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Therapeutic Horseback Riding Outcomes of Parent-Identified Goals for Children with Autism Spectrum Disorder: An ABA′ Multiple Case Design Examining Dosing and Generalization to the Home and Community

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Abstract

We examined whether different doses of therapeutic riding influenced parent-nominated target behaviors of children with autism spectrum disorder (ASD) (a) during the session (b) at home, and (c) in the community. We used a single subject multiple Baseline, multiple case design, with dosing of 1, 3, and 5 times/week. Three boys with ASD, 6–8 years of age participated, and counts of target behaviors were collected in each setting and phase of the study. Compared to Baseline, 70 % of the target behaviors were better during Intervention and improvement was retained in 63 % of the behaviors during Withdrawal. Increased doses of therapeutic riding were significant for magnitude of change, and the effect of the therapeutic riding sessions generalized to home and community.

Keywords

Autism spectrum disorder; Single subject design; Home; Community

Introduction

While hippotherapy, equine-facilitated psychotherapy, and therapeutic riding have therapeutic use of horses in common, there are distinct differences. In general, hippotherapy tends to focus on posture, balance, and mobility. It is usually carried out by physical and occupational therapists, who consider horseback riding to be a therapeutic modality (All and Loving 1999). In equine-facilitated psychotherapy, during a riding session, the therapist is often the instructor, and the presence of the horse is deemed to be therapeutic (Bates 2002; Masini 2010). The focus of therapeutic riding is broader, and may include physical, social, learning, sensory, and psychological goals, including the relationship between the rider and the horse, and is directed by a certified therapeutic riding instructor (All and Loving 1999). Using a single-subject design methodology, the current study sought to examine the effectiveness of 3 different doses of therapeutic riding on parent-identified target behaviors of three boys with autism spectrum disorder (ASD), in three environments: the therapeutic riding center, the home, and the community.

Previous research on the effectiveness of hippotherapy, equine-facilitated psychotherapy, and therapeutic riding for children has mostly focused on those with physical (Davis et al. 2009; Drnach et al. 2010; McGibbon et al. 2009; Shurtleff et al. 2009), social/emotional/ behavioral (Bass et al. 2009; Ewing et al. 2007; Schultz et al. 2007), and language/learning conditions (Kaiser et al. 2006; Macauley and Gutierrez 2004). These studies examined changes in gait, posture, strength, coordination, self-concept, depression, pain, anxiety, or quality of life. In most studies, some level of effectiveness was reported, although the quality of studies varied considerably. Several systematic reviews/ meta-analyses on the effectiveness of hippotherapy and therapeutic riding were found for children with cerebral palsy (Snider et al. 2007; Tseng et al. 2013; Whalen and Case-Smith 2012; Zadnikar and Kastrin 2011). These studies examined outcomes related to gross motor function (Sterba 2007; Whalen and Case-Smith 2012; Snider et al. 2007), asymmetrical activity of the hip

adductors (Tseng et al. 2013), and postural control and balance (Sterba 2007; Zadnikar and Kastrin). Two studies found that even a short session (e.g., 8–10 min) could decrease asymmetrical hip adductor activity significantly and that once a week sessions lasting only 8–10 weeks could yield significant improvements in gross motor function. All studies found that hippotherapy or therapeutic riding yielded at least short-term positive outcomes on physical outcome measures for children with cerebral palsy.

However, only one study was found on the use of therapeutic riding for children diagnosed with autism spectrum disorder (ASD) (Bass et al. 2009). Compared to waitlist controls, children in the riding program showed greater social motivation, sensory seeking, and a reduction in sedentary behaviors, inattention and distractibility. However, no research has examined the "dosing" effect of therapeutic riding on parent-identified target behaviors. In addition, research linking the use of therapeutic riding with parent-identified negative or positive target behaviors was also lacking, as were studies focused on generalization of the therapeutic riding session effects to the home or community environments. Therefore, the current study examined the impact of 3 dosages of therapeutic riding (1, 3, and 5 times/ week) on three parent-identified target behaviors for three boys with ASD, in three environments: the therapeutic riding center, the home, and the community.

Methods

The study used an ABA' single subject design, with each phase lasting 4 weeks and the entire study lasting 12 weeks. Common to education, single subject designs, or N-of 1 trials are becoming common in medical therapeutics, and allied health because patients serve as their own controls, variability of response can be seen if the data are graphed, and the statistical significance of the behavioral change following the Intervention can be calculated several ways (e.g., mean levels, celeration lines, 2 standard deviation bands, and the more rigorous C-statistic) (Larson 1990; Lillie et al. 2011; Ottenbacher 1986). Moreover, depending on the Intervention, data gathered in the Withdrawal phase reflects whether the effects of the Intervention continue when the Intervention is stopped (i.e., learning has taken place), or if removal of the Intervention (i.e., a reward, a splint, a technology device) results in a return to Baseline (control condition) behaviors. In the Baseline (control condition) phase (A) the 3 participants received their typical 1 session (30–45 min) of therapeutic riding per week for 4 weeks. In the Intervention phase (B) the participants received either 1 (control dose), 3, or 5 sessions per week (dosing effect). In the Withdrawal phase (A') all participants returned to their usual 1 session per week routine. For each participant, researchers collected data on parent-generated target behaviors during the therapeutic riding sessions, and parents also collected data on the same target behaviors at home and in the community (generalization effect). The study was conducted during the months of July (A), August (B), and September (A').

