

**THE EFFECTS OF HIPPO THERAPY ON MOTOR ABILITIES AND SOCIAL  
COMMUNICATION FOR CHILDREN WITH ASD DIAGNOSIS**

by

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Distinction

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## **ABSTRACT**

Due to the increasing number of children diagnosed with ASD, alternative forms of therapy, such as hippotherapy, are becoming more popular. This study aimed to investigate the impact of hippotherapy treatment on 4 children age ( $5.33 \pm 1.6$ ) with an ASD diagnosis. Social communication was evaluated by video recording 8 weeks of hippotherapy sessions and coding for all verbalizations on days 1, 4, and 8 using Datavyu software. Additional social communication data was retrieved from using a joint attention test (JTAT) pre-and post-treatment. Motor data was achieved from the Bruininks-Osteresky Test of Motor Proficiency (BOT), administered pre-and post-treatment. Results concluded increases in the quality of language spoken across the course of treatment for all 4 participants. Slight increases in JTAT results was also observed for most subjects. Motor results could deduce an increase in Manual Dexterity for the participants that completed that testing. Future studies should utilize large sample sizes of which no subjects have had prior hippotherapy treatment. Additionally, future research into hippotherapy and ASD should evaluate behavioral changes across treatment. Hippotherapy intervention was determined to have aided in the increase in social communication and manual dexterity of the participants in this study.



## **Chapter 1**

### **OVERVIEW OF AUTISM SPECTRUM DISORDER AND HIPPO THERAPY**

#### **1.1 Autism Spectrum Disorder**

Autism Spectrum Disorder (ASD) is a developmental disability that causes impairments social communication, repetitive behaviors, and motor impairments (4). ASD is also referred to an intellectual disability or a neurological disorder. Recently, the ASD diagnosis has come to include multiple diagnoses that were previously separate including: autistic disorder, PDD-NOS (pervasive developmental disorder not otherwise specified) and Asperger syndrome (4). This shift in labeling diagnosis by the DSM-5 (The American Psychiatric Association's Diagnostic and Statistical Manual, Fifth Addition) came about to encompass the spectrum of autism due to the disorder's variation between individuals. Autism Spectrum Disorder has had a significant increase in diagnosis in recent years.

As of 2012, the CDC has estimated that 1 in 68 children were diagnosed with ASD (4). In 2000, the prevalence of ASD was only 1 in 150 children (4). Researchers are unable to definitively explain this sharp increase in recent years, although hypotheses exist. Those diagnosed with ASD have been reported from every racial and ethnic group, as well as all socioeconomic cohorts (4).

Per the DSM-5, individuals with ASD display consistent impairments in social communication (4). Those with ASD struggle with both verbal and nonverbal communication which leads to difficulty in sustaining relationships (4). Children and adults with ASD have also shown impairments in motor functioning (5).

In comparison to their age-matched counterparts, those with ASD perform worse in lower-limb coordination tasks that require balance, as well as speed and agility (5). Postural control is also impacted by an ASD diagnosis that can carry into adulthood. Specifically, children have trouble with both static and dynamic postural control in addition to balance (10). One explanation for limitations in postural coordination is sensory modulation disorders. Sensory modulation disorders are described as trouble processing and executing behavior in response to outside stimuli like sound or touch (5). When proprioceptive or somatosensory feedbacks are limited, those with ASD display notable postural unsteadiness (10). There is also a link between social impairments and motor impairments for children with ASD (5).

The Journal of American Physical Therapy Association ascertains that the link between social and motor impairments is based upon an ecological dynamic systems perspective (5). In summary, this perspective emphasizes the importance of daily exploration and contact with the environment to fully develop both socially and physically (5). Research has shown that a lack of coordination or movement in young children leads to a lack of participation in social interaction, causing a cyclic delay in motor and social development (5). Although no cure exists for ASD, there are treatments that can address both the social and motor developmental needs of those with the diagnosis (4).

## **1.2 Hippotherapy**

There are behavior and communication interventions for ASD, including Applied Behavior Analysis (ABA), however they do not dually address motor impairments (4). Hippotherapy is a treatment that can specifically address the needs of

those with ASD. Literally defined, hippotherapy means the aid of a horse for therapy (8). Hippotherapy is a treatment used by occupational therapists, physical therapists, and speech pathologists (1). The therapy utilizes the natural, rhythmic, motion of a horse to engage specific sensory and motor input for riders (7). Patients mount the horse, which is led by a horse handler. On either side of the horse are sidewalkers who provide physical and functional support to the rider (1). The therapist guides the session by directing the handler when and how to alter the horse's movement and by directing the sidewalkers on how to support the patient. Hippotherapy can be used as a treatment for many adults and children with conditions like ASD, Down syndrome, cerebral palsy, spinal cord injury, or stroke (7). There is confusion in the field about the different types of therapy involving horses and it is crucial to understand the difference.

Hippotherapy is categorized under what is referred to as equine-assisted activities and therapies (EAAT) (3). Therapeutic riding (TR), which is also considered under EAAT, is vastly different, but often confused with hippotherapy. Therapeutic riding is directed by a professional horseback-riding instructor, while hippotherapy is directed by a licensed occupational, physical, or speech therapist (7). In hippotherapy, a therapy horse is thoughtfully screened based on movement and temperament, however in therapeutic riding, the horses are not subject to any standardized screenings (7). Therapeutic riding may be conducted in a group or individual setting whereas hippotherapy is always individual (7). The most important difference between TR and hippotherapy is the goal. In TR, the goal is for the rider to develop proper riding skills (7). The goal of hippotherapy is to improve neurological functioning, which can influence motor skills or cognitive skills (7). Hippotherapy specifically has

shown in research to incite positive changes in social communication and behavior for those with ASD.

### **1.3 Literature Review**

#### **1.3.1 Social and Behavioral Changes for ASD Patients After Hippotherapy**

Tabares et al. (2012) reported a significant change in hormone levels that improved social attitudes in children with ASD. In this study, cortisol and progesterone levels were taken before and after a hippotherapy intervention for eight children between the ages of 8 and 16 with an ASD diagnosis (10). Participants completed 4 sessions, one per week for one month, and their cortisol and progesterone levels were measure before and after each session by salivary samples (10). Results of the study indicated significant decreases in cortisol after just one hippotherapy session (10). Cortisol decreased even further after 4 weeks of hippotherapy (10). The cortisol-progesterone balance also decreased similarly (10). The decrease in cortisol and increase in progesterone levels as a result of hippotherapy are indicative of an improvement in social attitudes in the participants with ASD (10).

Taylor et al. (2011) completed a single-case design study of how hippotherapy impacts motivation or volition in children with autism. The study focused on 3 children who completed 16 weeks of hippotherapy treatment (12). A play activity was used to elicit interactions with the participants (12). To evaluate volition, Taylor et al. (2011) used the Pediatric Volitional Questionnaire (PVQ) that was completed by two occupational therapists. Overall, all 3 participants had markedly improved volition based on pre, mid, and post testing PVQ scoring (12). This study reported that

improvements in volition could be an under-valued effect of hippotherapy (12). There is literature that suggests that increased volition or motivation may have a large impact on communication (9).

