to engage in more activities because of improvements in some of their language, motor, and social skills. These activities could initiate a virtuous cycle in which more engagement hones skills that then enable even more engagement.

Limitations and Future Studies

One limitation of this study is the small sample size, which makes its applicability to a larger population more difficult. However, because it was pilot work, the purpose was to test a measurement model and gain some indication of what changes might occur after HPOT. This study will provide a foundation on which to design a larger study in which the number of participants may allow for increased statistical significances in other factors of adaptive behaviors and participation.

The assessment tools used to measure adaptive behaviors and participation in everyday activities were parent-report measures. Because of the differing functioning levels, communication abilities, and compliance tolerance during testing, we concluded that parent-report measures were the best way to get consistent responses about these domains. In future studies, to prevent parental biases, we suggest using teacher-rating forms in addition to parent forms and blinding teachers to the therapy participants receive.

Another limitation was an unknown level of consistency between therapists in the use of the treatment progression strategy developed for the HPOT. Decreased uniformity of treatment may have occurred with participants in each session and over the entire intervention. It is possible that other components of adaptive behavior and participation might have been significant with increased consistency of structured treatments. An important note is that consistent structured treatment strategies across clients are not the norm in most HPOT (or any therapy) settings. This consistency presents a dilemma because a trade-off and tension exist between unique client-focused treatment strategies for therapy and consistent treatment protocols for research. For future studies, more intensive training and monitoring by researchers may ensure fidelity of treatment with therapists while still allowing therapists to use their judgment within a treatment progression while remaining client centered. However, because client-centered care allows for wide variability in treatment strategies, it is still likely that these results are actually quite similar to real-world changes seen in many children with ASD after HPOT.

The length and intensity of HPOT should be investigated to determine its potential impact on participation and performance of daily activities. In this brief intervention, we observed significant changes in postural control, basic performance and participation components of adaptive behaviors, and daily living skills, but nonsignificant findings in more complex skills. A longer (>12 wk) or more frequent (e.g., 2×/wk) time frame using HPOT may result in greater or more measurable benefits for children with ASD.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:
- HPOT is a useful treatment strategy for improving postural control in children with ASD.
- Improved postural control may have a positive influence on adaptive behaviors and participation in daily activities, particularly social interactions.
- HPOT appears to have an impact on a variety of factors that improve participation and performance for children with ASD.

Conclusion

Children with ASD showed improved postural stability and improvements in receptive communication, coping,
and daily activity participation after 12 weekly HPOT sessions. Because the horse’s movement continually challenged stability, they may have developed automatic postural mechanisms to better engage in therapeutic and functional activities, suggesting that HPOT may have affected very basic skills fundamental to the development of more complex motor skills. These complex distal upper-extremity and hand skills are important for performance and participation in daily activities. Improvements in receptive communication, coping, and daily activity participation could result from improved postural control. HPOT has the potential to increase postural stability, providing children with ASD the opportunity to increase performance and participation in daily activities. ▲

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References