Participants

To be eligible for the study, participants had to (a) be diagnosed with ASD by a physician (b) be between 5 and 13 years of age (c) be available to participate in the Intervention phase of the study which could require up to 5 days/week riding sessions for 4 weeks (d) be able to

participate in the therapeutic riding sessions for 12 weeks, and (e) have parents willing to identify and document target behaviors they wanted increased (positive) or decreased (negative) in their child. Eight children met 3 of the criteria, and three boys between the ages of 6 and 8 years met all criteria and participated in the study. Each of the boys had been riding once a week for approximately 1 year. The three boys were randomized by coin flip to receive the therapeutic riding Intervention (dosing) for 1 (Participant A; Control dose), 3 (Participant B), or 5 (Participant C) sessions per week. Examples of short-term and long-term therapeutic riding goals for the three participants are listed in Table 1.

Participant A—Participant A was an 8-year-old boy, who had just completed the 2nd grade. He could read easy sentences, and was also able to do subtraction and addition using touch math. According to the Kaufman Test of Educational Achievement-Second Edition, he achieved less than 1.0 grade level for Phonological Awareness, K.2 for Letter and Word Recognition, K.0 for Match Concepts and Applications, K.4 for Math Computation, 1.0 grade for Reading Comprehension, and less than 1.0 grade for Spelling. No IQ or other standardized measures were available because of non-compliance with testing. The three target behaviors identified by his parents were: (1) decrease tensing/ clenching of facial muscles (2) decrease snapping of fingers, and (3) increase spontaneous communication of wants/needs.

Participant B—Participant B was a 6-year-old boy, who had completed kindergarten. He had mastered the kindergarten reading list (pre-primer dolch words) and was moving on with the primer words. He was able to “sound out” simple words phonetically, as well, and was adding single digits, but not yet subtracting. No IQ or other standardized measures were available because of non-compliance with testing. The three target behaviors identified by his parents were: (1) decrease pounding on surfaces with either hand (2) decrease pushing in nose with either hand, or (3) decrease clapping.

Participant C—Participant C was a 6-year-old boy, who had completed kindergarten. He was able to read above grade level and had excellent spelling test scores too. He could do simple addition and subtraction. His grade equivalent PIAT scores were: 1.9 for Reading Recognition, 1.4 for Reading Comprehension, 1.6 for Total Reading, 1.6 for Spelling, and less than K.0 for Mathematics. The General Information subtest was not scoreable because of the open-ended question format. The three target behaviors identified by his parents were: (1) decrease echolalia/scripting (2) decrease mouthing/chewing on fingers/hands and non-edible objects, and (3) increase verbal demands using 3 or more words.

Standardized Measures of Change

Standardized measures of change were completed four times by the parents, each time with a look-back period of 1 month: Pre-study (Pre-Baseline), Post-phase A (Baseline), Post-phase B (Intervention), and Post-phase A’ (Withdrawal) (see Table 2).

Aberrant Behavior Checklist-Community (ABC-C) (Aman and Singh 1994). The ABC-C was designed to assess behaviors and measure Intervention effects of individuals with developmental disabilities. The ABC-C (Aman et al. 1985; Brown et al. 2002) consists of 58

items in five symptom clusters: (1) Irritability, Agitation, Crying (15 items); (2) Lethargy, Social Withdrawal (16 items); (3) Stereotypic Behavior (7 items); (4) Hyperactivity/ Noncompliance (16 items); and (5) Inappropriate Speech (4 items). Parents were asked to consider their children's behaviors for the past month, and rate each item on a 0 to 3 scale (0 = not at all a problem; 3 = the problem is severe in degree). The symptom-cluster subscales are scored separately and stand alone.

Social Responsiveness Scale (SRS) (Constantino and Gruber 2005). The SRS is designed to describe and measure the severity of symptoms associated with ASD as they occur in natural social settings. The SRS consists of 5 scale scores (Social Awareness, Social Cognition, Social Communication, Social Motivation, and Autistic Mannerisms) and a total score. Parents were asked to consider their children's behaviors for the past month (instead of 6 months) and rate each item on a 1–4 scale (1 = not true; 4 = almost always true).