### **1.3.2 Motor Changes for Children with ASD after Hippotherapy**

The highly referenced pilot study by Ajzenman et al. (2013) evaluated motor control after hippotherapy intervention for six children with ASD. Participants were ages 5 to 12 years old with a primary diagnosis of ASD and no confounding physical limitations (2). The participants completed 12 weeks of 45 min hippotherapy sessions directed by a PATH-certified instructor (2). One week prior to and one week after hippotherapy intervention postural control was measured using a force plate and an eight-camera video motion capture (VMC) system (2). Participants were instructed to stand on the force plate while being recorded by the VMC system (2). Using Cortex software, Ajzenman et al. (2013) calculated center-of-mass (COM) and center-of-pressure (COP) as well as COP anteroposterior sway, mediolateral sway, sway path length, and movement variability during static postural control. Results comparing pre-and post hippotherapy treatment indicated a significant enhancement in postural stability, or balance (2). Anteroposterior sway decreased significantly for both COP and COM post intervention, as did movement variability of sway area (2). There were also significant decreases in sway path length and sway area for COP and COM post intervention (2).

Giagazoglou et al. (2012) investigated the effect of hippotherapy on static balance in children with intellectual disabilities (ID). The study design included a control and experimental group, each of which contained 9 to 10 participants with ID (6). The control group followed their normal routine, while the experimental group

received 10 weeks of hippotherapy (6). To measure balance, an EPS pressure platform was used and recorded plantar pressure (6). Participants were asked to complete Double-Leg Stance (DLS) with closed and open eyes and One-Leg Stance (OLS) with eyes open (6). Center of pressure (CoP) along both the medio-lateral and anterior-posterior were analyzed (6). Results of the OLS on the right leg indicated a significant Group x Time interaction for the maximum and standard deviation of CoP (6). Giagazoglou et al. (2012) explain that the significant improvements in ability to balance with OLS post intervention could be due in part to shifts in the sensory-motor stimulation that hippotherapy offers (6).

#### **1.4 Aim and Hypothesis**

The purpose of the current pilot study was to evaluate the impact of hippotherapy on social communication and motor abilities for children with ASD. We were interested in how social communication would change from beginning, to middle, to end of an 8-week period of hippotherapy treatment. We hypothesized that there would be increases in the quality as well as the spontaneity of social communication and decreases in meaningless communication. An increase in quality would be shown as a decrease in the use of approximation speech and an increase in language.

We also wanted to investigate the changes in balance and motor abilities before and after hippotherapy intervention. Motor data was retrieved from the Bruininks-Osteresky Test of Motor Proficiency (BOT).

## **Chapter 2**

### **METHODS AND PROCEDURES**

#### **2.1 Protocol and Research Design**

The study was designed as a simple pilot single group pre-posttest. Training was 8 weeks, 1 session per week, and pre-and post-testing measures were completed within 1-2 weeks of the start or end of training. Sessions 1, 4, and 8 were coded for verbiage and social communication using Datavyu software. Additional data on communication was acquired by using a joint attention test (JTAT). Motor testing protocol included the use of the BOT (Bruininks-Osteretsky Test of Motor Proficiency). The BOT and JTAT were administered pre-and post-testing either by Dr. Anjana Bhat, MS, PT, PhD or a qualified graduate student of the Move to Learn Innovation Lab.

All individuals involved in the study and with access to video files of the training completed minimally the CITI (Collaborative Institutional Training Initiative) Course In the Protection Human Subjects and the Responsible Conduct of Research course. The study received International Review Board (IRB) approval through the university on 8/18/2015.

All participants were minors and thus consent forms were completed prior to pretesting by the parents. Additionally, an assent form was completed for each session to ensure the child's willingness to participate.

### **2.1.1 Participants**

The 4 participants were school-aged children (average age  $5.33 \pm 1.6$ ) that were current clients of Lauren Janusz, MOT, OTR/L. All participants were asked to show confirmation of an ASD diagnosis through a medical profession or through school documentation. Additionally, 2 participants had a dual diagnosis. One subject had a diagnosis of ASD and Williams Syndrome while the other had a diagnosis of ASD and ADHD. One participant (Child 4) was considered to have high-verbal functioning while the rest had low-verbal functioning. Of the 4 participants, 75% identified as Caucasian and 25% as African American. The sample was a convenience sampling of 4 participants who had about  $1.43 \pm 1.53$  years of previous hippotherapy exposure. Child 1 had about 2.5 years of treatment, but not consistently. Child 2 had 0.08 years of hippotherapy. Child 3 had 0.15 years of previous hippotherapy. Child 4 had 3 years of previous hippotherapy, but not during the summer months. Child 1 and Child 4, who had the longest previous exposure to hippotherapy had both taken at least a 2 to 3-week hiatus prior to the beginning of this study.



ID #	Gender	Age	Diagnosis	Race	Verbal Level	Other services (speech, PT)	Onset of Hippotherapy
41233	M	5 yrs	ASD, Williams Syndrome	White	low	OT, PT, Speech 90 min/wk each. ABA+RDI, 3 hrs/wk	10/26/13 (seasonal breaks)
41243	M	3 yrs 9 mo	ASD	White	low	ABA (5d/wk), Speech Th (3 d/wk), Hippo (1d/wk)	4/7/16
41253	F	5 yrs	ASD	African American	low	Speech (1d/wk, 1 hr), ABA-None, OT (1 hr /wk)	5/4/16
41563	M	7 yrs 7 mo	ASD, ADHD	White	high	N/A	10/26/13 (breaks in summer)

Table 1 Demographics and Information on Participants

## 2.2 Training Protocol

All 8 hippotherapy sessions were administered by either Lauren Janusz, MOT, OTR/L or Brooke Zuvich, COTA. Lauren Janusz is a licensed occupational therapist with 17 years of experience and has owned and operated her business, Brandywine Occupational Therapy LLC, for the past 6 years where she has been using hippotherapy to treat her clients. She is a Board Certified Clinical Specialist in Hippotherapy. Lauren Janusz was also a member of the American Hippotherapy Association committee that put together the “best practice guidelines”. All training sessions were completed at Wellspring Farm in Bellevue State Park located in Wilmington, DE. Most sessions were completed outdoors, although due to weather constraints, some sessions had to be completed in an indoor arena.



Figure 1. Indoor Arena. Alternative area in which hippotherapy sessions were completed with weather limitations.



Figure 2 Outdoor Arena. Main area in which hippotherapy sessions were completed.

For every session, the child wore a sized helmet for safety and rode on the horse with what is called a bareback pad. The pad was thin enough that the participants could receive the maximum amount of sensory feedback from the horse's movement, but thick enough to be comfortable.



Figure 3 Bareback pad with surcingle on horse

Each session included a group of individuals aiding in the therapy. The therapist, either Lauren Janusz or Brooke Zuvich, a horse leader, and 1-2 side walker(s) were present. There were sessions where students were present and aided in activity portions by holding equipment or toys. The horse leader, therapist, and side walker(s) all had interactions with the participants (see Appendix A Hippotherapy Training Manual for details of training).

### **2.2.1 Conditions of Training**

All sessions followed the same chronological format of conditions. Each session began with a play activity. For sessions 1, 4, and 8, the play activity was the same for all participants and required the participant to choose between a red or blue ball and engage in a reciprocal game of catch including 5 attempts at catching and throwing. Participants then mounted the horse and completed a warm up, which

included a brief walk through an outdoor trail or around the indoor arena. The hippotherapy condition of the training included school figures. School figures in the equine setting describe the circular or figure-8 repeated movement of the horse. Additionally, pace changes were included in the hippotherapy condition. Pace changes were abrupt starts and stops of the horse. Participants also engaged in position changes, including facing their body forwards, backwards, to the left side, and to the right side. Each session also included a goal-oriented activity geared towards the specific goals each participant had as set forth by the hippotherapist. All hippotherapy activity was completed in the indoor arena, outdoor arena, or a large open space of level grass area. Throughout each session, the occupational therapist prompts the subject with verbal questions during each condition.