Sensory Profile-Caregiver Questionnaire (SP-CQ) (Dunn 1999). The SP-CG was designed to allow caregivers to describe the sensory responses of their children. The questionnaire consists of 125 items grouped into three categories: Sensory Processing, Modulation, and Behavioral and Emotional Responses (Dunn 1999 p. 1). Within the three categories, behaviors are further grouped into 14 subcategories (Sensory Processing = 6; Modulation = 5; Behavior and Emotional Response = 3), and ranges of scores for each subcategory are interpreted as: typical performance (≤1 SD below the national research sample mean), probable difference (≤2 SD but >1 SD below the national research sample mean), and definite difference (>2 SD below the national research sample mean). Parents were asked to consider their children's behaviors for the past month, and rate each item for the frequency with which they observed their children exhibit the behaviors on the questionnaire using a 5-point scale (1 = always, 5 = never). Scores from subcategory items are then transferred to a 9-category factor summary table, and again rated as typical performance, probable difference or definite difference.

Observed Measures of Change

Data for observed measures of change were collected during the three phases of the study. Each set of parents identified three target behaviors they wanted to see their child increase (e.g., verbalization) or decrease (e.g., scripting). Examples of "typical" negative behaviors to be decreased through participation in the therapeutic riding program included finger licking, clapping, finger twisting, and body hitting, and pinching. Examples of positive behaviors to be increased included eye contact, verbalization, and naming of people/items. Each behavior was clearly defined and each observation of the behavior during a data collection session counted as 1 observance.

Therapeutic Riding Sessions—The first author and two graduate students videotaped each riding session. Each videotape was reviewed by both graduate students, coded, and entered into a database. Each "walker" (one on each side of the horse) and the leader also collected data for one target behavior by moving a bead down a shoelace tied to their belts in case the video did not capture a behavior. Each session lasted approximately 45 min. Overall inter-observer reliability was 0.87 % agreement.

Home—Parents recorded the frequency of each targeted behavior at home (lived-in environment, for 1/2 h for each behavior, 3 times/week. Parents chose the times when the target behaviors tended to be most prevalent (e.g., getting ready for school, mealtimes, etc.). At the end of each month, the data sheets were turned into the research team, and the data were entered into the database.

Community—Parents recorded the frequency of each targeted behavior in a community setting (e.g., church, grocery store, friend's home) for 1/2 h for each behavior, 3 times/week. Parents chose the settings and times when the target behaviors tended to be most prevalent. At the end of each month, the data sheets were turned into the research team, and the data were entered into the database.

Procedures

The Nickers 'N Neighs Therapeutic Riding Center, Donegal, PA, was chosen for the study because the Director had a baccalaureate degree in Equine Facilitated Therapeutics, and was a Certified and Registered Instructor (Pennsylvania Council on Therapeutic Horsemanship; The North American Riding for the Handicapped Association). Potential participants were recruited from Nickers 'N Neighs. A flyer was distributed to parents of children ages 5–13 who were enrolled in a therapeutic riding program. The flyer included the design of the study, and the eligibility criteria. The study was approved by the Full Board of the University of Pittsburgh Institutional Review Board for the Protection of Human Subjects. After reviewing the study with each set of parents, and obtaining informed consent, the first author, the Center Director and the parents identified 3 observable target behaviors for each participant. Operational definitions for each behavior were then generated. Directions for data collection at home and in the community were reviewed with each set of parents, who were then provided with a notebook of data collection forms and measures to be completed prior to Baseline, and immediately following each phase using a look-back period of 1 month. C-statistics were chosen for data analysis because they are more rigorous than celeration line graphics.

The instructors were certified in therapeutic horsemanship, set overall goals with the family and the student (see sample goals, Table 1), and had lesson plans for each session. Each session began with grooming of the horse, emphasizing touch, naming of parts, and following directions given by the instructor. During the riding session, students were accompanied by a leader (who lead the horse around the indoor track), and two trained walkers (persons who walked on either side of the horse and placed their forearms across each of the child's legs to ensure student safety, or provide cues to the student). The instructor stood in the center of the arena and guided the lesson, by giving directions to the student. The students wear appropriate clothing such as helmets for their physical protection. All riding activities take place on the stable grounds in a controlled environment and follow a pre-planned sequence to meet the therapeutic riding program goals and objectives.

Standardized test data were analyzed using descriptive statistics, and then converted to the performance level indicator. Observed measures consisted of frequency counts, and were entered into excel to be analyzed using the C-statistic (Ottenbacher 1986), which yields a Z

score. Inter-rater reliability was calculated for the two research assistants for 25 % of their observations, and confirmed by the principal investigator.