A Training Diary was completed for every session documenting the day, duration, theme, trainer, participant's affect, list of conditions, difficulty level, participant enjoyment, challenges, and additional notes about the training.

Week 1					
Categories	Monday	Tuesday	Wednesday	Thursday	Friday
Session completed (Circle one)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Session duration (min)					
Session theme(s)					
Trainer: (P)arent/(C)aregiver/ (E)xpert trainer					
Affect during entire session: (H)appy/ (N)eutral/ (D)isinterested/ (U)ncooperative					
Check off the conditions completed	Play activity/SB Warm up (trail) School figures Pace changes (st/stops) Position changes Activity	Play activity/SB Warm up (trail) School figures Pace changes (st/stops) Position changes Activity	Play activity/SB Warm up (trail) School figures Pace changes (st/stops) Position changes Activity	Play activity/SB Warm up (trail) School figures Pace changes (st/stops) Position changes Activity	Play activity/SB Warm up (trail) School figures Pace changes (st/stops) Position changes Activity
How difficult was this session? (E)asy/(M)oderately difficult/ (V)ery difficult					
Were the provided materials appropriate? (Circle one)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Did your child enjoy the session? (Circle one)	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
List the activities your child found challenging					

Figure 4 Training Diary Example Training Diary consisting of all conditions and details of each session to ensure continuity.

### 2.2.2 Coding Protocol for Social Communication Variable

All video recorded sessions were documented using a camcorder. After the video recording of 8 weeks for 3 participants, video footage of the 1<sup>st</sup>, 4<sup>th</sup>, and 8<sup>th</sup> sessions were coded using Datavyu software. Each participant was assigned an identification code that corresponded as the following:

Child	ID
1	41233
2	41243
3	41253
4	41263

Table 2 Child number and corresponding code

First videos were coded based on the conditions of the session. The conditions in chronological order used were as follows: “play”, “mount”, “null1”, “hippo”, “activity”, “null2”, “post/treat”. “Play” represents the time in which the subject is asked to choose a red or blue ball and engages in 5 reciprocal tosses with the trainer. The “play” condition took place in what is referred to as the “Tube”, which is a semi-enclosed indoor space in which every session begins and ends. “Mount” is the time from which the subject begins to ascend the mounting block stairs until the horse begins to walk. During this condition the subject must ask the horse leader if the horse is ready for them to mount. “Null1” is representative of the time after mounting while the horse, subject, trainer, and side walker(s) are traveling to the area in which the hippotherapy condition will take place. During this time the child is only facing forward and serves as a warmup for all involved in the session. “Hippo” represents the onset of any hippotherapy activity. This includes position changes, meaning the subject faces a direction other than forward, abrupt starts and stops, or the formation of school figures, like a figure 8, made by the horse.

“Activity” describes the condition in which the horse comes to a stop and the subject engages in an activity, designed by the therapist/trainer, with varying goals. Activities are meant to encourage a variety of skills. For example, encourage the subject to cross midline while reaching, practice fine motor skills, or enhance motor

planning. All activities are also designed to increase communication. “Null2” denotes the time from the end of the activity while the subject is front facing, and the trainer, horse and side walker(s) are traveling back to the Tube. “Post/treat” represents the moment the subject dismounts the horse and prepares a peppermint treat for the horse. The preparation includes retrieving a bucket and a small container with the peppermint candies. The subject opens the candies, places them in the bucket, and calls the horse to retrieve it. This condition, and the session altogether, ends after the subject is told to say “good bye” and “thank you” to the leader and or side walker(s).








Condition	Description	Image
Play activity	Child chooses red or blue ball; 5 reciprocal attempts of catch/throw	
Mount	Child asks permission and mounts horse	
Null1/warm up	Walk to area where hippotherapy will take place; warm up for horse and child	
Hippotherapy	Begins with either starts/stops, position changes, school figures or combination of any	
Activity	Specific goal-oriented activity designed by the therapist; takes place on the horse	
Null2	Walk back to activity area	
Post/treat	Child dismounts, prepares treat, thanks horse leader and <u>side walker(s)</u>	

Figure 5 Hippotherapy Session Conditions with Images and Description

Following the temporal coding of the various conditions of each session, verbalizations were then coded under the same file in Datavyu. Every verbalization during the duration of the session was coded. Verbalizations were considered utterances by the subject in an attempt to communicate. Verbalizations differ from vocalizations, which were considered as noises or sounds with no intent of communication. Vocalizations included cries, yells, and stimming and were not coded.

Verbalizations were coded based on a coding scheme developed by Anjana Bhat, Stephanie Paoletti, and the first author. The coding scheme included a “primary code”, a “secondary code” and a “tertiary code”. The primary code denoted the quality of the verbalization. Every verbiage was labeled with at least a primary and secondary code, while others required a tertiary code.

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condition	code
1 00:00:00:000 00:04:13:299 (play)	1 00:00:00:000 00:00:38:900 (q)
2 00:04:13:300 00:04:43:632 (mount)	2 00:00:38:901 00:00:39:766 (JSM)
3 00:04:43:633 00:07:08:669 (null1)	3 00:00:39:767 00:02:20:133 (q)
4 00:07:08:670 00:21:27:133 (hippo)	4 00:02:20:134 00:02:20:799 (WR)
5 00:21:27:134 00:26:15:700 (activity)	5 00:02:20:800 00:03:54:866 (q)
6 00:26:15:701 00:27:44:400 (null2)	6 00:03:54:867 00:03:56:166 (JRM)
7 00:27:44:401 00:30:19:334 (post/treat)	7 00:03:56:167 00:04:19:367 (q)
8 Click to create new cell	8 00:04:19:368 00:04:20:199 (JRM)
	9 00:04:20:200 00:04:21:433 (q)
	10 00:04:21:434 00:04:22:700 (ARP)
	11 00:04:22:701 00:04:25:533 (q)
	12 00:04:25:534 00:04:26:266 (ARP)
	13 00:04:26:267 00:04:35:666 (q)
	14 00:04:35:667 00:04:36:266 (WR)
	15 00:04:36:267 00:04:39:832 (q)
	16 00:04:39:833 00:04:40:500

Figure 6 Example of Datavyu Coding for D8 of Training. All conditions were coded in the left column then each verbalization was timed/coded as depicted with the appropriate label.

The primary codes included *T*, *H*, *W*, *A*, *J*, and *Q*. *T* represented a full sentence consisting of more than 4 words. *H* represented a verbalization of 3 to 4 words. *W* represented a phrase of 1-2 words. *A* represented an approximation of a word. For example, the verbalization “ba” to communicate the word “ball” was considered an approximation. *J* represented jargon, which was an attempt at communication, but was not understandable and resembled babbling. *Q* meant that the subject was silent or quiet.

All primary codes were labeled additionally with a secondary code. The secondary codes were *S* and *R*. *S* represented verbiage that was spontaneous, meaning

it was unprovoked by the trainer or side walker(s). *R* represented verbiage that was responsive. Only the codes *A* and *J* received an additional tertiary code. The tertiary codes were *P* and *M*. *P* represented that the verbiage was purposeful while *M* meant that the verbiage was meaningless. The tertiary code was implemented to distinguish between jargon/approximations that were random and unimportant and those that were a purposeful attempt to communicate.