Results

Standardized Measures of Change

Screening with the Childhood Autism Rating Scale (CARS; Schopler et al. 1988) indicated that all three boys were “mildly-moderately autistic.” On the repeated standardized measures of change, the participants showed little variation in behaviors from Pre-Baseline to Post-Baseline to Post-Intervention to Post-Withdrawal. On the ABC-C, parent-rated behaviors of all three boys ranged from the 60th to the 98th percentile across phases. On the SRS, all but one T-score of parent-rated behaviors ranged above 60, indicating mild to severe social impairment. On the SP-CQ, parent-rated sensory indicators tended to remain stable, with each participant being rated as “typical performance” during all phases of the study for low endurance/tone, sensory sensitivity, and sedentary factors. Participants A and B were also rated as “typical performance” in all phases for emotionally reactive, and Participant B for poor registration. In contrast, Participants A and C were rated as “definite difference” for sensory seeking, and Participant C for fine motor/perceptual (see Table 3).

Observed Measures of Change

Participant A (Control Dose, 1 Time/Week)

Tenses/clenches facial muscles: Although the behavior increased during the riding sessions compared to Baseline it decreased at home and in the community during Intervention and during Withdrawal. The change in the behavior in the community, from Baseline to Withdrawal, was significant (see Table 4).

Snapping fingers: Again, compared to Baseline, the behavior increased during the riding sessions, and decreased at home during Intervention and during Withdrawal. In the community, compared to Baseline, the behavior decreased significantly during the Intervention, but increased significantly during Withdrawal (see Table 4).

Spontaneous verbal communication of wants/needs; any number of words: Compared to Baseline, the behavior increased during Intervention and Withdrawal during riding sessions, at home, and in the community. Significant changes occurred during riding sessions from Baseline to Intervention, and at home from Baseline to Withdrawal (see Table 4); however, because increases in verbalization were observed during Baseline and the data were autocorrelated (data were already increasing in a linear path), it is not clear that the changes were due to the Intervention alone.

Participant B (Dose = 3 Times/Week)

Pounding on surfaces with either hand: While riding, compared to Baseline, the behavior increased significantly during Intervention, but there was no change from Baseline to Withdrawal. Compared to Baseline, the behavior decreased at home and decreased significantly in the community during Intervention and Withdrawal. However, because

decreases in the behavior were observed during Baseline and the data were autocorrelated, it is not clear that the changes were due to the Intervention alone (see Table 5).

Pushing in nose with either hand: Compared to Baseline, during Intervention and Withdrawal the behavior decreased during riding sessions, at home, and in the community, and the decrease from Baseline to Intervention in the community was significant (see Table 5).

Clapping: For both during riding sessions and at home, compared to Baseline, the behavior increased during Intervention and Withdrawal. However, only the increase during Intervention riding sessions was significant. In the community, compared to Baseline, the behavior decreased during Intervention and Withdrawal (see Table 5).

Participant C (Dose = 5 Times/Week)

Echolalia/scripting—Compared to Baseline, the behavior increased while riding during Intervention (significant) and Withdrawal (significant). Likewise, compared to Baseline the behavior increased at home during Intervention (significant) and Withdrawal and in the community during Intervention and Withdrawal (significant) (see Table 6).

Mouthing/chewing fingers/hands and non-edible objects—Although the behavior decreased significantly during Intervention compared to Baseline during the riding sessions, the behavior increased from Baseline to Withdrawal. However, compared to Baseline the behavior decreased at home during Intervention (significant) and Withdrawal (significant) and in the community during Intervention and Withdrawal (significant) (sees Table 6).

Verbal demands of 3 words or more—Compared to Baseline, the behavior increased significantly during Intervention and Withdrawal during the riding sessions, and increased in the home and community during Intervention. It also increased significantly at home during Withdrawal, but the increase in the community during Withdrawal was not significant (see Table 6).

Goal-Free Evaluation of Change

At the end of the study, each set of parents was interviewed again and asked if they had noticed any changes in their child during the study beyond the identified target behaviors. Each set of parents identified several common behaviors that they perceived as improving during the Intervention phase of the study, and continuing into the Withdrawal phase: (1) increased overall verbalization (2) increased ability to follow directions (3) improved physical strength and coordination, and (4) increased ability to respond to the rhythm of their horses' movements.

Discussion

The current study examined the impact of 3 doses of therapeutic riding [1 time/week (Control dose), 3 times/week, and 5 times/week] on parent-identified target behaviors of three boys with ASD. In addition, we examined whether changes in behavior occurred

during therapeutic riding sessions and if there was any carryover into the home and the community.

At first glance, dosing of therapeutic riding did not seem to have an obvious effect on the parent-identified targeted behaviors. In fact, Participant A showed improvement in 13/18 behaviors across the phases and environments; Participant B showed improvement in 12/18 behaviors; and Participant C showed improvement in only 11/18 behaviors. However, the statistical significance of the changes (magnitude) did vary based on dosage, with changes for the better and for the worse. For Participant A, 5/18 changes were significant: 4 were significantly better and 1 was significantly worse. For Participant B, 5/18 changes were significant: 3 were significantly better and 2 were significantly worse. For Participant C, 11/18 changes were significant: 7 were significantly better and 4 were significantly worse. Therefore, although increasing the dosage of weekly therapeutic riding sessions did not seem to impact the number of positive behavioral changes, it did impact the magnitude of those changes—primarily for the better.

We also sought to examine whether the target behaviors changed for the positive during the riding sessions, and if the benefits of the therapeutic riding sessions carried over to the home and community. For changes during the riding session between phases (A–B; B-A'), 2/3 behaviors each for Participants A and B changed for the worse or remained the same and 1/3 behaviors changed for the better, whereas 1/3 behaviors of Participant C changed for the worse, and 2/3 changed for the better. In contrast, even though some behaviors changed for the worse in each phase during the riding sessions, the impact of the riding sessions on the target behaviors in the home and community were uniformly positive. Of the 6 potential changes (3 behaviors × 2 phases), positive changes in the home and the community for Participant A were 6/6 and 5/6 respectively; for Participant B, the positive changes were 4/6 and 6/6 respectively, and; for Participant C, the positive changes were 4/6 for both home and community. Therefore, even though the target behaviors often exacerbated with the excitement during the therapeutic riding sessions, the carryover of the session effect on the target behaviors in the home and community was positive.

However, there were few changes in the standardized measures over the 3 months of the study. Each of the boys was scored as "mildly-moderately autistic" on the CARS at the beginning of the study. On the ABC-C measure, all three boys were scored lowest on the irritability scale, but all other scales were more indicative of severe symptoms. Likewise, for the SRS, most of the T-scores for each time period were in the severe range. Perhaps the CARS level of "mildly-moderately" versus severely autistic is associated with the number of scales on which the boys were scored as having "typical performance" for their ages in regard to sensory processing. According to the results of the SP-CQ throughout the study, for Participant A, four scales were rated as typical; for Participant B, seven scales; and for Participant C, three scales. Compared to the research norming sample, all three boys were typical for low endurance/tone, sensory sensitivity, and being sedentary. Two of the boys were also typical for emotionally reactive, and one boy for both oral sensory sensitivity and the fine motor/perceptual factors. Participants A and C were rated as having a "definite difference" in sensory processing from the research norming sample for two and three scales, respectively. Given that sensory issues are often thought to be a hallmark of children

diagnosed with ASD, “typical performance” in multiple factors of the SP-CQ was not surprising (Dunn, 1999), although those factors where there was a definite difference were consistent with ASD: sensory seeking, inattention/distractibility, poor registration, and fine motor/perceptual.

Of the nine target behaviors, one behavior involved verbal stereotypy (e.g., echolalia), six involved physical stereotypy (e.g., mouthing objects, pushing in nose), and two involved spontaneous verbalization. Of all the target behaviors, it was spontaneous verbalization that consistently increased between phases (A to B; A to A’) and each setting (riding, home, and community). Increased verbal communication was also mentioned by all three sets of parents during the goal-free evaluation at the end of the study. For each boy, communication with the instructor was a therapeutic riding goal, and this mostly consisted of verbalizing to the instructor what he wanted to do (e.g., trot, canter). The therapeutic riding instructor also required the boys to follow directions for the planned lesson first, before granting choices, and if the boys did not verbalize the choice accurately (e.g., 3 or more words), then the horse would stand still until they did. All parents reported consistent increases in verbalization at home and in the community over the Intervention and Withdrawal phases of the study. Likewise, for the same phases, all parents also reported that their boys improved at following directions at home and in the community, and associated it with the clear cause-effect linkage the boys experienced during their riding sessions: they had to follow the instructor’s directions if they wanted the horse to move, trot, or canter, which all of the boys enjoyed.

Changes in physical core strength and coordination were two other positive outcomes of the therapeutic riding program reported by parents, including improved abilities to sit up straight on the horse for a greater proportion of the session, manage the reins better, and stand up in the stirrups. Parents also commented on how their boys had learned to adjust their postures in response to their horse’s gait and rhythm, even if it was only to avoid a “bumpy” ride! Although they had not been target behaviors for any of the boys, each boy had “physical” goals as part of their therapeutic riding program.