Primary Code	Verbiage Meaning:
T*	Sentence
H*	3-4 words
W*	1-2 words
A**	Approximations of words (ba', ga')
J**	Jargon
Q	Quiet/silent
Secondary Code*	
S	Spontaneous
R	Responsive
Tertiary Code**	
P	Purposeful
M	Meaningless

Table 3 Primary, Secondary, and Tertiary codes with corresponding meanings

Based on the coding scheme there are 15 possible codes that a verbalization could be labeled with.

TS	spontaneous sentence
TR	responsive sentence
HS	spontaneous 3-4 word phrase
HR	responsive 3-4 word phrase
WS	spontaneous 1-2 word(s)
WR	responsive 1-2 word(s)
ASP	spontaneous, purposeful approx.
ARP	responsive, purposeful approx.
ASM	spontaneous, meaningless approx.
ARM	responsive, meaningless approx.
JSP	spontaneous, purposeful jargon
JSM	spontaneous, meaningless jargon
JRP	responsive, purposeful jargon
JRM	responsive, meaningless jargon
Q	quiet

Table 4 All Possible Codes and Meanings

***a.) Inter-Rater Reliability***

To establish adequate inter-rater reliability, an undergraduate research assistant and the first author coded various video files of hippotherapy sessions. A D1, D4, and D8 were selected randomly from the data videos, each corresponding to a different child to ensure that all subjects could be coded reliably. Once all 3 videos were coded using Datavyu by the assistant and the author separately, the results were processed through Matlab software to ensure that all the possible codes for verbalization (15 in

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total possible combinations resulting from the coding scheme) had a reliability of 80% or higher.

Three rounds of reliability attempts (denoted at R1, R2, R3, and R4) were completed before adequate inter-rater reliability was established. Reliability attempt 1 (R1) Matlab results showed that 40% of the 15 codes had a reliability of 80% or less. R2 resulted in only 6.6% of the codes with a reliability of 80% or less. For the following R3, all the 15 possible codes had a reliability of 80% or higher.

#### ***b.) Intra-Rater Reliability***

To ensure intra-rater reliability, the author coded the data videos previously selected for inter-rater reliability. This coding took place about 5 weeks later than initial coding. The videos were coded using Datavyu and the results were compared to the earlier coding to ensure 80% reliability. Matlab results indicated that all codes had a reliability of no less than 95%, thus only one round of reliability attempt was needed to establish intra-rater reliability.

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#### **2.2.2.1 Joint Attention Testing Protocol**

Additional data was acquired from the pre-and post-testing using a joint attention measurement (JTAT). The JTAT was designed and implemented in multiple studies direct by Dr. Anjana Bhat. The aim of the test is to quantify the quality of social communication prompts as they relate to joint attention. The test includes 9 conditions including: Handshake/Hi, Hand Pen, Poster Prompt, Novel Object, Personal Object, Hi-five, Lo-five, and Wave Bye. In each condition the subject is verbally and physically prompted to engage with the tester. The subject's responses are given a score based on if they complete the correct action, look at the tester's face,

engage in eye contact, smile, or verbally respond. Each condition is also graded on the subject's response level, including Level 1, Level 2, and Level 3.

### **2.2.3 Coding Protocol for Motor Variable**

The BOT consisted of 6 main subsets including: Bilateral Coordination, Balance, Strength, Fine Motor Precision, Fine Motor Integration, and Manual Dexterity. Each subset assessed various motor functioning for the child. For example, Bilateral Coordination evaluated the child's ability to coordinate upper and lower limbs, Balance evaluated postural control in various conditions. Fine Motor Integration appraised hand and finger control, Fine Motor Integration appraised the child's ability to synthesize visual input during motor control, and finally Manual Dexterity assessed the ability to manually employ small objects. Each condition was scored by the tester based on the subject's ability to complete the prompted tasks.

For the purpose of this study only the Manual Dexterity and Balance subsets were conducted because they correlate the strongest with the goals of the hippotherapy training administered by the occupational therapist. The Manual Dexterity and Balance subsets were administered pre-and post-testing and scored by Dr. Anjana Bhat.

## **Chapter 3**

### **RESULTS**

#### **3.1 Training Diary Results**

Using the Training Diary information, the percentages of sessions completed was calculated. Child 1 completed 62.5% of the 8 total sessions. Child 4 completed 87.5% of the total sessions, Child2 and Child 3 completed 100% of the sessions. Child 4 had a session cancelled due to a snow storm. The level of difficulty was also calculated using the Training Diary information. “Easy” was assigned a value of 1, “Moderate” was assigned a value of 2, and “Difficult” was assigned a value of 3. Child 1 had an average level of difficulty of 2, Child 2 had an average difficulty of 2, Child 3 had an average difficulty of 1.86, and Child 4 had an average of 1.93.

#### **3.2 Social Communication Results**

Following the coding of D1, D4, and D8 for all participants using Datavyu, the data was processed using Matlab. Participant 41233 could not complete all the training sessions due to scheduling conflicts with the family and thus data from only D1 and D4 was included. To evaluate if hippotherapy led to an increase in the quality of verbalization, the data was separated into time spent in “Language” or time spent in “Approximations”. Time spent in “Language” included all verbalization that was words, phrases, or sentences. This corresponds to all codes with the primary label T, H, or W. The Matlab software calculated the amount of time in minutes that each child in a given video spent verbalizing the following codes considered as “Language”: TS,

TR, HS, HR, WS, and WR. Time spent in “Approximations” was categorized as verbalization that was an approximation or jargon. This included all codes with the primary label of A or J. The software calculated, per video, the amount of time spent in “Approximations” which included the following codes: ASP, ARP, ASM, ARM, JSP, JSM, JRP, and JRM.

From this data, we could identify how much time in each video that a subject spent verbalizing. We then calculated the percentage of time spent in “Language” and percentage of time spent in “Approximation” out of the subject’s total time verbalizing. These percentages do not reflect time spent “Quiet” (not verbalizing). The following figure depicts this data for each child respectively across D1, D4, and D8.

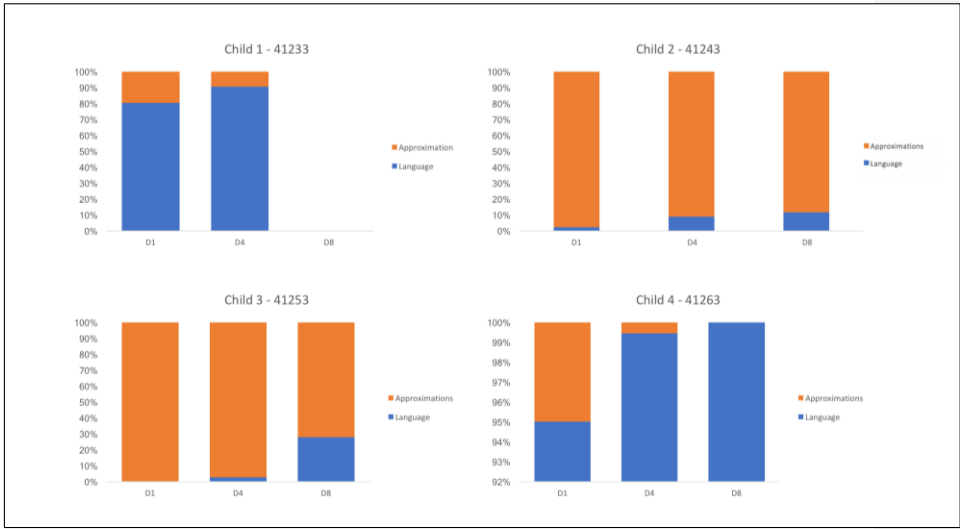


Figure 7 Percentage of Verbalization Time Spent in “Language” or “Approximations” For Each Child

Figure 7 shows positive results for all 4 participants in which the percentages of “Language” increase from beginning to end of training and percentages of “Approximations” decreased across training.

Child 1, who dropped from the study too soon to complete D8 had an increase in their percentage of time spent verbalizing “Language” from D1 to D4 going from 80.4 % Language to 90.6 % Language. Child 1 also had a notable decrease in “Approximation” percentage. On D1, Child 1 spent 19.6 % of verbalization time in Approximation; this decreased to only 9.3 % in D4.

Child 2 showed substantial decreases in Approximation time and increases in Language time. Child 2’s Language percentage increased from 2.3% on D1, to 9.0% on D4, to 11.7% on D8. Child 2 decreased their percentage of verbalization time in Approximation as well. On D1 Approximation percentage was at 97.6%, D4 decreased to 91.0%, and D8 dropped further to 88.3%.

Data from Child 3 indicated that they had the greatest improvements in percentages of Language and Approximations. On D1, Child 3’s Language percentage was at 0%, increasing to 2.9% on D4, and increasing significantly to 28.1% on D8. In terms of Approximation percentage, Child 3 had the greatest decrease out of all participants. Child 3 spent 100% of D1 verbalizing in Approximations, decreasing to 97.1% on D4, and decreasing again to 71.9% on D8.

Child 4, despite being at a higher verbal capacity than the other participants, also had increases in Language and decreases in Approximation percentages. For Language, Child 4 spoke in Language 95% of verbalization time, then at 99.5% on D4, and finally at 100% on D8. Thus, Approximation percentages decreased across



training. On D1, Child 4 spoke in Approximation about 5.0% of verbal time, then decreasing to 0.55% by D4, and ultimately to 0% by D8.

Additional information was gathered to determine a trend between the rate of Language verbalization and the rate of Approximation verbalization. The rate was determined by using the *number* of codes that were considered Language, including every occurrence of TS, TR, HS, HR, WS, and WR in a video and dividing that number by the amount of *time* a child spent speaking in Language. The same technique, dividing the number of codes (ASP, ARP, ASM, ARM, JSP, JSM, JRP, and JRM) by the time spent in those codes, was used to determine the rate of Approximation as well. The units for both Language and Approximation rate is occurrences (or times) per minute. The unit emphasizes that the rate reflects the number of times per minute that a subject spoke in Language or in Approximation during a given session.

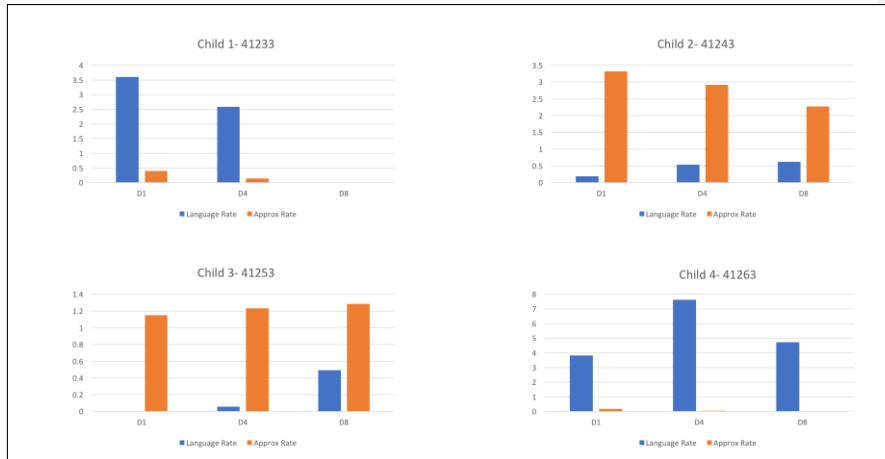


Figure 8 The Rate of Language and Approximation Verbalizations for Each Subject Across Training

Figure 8 elaborates on the inference that Language increased while Approximation verbalization decreased. Half of the subjects (Child 2, Child 3) showed increases in Language and  $\frac{3}{4}$  of the subjects showed decreases in Approximation verbalization.

Child 1's Approximation rate decreased from 0.40 times per minute on D1 to 0.14 times/min on D4. Interestingly, Child 1's Language rate showed a decrease from D1 to D4. On D1, Language rate was 3.6 times/min, but on D4 Language rate was 2.6 times/min. Nonetheless, Child 1 displayed a decrease in Approximation rate from beginning to middle of training, when the child ended treatment.

Child 2 showed an optimal increase in Language rate and a decrease in Approximation rate. For Language rate, on D1 the child's rate was 0.19 times/min, increasing to 0.54 times/min on D4, and increasing further to 0.62 times/min on D8.

For Approximation rate, D1 had a rate of 3.3 times/min, which decreased to 2.9 times/min on D4, and decreased again to 2.3 times/min upon completing D8. Out of the 4 participants, Child 2 showed the greatest decrease in Approximation rate.

Child 3 displayed the largest increase in Language rate, but also intriguingly had a slight increase in Approximation rate as well. On D1, Child 3's Language rate was at 0 times/min, which increased to 0.06 times/min on D4, and again increased to 0.50 times/min by D8. For Approximation rate, Child 3 had a rate of 1.1 times/min on D1, which increased slightly to 1.2 times/min by D4, and by D8 had increases minimally to 1.3 times/min.

Child 4 had the most inconsistent rate results that may have been circumstantial to D8. Regardless, Child 4 still displayed a decrease in Approximation rate, however showed inconsistent results regarding rate of Language. For Language, Child 4's rate on D1 was 3.8 times/min, which increased significantly to 7.6 times/min on D4, but on D8 the rate decreased, not below baseline, to 4.7 times/min. Child 4's Approximation rate decreased from 0.17 times/min on D1, to 0.05 times/min on D4, and finally to 0 times/min on D8.

Given the small sample size it was not ideal to use averages when interpreting the data, however, there was a significant trend in the average amount of time of Jargon (J) across all subjects.

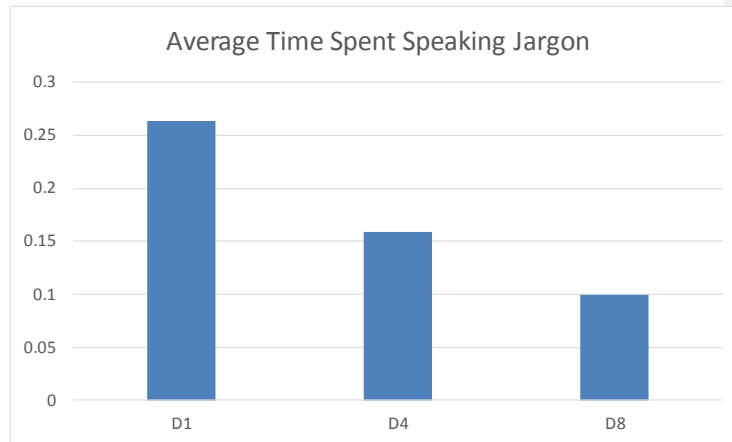


Figure 9 Average Time Spent Speaking Jargon (in minutes) Across Training

Figure 9 demonstrates how the amount of Jargon exclusively decreased on average for all participants during training. On D1, the average time spent speaking Jargon was 0.26 minutes. The average decreased on D4 to 0.16 minutes. Finally, on D8, there was an average decrease to 0.10 minutes.