Only two studies have been published on the use of therapeutic horseback riding for children with ASD (Bass et al. 2009; Wuang et al. 2010), and one study simulated horseback riding by using a gymnastic metal “horse” (Wuang et al. 2010). Bass et al. (2009) compared the social interactions of children with ASD who participated in a 12-h, 12-week therapeutic riding program versus those on a wait-list. They found that the social motivation scale of the SRS increased significantly for the children in the experimental group, as did four factors of the SP-CQ: sensory seeking, inattention/distractibility, sensory sensitivity, and sedentary. In contrast, our participants did not show meaningful changes over the phases of the 12-week study for the SRS, or for the sensory seeking and inattention/distractibility factors of the SP-CQ. However, our participants scored in the “typical performance” range for sensory sensitivity and sedentary factors across all phases of the study, with little room for improvement. Wuang et al. (2010) administered a 40-h, 40-week protocol using a crossover design with the experimental group receiving 21-h sessions/week on the simulated “horse” + traditional occupational therapy. The control group received traditional occupational therapy only, with conditions reversed at the 20-week point, and measures taken at weeks 1–2 (T1),

weeks 23–24 (T2), and week 44 (T3). Because Wuang et al. (2010) focused on the specific gross and fine motor skills of the Bruininks–Osteresky Test of Motor Proficiency (BOTMP; Bruininks 1978), and the Test of Sensory Integration Function (TSIF; Lin 2004), comparison of results is more difficult, especially since neither test is a parent report, but rather a therapist administered tool. Also, participants in the Waung et al. received 40 h of riding and 40 h of occupational therapy, whereas our Intervention consisted of either 4, 12, or 20 h of therapeutic riding at the most. Waung et al. found significant effect sizes for all BOTMP and TSIF items, for both the experimental and the control conditions at T2 and T3, although the effect sizes were larger for the experimental condition. Our participants' parents also reported that their children demonstrated improved strength and coordination as well as the ability to respond to the rhythm of the horses' movements, both of which could be categorized under the rubric of motor proficiency.

As with all studies, our study had limitations. Although the study met all criteria for a well-designed single subject study (Horner et al. 2005; Kazdin 2011), it still had only three subjects, and generalization becomes more limited to the inclusion criteria, demographics, and clinical characteristics of each of our participants. Also, the parents were not masked to the general purpose of the study, and also served as data collectors for target behaviors in the home and community. Because each of the participants had ridden once a week for about 1 year, they had already mastered any fear associated with approaching, grooming or riding a horse. Future studies should include larger samples, and gather more data on the impact of confounding factors during each phase of the study. The use of a goal-free evaluation can provide further evidence of the parents' perceived positive outcomes of a therapeutic riding program for children with ASD when it is conducted by a certified and registered instructor.

This study sought to fill in gaps on previous therapeutic riding studies of children with ASD by including parent-identified target behaviors, dosing, and generalization of effect to the home and community. Of the 27 target goals (3 per boy × 3 settings × 3 boys), 70 % of goals were better during Intervention compared to Baseline, and 63 % of goals remained better during Withdrawal compared to Baseline. Dosing of therapeutic riding was associated positively with the magnitude of changes in target behaviors, but not the number of behavioral changes. Additionally, even though target behaviors worsened during the excitement of the riding sessions, the effect of the sessions generalized positively to the home and community for physical stereotypy behaviors and spontaneous verbalization, but not for verbal stereotypy behaviors. Single subject design was an effective, yet intense, method of establishing evidence for an Intervention that has the potential to increase positive behaviors and reduce negative behaviors in children with ASD.

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Table 1

Examples of therapeutic riding goals for students in the study

Physical
The student will learn to canter
The student will learn to post the trot
The student will learn the rhythm of the trot
The student will learn to balance independently at the trot
The student will learn to keep an upright neutral position at the trot
The student will learn to keep an upright neutral position with his leg underneath him at the trot
The student will learn two point positions
The student will learn to balance through transitions
The student will learn to transition between two-point and posting trot
The student will learn to hold onto the saddle for canter transitions
Emotional/behavioral
The student will become more comfortable with the horse
The student will learn to groom his horse
The student will learn to touch his horse appropriately
The student will learn the body parts of the horse
The student will follow directions upon being first asked with no additional prompts
Cognitive
The student will develop communication systems with the horse and instructor
The student will learn to use his leg aids
The student will learn to use his rein aids
The student will learn to use sentences to interact with the instructor

Table 2

Design of the study and measures taken before and after each phase

Pre-Baseline measures	Phase A Baseline measures	Post-Baseline measures	Phase B Intervention measures	Post-Intervention measures	Phase A′ Withdrawal measures	Post-Withdrawal measures
CARS	Count of parent-identified target behaviors observed during the riding session, in the home, and in the community	ABC-C	Count of parent-identified target behaviors observed during the riding session, in the home, and in the community	ABC-C	Count of parent-identified target behaviors observed during the riding session, in the home, and in the community	ABC-C
ABC-C		SRS		SRS		SRS
SRS		SP-CQ		SP-CQ		SP-CQ
SP-CQ						

CARS Childhood Autism Rating Scale, *ABC-C* Aberrant Behavior Checklist-Community, *SRS* Social Responsiveness Scale, *SP-CQ* Sensory Profile-Caregiver Questionnaire

Table 3

Screening and standardized assessments of change

Assessment	Participant A				Participant B				Participant C			
	Pre-study	A	B	A′	Pre-study	A	B	A′	Pre-study	A	B	A′
CARS	37				32				31			
ABC-C (lower = better)[a]												
Irritability	60	70	85	75	60	70	50	60	80	60	70	60
Lethargy	90	95	85	80	80	80	75	75	95	95	80	75
Stereotypy	95	90	90	90	90	90	85	90	95	95	90	85
Hyperactivity	98	90	95	85	80	90	70	85	95	90	95	80
Inappropriate speech	95	98	95	95	95	95	95	95	98	98	98	98
SRS (lower = better)[b]												
Social Awareness	81	78	81	81	72	75	62	62	81	78	72	78
Social Cognition	88	≥ 90	88	90	63	68	61	63	≥ 90	90	81	≥ 90
Social Communication	80	≥ 90	85	70	77	81	74	76	86	84	79	83
Social Motivation	63	75	54	78	75	80	65	68	78	82	80	83
Autistic Mannerisms	80	≥ 90	90	78	87	90	75	78	85	80	80	78
SRS total	83	≥ 90	85	82	79	84	72	74	≥ 90	88	83	86
SP-CQ factors (TP > PD > DD: higher is better)[c]												
Sensory seeking	DD	DD	DD	DD	DD	TP	TP	TP	DD	DD	DD	DD
Emotionally reactive	TP	TP	TP	TP	TP	TP	TP	TP	PD	PD	PD	TP
Low endurance/tone	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP
Oral sensory sensitivity	TP	DD	PD	TP	TP	TP	TP	TP	PD	PD	PD	TP
Inattention/distractibility	DD	DD	DD	DD	PD	PD	TP	TP	PD	PD	PD	PD
Poor registration	PD	DD	DD	DD	TP	TP	TP	TP	DD	DD	DD	DD
Sensory sensitivity	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP
Sedentary	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP
Fine motor/perceptual	TP	PD	DD	PD	TP	TP	TP	TP	DD	DD	DD	DD

Pre-study = Pre-Baseline measure, A = Post-Baseline measure, B = Post-Intervention measure, A′ = Post-Withdrawal measure, CARS = Childhood Autism Rating Scale, ABC-C = Aberrant Behavior Checklist-Community, SRS = Social Responsiveness Scale, SP-CQ = Sensory Profile-Caregiver Questionnaires

[a] Severity of symptoms is indicated with percentile scores. Because the tool is measuring aberrant behaviors, lower percentile scores are better

[b] Severity ranges are indicated by T-scores: T-scores of 59 or less indicate a Normal range, T-scores of 60 through 75 indicate a Mild to Moderate range, and T-scores of 76 or higher indicate a Severe range. The SRS Total T-score is comprised of five subscale results that assess Social Awareness, Social Cognition, Social Communication, Social Motivation, and Autistic Mannerisms

[c] Interpretations of raw scores indicate: TP = typical performance (≤1 SD below the national research sample mean), PD = probable difference (≤2 SD but >1 SD below the national research sample mean); DD = definite difference (>2 SD below the national research sample mean)

Table 4

Summary of observed measures of change for participant A: mean levels and C-statistics

Participant A	Changes phase A to phase B					Changes phase A to phase A'				
Target behaviors	Phase A	Phase B	Change?	C-statistic		Phase A	Phase A'	Change?	C-statistic	
	M (SD)	M (SD)		Z score	SIG	M (SD)	M (SD)		Z score	SIG
Tenses/clenches facial muscles										
Riding	14.13 (11.41)	22.13 (12.30)	Worse	0.86	ns	14.13 (11.41)	15.38 (7.91)	Worse	1.33	ns
Home	10.25 (4.73)	6.50 (5.05)	Better	0.94	ns	10.25 (4.73)	6.66 (4.27)	Better	0.82	ns
Community	5.58 (3.70)	3.08 (3.20)	Better	−1.32	ns	5.58 (3.70)	5.08 (5.87)	Better	−1.71	Sig
Snaps fingers										
Riding	32.50 (20.71)	54.38 (40.63)	Worse	1.57	ns	32.50 (20.71)	33.00 (28.96)	Worse	0.86	ns
Home	10.50 (4.48)	8.50 (4.40)	Better	0.28	ns	10.50 (4.48)	8.25 (4.07)	Better	1.27	ns
Community	5.67 (3.73)	3.33 (3.22)	Better	−1.82	Sig	5.67 (3.73)	6.17 (6.51)	Worse	−1.76	Sig
Spontaneous verbal communication of wants/needs; any number of words										
Riding	5.13 (4.70)	22.25 (10.41)	Better	*3.36*	*Sig*	5.13 (4.70)	47.13 (30.59)	Better	*1.48*	*ns*
Home	12.75 (9.20)	14.25 (9.70)	Better	*0.76*	*ns*	12.75 (9.20)	21.58 (9.69)	Better	*2.10*	*Sig*
Community	5.92 (3.92)	8.50 (6.57)	Better	0.32	ns	5.92 (3.92)	10.67 (7.80)	Better	−1.05	ns