### 3.2.1 JTAT Results

JTAT was performed pre-and post-testing and was completed for Child 2, Child 3, and Child 4. The test is graded based on Response Quality and Response Level. Both variables had significant increases for Child 2. Response Quality decreased minimally for Child 3 and Child 4. Response Level increased for Child 4 and decreased minimally for Child 3.

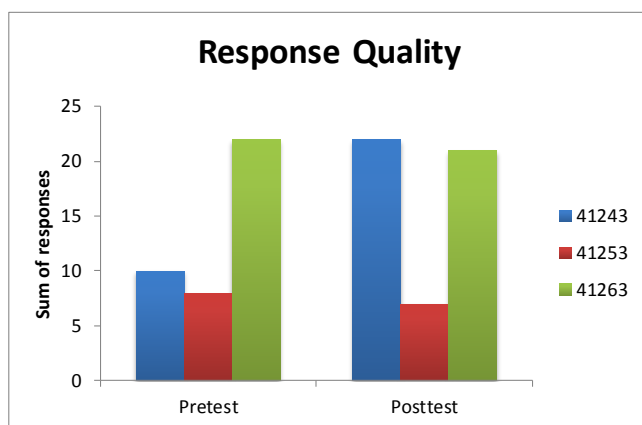


Figure 10 Response Quality of Joint Attention Test for Three Subjects Pre-and Post Hippotherapy

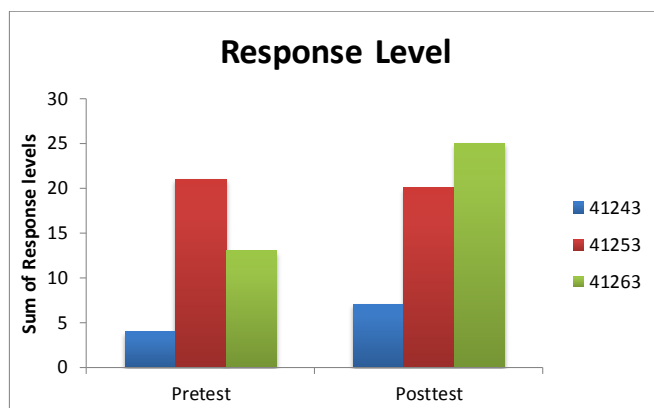


Figure 11 Response Level of Joint Attention Test for Three Subjects Pre-and Post Hippotherapy

Figure 10 depicts the increase in Response Quality for 3 subjects. Child 2 had the greatest increase in Response Quality increasing from a score of 10 at pre-testing to a score of 22 at post-testing. Child 3 had a slight decrease from a score of 8 to 7 from pre-to post-testing. Child 4 had a slight increase from a score of 22 at pretest to 21 posttest. Despite minimal decreases, on average Response Quality for all 3 subjects increased from  $13.3 \pm 7.6$  points pretest to  $16.7 \pm 8.4$  points posttest.

Figure 11 demonstrates the increase in Response Level for Child 2 and Child 4. Child 2 was at level 4 pretest and increased to level 7 posttest. Child 4 increased from level 13 pretest to level 25 at posttest. Child 3 had a minimal decrease from level 21 pretest to level 20 posttest. On average, the Response Level increased from level  $16 \pm 8.5$  pretest to level  $17.3 \pm 9.3$ .

### **3.3 Motor Abilities Results**

The BOT was used pre-and posttest to evaluate balance and manual dexterity. Balance testing was only completed by a single subject and thus that data is not reported. Manual Dexterity could be measured for Child 3 and Child 4; Child 2 had trouble focusing, staying seated, and regulating their behavior during testing. Results of the Manual Dexterity component showed increases for both participants in which testing was completed.

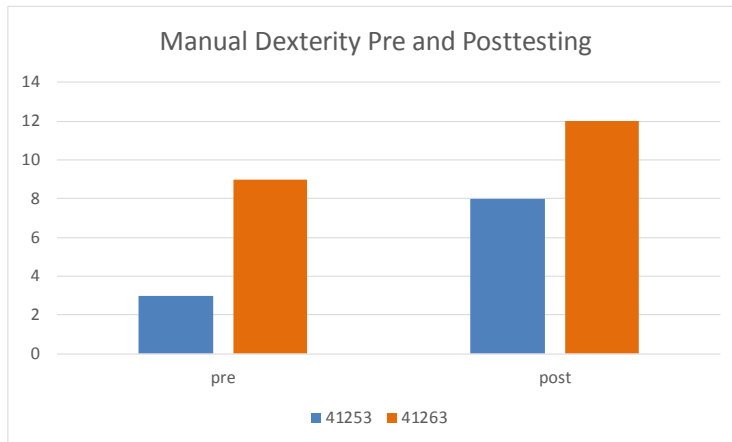


Figure 12 BOT Manual Dexterity Results Pre-and Post testing for Two Subjects (Raw scores)

Child 3 had a score of 6 at pretesting and after hippotherapy intervention had an increase to a score of 8. Child 4 began with a score of 9 at pretesting and increased to a score of 12 at post testing. Averaging these results yields an average increase from a score of  $6 \pm 4.2$  to a score of  $10 \pm 2.8$ .

## **Chapter 4**

### **DISCUSSION**

#### **4.1 Summary of Results**

In a general, the hippotherapy intervention yielded positive results in social communicant and motor ability for the subjects. The best results were seen when evaluating the percentage of time each child spent speaking Language or Approximation across the training. There was a notable increase in Language as well as a decrease in Approximation for all 4 participants. When evaluating the rate Language and the rate of Approximation, half of participants showed increases in their rate of Language and  $\frac{3}{4}$  of participants showed decreases in their rate of Approximation. The average time spent speaking in Jargon was calculated for all subjects across D1, D4, and D8 and there was a notable decrease.

In terms of JTAT scoring, on average there was a slight increase in Response Quality and Response Level. The average Response Quality increased from  $13.3 \pm 7.6$  points pretest to  $16.7 \pm 8.4$  points posttest. The average Response Level increased from level  $16 \pm 8.5$  pretest to level  $17.3 \pm 9.3$ .

The results of the BOT Manual Dexterity testing for the two subjects that could complete showed increases. On average, they increased from  $6 \pm 4.2$  to a score of  $10 \pm 2.8$ .



## **4.2 Effects on Verbalization and Joint Attention**

Based on Figures 7-9, there was notable increases in Language and decreases in Approximation verbalizations. These results align with the original hypothesis that hippotherapy intervention improves the quality of social communication in children with ASD. The most significant changes in social communication was for Child 2 and Child 3. Child 2 and 3 had the most similarities among all participants. Child 2 and Child 3 were the youngest of the subjects, had the least amount of hippotherapy treatment prior to this study, had only one diagnosis of ASD, and were considered low-verbal. Noting these factors, it could be assumed that the more novel the intervention, the younger the age of intervention, and a sole diagnosis shows the most promising increases for social communication in children with ASD. It should be noted that Child 4 had somewhat varying results and a decrease in the amount of time speaking on D8. Child 4 had a family situation that occurred close to D8 and thus changed the child's schedule. The mother of Child 4 typically picks up and drops off the child, but the father was set to pick the child up that day. Child 4 became emotional and upset at the beginning of the session and his emotional state altered his willingness to communicate socially. This is a typical response in children with ASD to changes in scheduling.

Joint attention had an increase on average in the children that completed the test. The decreases that occurred for one child were minimal and could have been due to the novelty of the tester. All JTAT testing was completed in the child's home. Again, it is important to note that novelty and changes in scheduling have large impacts on children with ASD and their performance on testing.