Phase A = Baseline; Phase B = Intervention; Phase A' = Withdrawal; SIG = significance; Sig = significant; ns = not significant; Italicized = data were autocorrelated

Table 5

Summary of observed measures of change for participant B: mean levels and C-statistics

Participant B	Changes phase A to phase B					Changes phase A to phase A'				
Target behaviors	Phase A	Phase B	Change?	C-statistic		Phase A	Phase A'	Change?	C-statistic	
	M (SD)	M (SD)		Z Score	SIG	M (SD)	M (SD)		Z Score	SIG
Pounding on surfaces										
Riding	0.00 (0.00)	0.86 (1.68)	Worse	2.89	Sig	0.00 (0.00)	0.00 (0.00)	No change	–	–
Home	23.16 (24.88)	2.50 (2.24)	Better	1.48	ns	23.16 (24.88)	1.00 (2.89)	Better	1.61	ns
Community	9.58 (11.16)	1.08 (1.44)	Better	*3.31*	*Sig*	9.58 (11.16)	0.17 (0.58)	Better	*3.42*	*Sig*
Pushing in nose										
Riding	0.50 (0.75)	0.29 (0.46)	Better	1.41	ns	0.50 (0.75)	0.13 (0.35)	Better	1.13	ns
Home	4.17 (4.04)	2.83 (2.12)	Better	−0.44	ns	4.17 (4.04)	2.92 (2.81)	Better	0.13	ns
Community	4.83 (4.69)	1.33 (1.07)	Better	2.07	Sig	4.83 (4.69)	2.92 (2.81)	Better	1.54	ns
Clapping										
Riding	0.25 (0.71)	10.71 (12.46)	Worse	1.93	Sig	0.25 (0.71)	1.13 (1.64)	Worse	0.74	ns
Home	5.75 (6.32)	7.08 (6.29)	Worse	−1.31	ns	5.75 (6.32)	8.42 (8.21)	Worse	0.48	ns
Community	6.58 (3.55)	5.58 (3.34)	Better	−0.64	ns	6.58 (3.55)	5.92 (3.68)	Better	−0.38	ns

Phase A = Baseline; Phase B = Intervention; Phase A' = Withdrawal; SIG = significance; Sig = significant; ns = not significant; Italicized = data were autocorrelated

Table 6

Summary of observed measures of change for participant C: mean levels and C-statistics

Participant C	Changes Phase A to Phase B					Changes Phase A to Phase A'				
Target behaviors	Phase A	Phase B	Change?	C-statistic		Phase A	Phase A'	Change?	C-statistic	
	M (SD)	M (SD)		Z Score	SIG	M (SD)	M (SD)		Z Score	SIG
Echolalia/scripting										
Riding	16.13 (7.51)	34.00 (15.26)	Worse	2.75	Sig	16.13 (7.51)	51.86 (15.29)	Worse	1.87	Sig
Home	13.50 (3.55)	15.08 (4.10)	Worse	2.00	Sig	13.50 (3.55)	16.41 (4.54)	Worse	0.69	ns
Community	10.33 (3.67)	13.91 (5.16)	Worse	1.12	ns	10.33 (3.67)	13.00 (3.10)	Worse	2.07	Sig
Mouthing fingers/hands and objects										
Riding	18.13 (10.41)	6.78 (6.17)	Better	2.93	Sig	18.13 (10.41)	21.88 (33.80)	Worse	−0.61	ns
Home	8.08 (5.23)	3.75 (2.70)	Better	1.86	Sig	8.08 (5.23)	1.75 (1.48)	Better	2.64	Sig
Community	6.58 (4.76)	2.92 (2.78)	Better	1.44	ns	6.58 (4.76)	0.17 (0.58)	Better	2.71	Sig
Verbal demands of 3 words or more										
Riding	4.25 (4.17)	19.5 (11.26)	Better	4.93	Sig	4.25 (4.17)	20.50 (12.50)	Better	2.00	Sig
Home	3.42 (0.90)	4.08 (0.99)	Better	−0.68	ns	3.42 (0.90)	5.83 (1.70)	Better	2.85	Sig
Community	3.17 (1.47)	4.08 (2.19)	Better	1.04	ns	3.17 (1.47)	5.92 (2.61)	Better	0.81	ns

Phase A = Baseline; Phase B = Intervention; Phase A' = Withdrawal; SIG = significance; Sig = significant; ns = not significant; Italicized = data were autocorrelated