The increases in quality of language and joint attention identified in this study elaborate on the results of other literature. Tabares et al. (2012) noted decreases in

cortisol and increases in progesterone levels in children with ASD as a result of hippotherapy. This study also indicated that these changes in hormone levels led to improvement in social attitudes in participants, which can explain the increases in social communication found in this study (10). Taylor et al. (2012) found increases in volition in children with ASD after hippotherapy intervention. Increases in volition has been suggested to increase communication as well, which serves as another explanation for the results found in this study (9).

#### **4.3 Effects on Motor Abilities**

As noted, only one subject completed the Balance testing portion of the BOT. This portion of the BOT requires the children to focus and follow directions specifically while holding poses of standing on one leg or balancing on a line. The young age of the participants made this a challenge and thus the subjects could not complete the test fully.

Of the 3 subjects who received the BOT pre-and posttest, 1 of them was unable to complete the Manual Dexterity test. This is again not due to the child's inability to manipulate objects using fine motor skills, but a challenge in following proper direction and regulating emotion throughout the testing procedure. Of the 2 subjects that completed this test, both increases in Manual Dexterity. This increase is due in part to the goal-oriented nature of the hippotherapy sessions. The "activity" portion of each session focused on a goal for each child set forth by the hippotherapist. Fine motor skills were a goal for the two participants that were tested. This data is meaningful because it is the first of its kind in the literature on hippotherapy and ASD.

Two major studies in the field have evaluated motor control in children with ASD after hippotherapy. Ajzenman et al. (2013) found increases in postural control

after hippotherapy. Giagazoglou et al. (2012) considered how hippotherapy impacted static balance in children with intellectual disabilities and found improvements in balance, most likely caused by shifts in sensory-motor stimulation that hippotherapy offers. Although Balance measures from the BOT were not reported, this study offers insight into other changes in motor abilities like fine motor skills which is something that this is no prior results on in the field at this time.

#### **4.4 Study Limitations**

This study was designed as a pilot study for the Move To Learn lab at the University of Delaware and garnered positive results, however there were limitations that could be improved upon. Most limitations are related to the sample of participants.

It has been common in the research of hippotherapy and ASD to have a small sample size, and for this study that was a limitation in determining averages of results. The small sample sizes caused large standard deviations for the averages determined from the results. Additionally, all the subjects had some previous hippotherapy exposure (4 participants had  $1.43 \pm 1.53$  years of previous hippotherapy). Two participants had over a year of experience while the other two had about a month of experience. This limitation led to varying results rather than all participants having no previous hippotherapy treatment. Furthermore, the age of the participants was very young. It would be ideal to have a variety of ages participating in the study to have results that could be more easily generalized to all children with ASD. Moreover, all subjects also were receiving other therapeutic services during the time of this study; including speech therapy, occupational therapy, and ABA therapy. These other interventions could be considered confounding, which is why all subjects had taken a

hiatus before the start of the hippotherapy treatment recorded for this study.

Nonetheless, it can be difficult to fully claim hippotherapy as the sole reason for increases in social communication or motor changes in these subjects. Due to the novelty of this study, using the available cliental of the hippotherapist was the best way to conduct the study, but that is unfortunately what gave rise to the limitations.

Another limitation lies in the design of the hippotherapy sessions. Although the Training Dairy was used to ensure that all conditions were completed during every session, there was still variability. Due to inclement weather, some sessions had to be cancelled, some had to be completed indoors or in a different area. This variability could have impacted the results. Additionally, the hippotherapy sessions took place on a farm with many distractions. Although this is helpful because the sessions are mimicking what real-life situations are like, there were distractions. Lawnmowers, traffic sounds, passersby, and so forth were noted as distractions for most of the children. For this study, it would have been more beneficial for the sessions to take place in a closed environment free from distractions as the distractions may have interfered with communication. Another part of the session design lies in the therapist-child interactions. The OT that conducted the hippotherapy was incredibly engaging and encouraging of social communication for the children, which may not be true for all hippotherapists and could be confounding.

Additionally, and possibly most importantly, future studies should utilize a control group. This would include a group of similarly age and diagnosis-matched children who would not receive hippotherapy. The comparison between control group and the hippotherapy group would make the results more profound in that it would account for the other therapies that the children receive. The children all received

therapies outside of the hippotherapy and it would be unethical to have the children stop those therapies, so the use of a control group not receiving hippotherapy is an alternative to that.

Finally, it is difficult to tease apart the environmental effects from the equine effects of hippotherapy. Hippotherapy takes place mainly outside in an engaging and pleasant environment that can have naturally calming qualities. It is hard to indicate if the actual hippotherapy techniques and movements of the horse are responsible for the increase in social communication or if it is more so the environment in which hippotherapy takes place.

#### **4.5 Future Directions**

Future studies should aim to have a larger sample size of which none of the participants have had previous hippotherapy. Ideally all participants should complete pre-and post-testing measures as well. It would be useful for future studies to also have 3 groups, one control, and two hippotherapy. One hippotherapy group should receive the therapy in the typical environment, while the other could receive the same treatment, but on a horse simulator in a clinic. This would allow researchers the opportunity to see if the environment of hippotherapy is largely responsible for results seen in children with ASD. Additionally, all future adaptations should have consistent conditions for every day of treatment. The use of different therapists may also be beneficial to investigate if the type or techniques of an individual therapist has an impact on social and motor results.

An added element that future research on this topic should take advantage of is the use of a control group. The results found in this study would have been made more

meaningful had there been a control group of similar size and age range that was not receiving hippotherapy to eliminate some confounding variables found in this study.

Furthermore, additional studies of hippotherapy and ASD should evaluate repetitive behaviors as well as other changes in behavior. During coding, there were notable behavior changes that were also noted by the subjects' parents which should be investigated further. It would also be beneficial to use an older sample size that can complete balance testing, as there are suspected increases in balance as well.

#### **4.6 Conclusions**

The aim of this project was to evaluate the impact of hippotherapy on social communication and motor changes in children with ASD. There was an increase in the quality of language for all participants and for half of the participants that completed the motor testing posttest, there was also a notable increase. Evaluating each child individually, all showed positive increases in motor and communication. The results of the study are promising despite limitations and further research should build upon the methods of this study.

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## Appendix A

### Hippotherapy Training Manual

#### Project Overview and Timeline

1. **Study Aim:** To examine effects hippotherapy on motor ability and social communication in children with ASD.
2. **Training Duration and Frequency:** Each child completed eight sessions over eight weeks @ of 1 session per week. Pre-and posttest were conducted within one week of training. All sessions lasted from 45 inutes to 1 hour minutes and were led by a certified hippotherapist/ OT
3. **People Involved:** During each condition of the therapy there were various people present and assisting the child. See the following information describing who was present and what their role was
  - a. **Play activity:** therapist (guide child through activity)
  - b. **Mount:** therapist (prompt child to mount), horse leader (grant child permission to mount and control horse), 2 sidewalkers (provide physical support to child as equipment is adjusted)
  - c. **Null 1/warm up:** therapist (engage child in conversation and to look at surroundings), horse leader (guide horse per direction of therapist), 2 sidewalkers provide physical and social support to child
  - d. **Hippotherapy:** therapist (guide child to change positions and instruct horse leader on how/when to manipulate horse movement) horse leader (guide horse per direction of therapist), 2 sidewalkers provide physical and social support to child

- e. **Activity:** therapist (guide/prompt child through activity) horse leader (guide horse per direction of therapist), 2 sidewalkers provide physical and social support to child
  - f. **Null 2:** therapist (engage child in conversation and to look at surroundings), horse leader (guide horse per direction of therapist), 2 sidewalkers provide physical and social support to child
  - g. **Post/treat:** therapist (aid in opening treat and thanking volunteers)
4. **Training Principles:** Hippotherapy involves the use of the horse's movements to positively influence child's behavior, social communication, and motor skills. The OT also used principles of ABA.
5. **Training Goals:** Goals were evaluated on an individual basis by the therapist. The therapist conducted standardized testing of fine and gross motor skills typically utilized by OTs to determine the goals for each child. Examples of possible goals include:
- a. Posture and core muscle strength
  - b. Upper limb/quarter strength
  - c. Social communication skills including turn taking and responsive and spontaneous verbal and non-verbal communication
  - d. Bilateral coordination
  - e. Behavioral/emotional regulation
6. **Weekly Activities:** Every week the child arrived at the Brandywine Occupational Therapy clinic and followed the same series of conditions across each session. The conditions are as follows:
- a. Play activity
  - b. Mount
  - c. Null 1/warm up
  - d. Hippotherapy
  - e. Activity
  - f. Null 2

- g. Post/treat

## General Session Instructions

### 1. Preparation for the session:

- a. At the D1, D4, and D8 sessions, all children participated in the same structured play activity; which involved ball play. The child was asked to choose between the red or blue ball and engage in five attempts to engage in reciprocal ball catching and throwing.
- b. For all other sessions, the child engaged in an activity that was goal-oriented and designed by the OT. The volunteers helped set up the activity for the child.

### 2. Assemble materials:

- a. Therapist or volunteers would assemble the activity” prior to the child mounting and carry play supplies with them during the session.
- b. The horse leader set up the horse’s materials such as the bareback pad and surcingle, prior to child’s arrival.
- c. Child was taught to don a safety helmet.
- d. All sessions took place at the Brandywine Occupational Therapy LLC clinic located in Bellevue State Park at Wellsprings Farm

#### e. Locations used within the farm:

*Play activity* was conducted in the “Tube”, a semi enclosed environment with various therapeutic supplies and activities or directly outside at a

picnic table with supplies. Mounting was performed at the mounting block located directly outside the “Tube”. During warm up (null 1) the



child and the horse walked along a trail to an open hippotherapy location, an arena near “Tube”. Hippotherapy activities occurred in a flat grassy area or at an indoor/outdoor arena on the farm. Play activities were done on the horse when the horse stopped over a flat area near the “Tube”. Cool down (null2): involved the child and the horse returning via the trail to an area where treats were to be offered to the horse in the area located outside the “Tube”. Post/Treat occurred in the “Tube”.

3. **Communication during the sessions:**
  - a. Therapist consistently encouraged social communication throughout session with social bids/questions and encouraged sidewalkers to do the same.
  - b. Therapist asks child questions throughout session
  - c. Therapist comments on aspects of the environment while child is on horse (ex. “Look at the yellow flowers over there”, “I hear birds chirping”)
  - d. Therapist encourages child to engage with side walkers and horse leader throughout session
4. **Training Diary Entries:** At the end of each session, describe the child’s engagement and performance in the training diary

## Activity-Specific Instructions

**Session outline:** Each session followed the same conditions, *Play activity*, *Mount*, *Null1/warm up*, *Hippotherapy*, *Activity*, *Null2*, *Post/treat*. Detailed descriptions of each condition are provided below:

### 1. **Play Activity (5-10 min)**

#### a. D1, D4, D8

- ***Purpose:*** To engage the child by asking a question and giving them a choice, encourage reciprocal actions, eye contact, and exercise gross motor skills and motor planning

#### b. D2, D3, D5, D6, D7

- ***Purpose:*** To complete play activity that is goal-oriented and designed by the therapist

- ***Examples:***

- 1 Planning/organization/handwriting: have child write down list of activities for the day
- 2 Grasp/pull: pull flowers from potted plant
- 3 Gross motor/motor planning: ride tricycle working on steering



**2. Mount (3-5 min):**

- **Purpose:** To teach the child safe donning and doffing of the helmet through demonstration and practice. To encourage spontaneous communication, for example, child must ask the horse leader “Is (horse’s name) ready?”

**3. Null 1/Warm up (8-10 min):**

- b. Purpose:** : To allow child, horse, horse leader, sidewalkers, and therapist time to warm up for session and to allow the horse to develop a walking rhythm for the child to experience the horse’s rhythmicity.
- c.** Therapist offers child appropriate social bids about the surroundings and about themselves.

Sidewalkers offer physical support (depending on child’s needs) by placing hand on the thigh or ankle of the child.



**d.**

#### **4. Hippotherapy (25-30 min):**

- **Purpose:** To facilitate neuromuscular, vestibular, and attention systems through the use of the horse's movements including cadence, turns, etc.
- Consists of 3 subsets:
  - Pace changes (starts and stops): These were abrupt stops and starts to perturb the child's attention while working on core strength to compensate for forward or backward displacements and to enhance spatial awareness of their own body and their body in relation to vertical and in relation to the horse.
  - Position changes: child faces, forwards, backwards, and to both sides
    1. Backwards facing: To encourage children to place hands on backside of horse increasing upper body strength. Some children were asked to hold onto front of bareback pad to improve extension strength.



2. Side facing: To work on core strength and spinal posture



- School figures: To encourage figure 8 or circular motions of the horse causes additional readjustments in the child's position and vestibular systems



#### **5. Goal-oriented Activities/Functional Activities (12-15 min):**

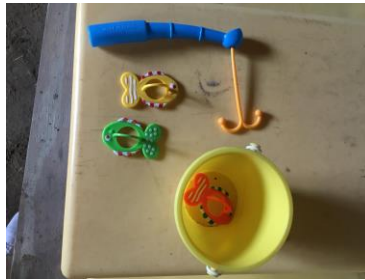
- **Purpose:** To utilize goal-oriented activities with appropriate materials to engage the child and encourage functional skills.
- **Examples**
  - For example, one of the children was interested in TV station logos and thus they were drawn and placed on foam pieces to be collected in an arena during the session. The logos were placed either by the OT on the fence posts of the arena and the horse made a figure 8 and the child was instructed to reach and retrieve the pieces. Or the logos were “hidden” by the child himself and then he was told to give verbal instruction to the horse leader as to where to go to retrieve the logos.



- Mr. Potato Head: This toy/activity made the child work on fine motor skills and identifying parts of the body.



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- Fishing toy: This toy/activity made the child work on motor planning and color identification by verbally identifying the colors of the fish pieces.



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- Lace & trace pets – This toy/activity worked on lacing (fine motor skill) for the child as well as encouraged verbal identification of animals.



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- Sponge balls - This toy/activity required the child to pick up the water-soaked sponge balls and throw them at a target. The

activity helped with adjust children to new sensory input (water) and worked on the gross-motor act of throwing as well as visual tracking.



- Play with crayon and rings: This toy/activity required the child to cross midline by moving rings from one side walker to the other while verbally identify colors.



- The pom-pom bottle: This toy/activity was used to open and close the bottle and fill with small pom poms, making the child work on fine motor skills as well as introducing them to new sensory stimuli associated with the texture of the pom poms



7. **Null 2: (5-10 min)**





- ***Purpose:*** To cool down and walk back to the “Tube” for dismount and end of the session.




8. **Post/treat (5-10min)**


- ***Purpose:*** To work on fine motor skills (opening treat) and social skills such as greetings/farewells i.e., thanking/saying good-bye.
- Child is asked to open the peppermint treat and place it in a bucket to be eaten by the horse.
- Therapist encourages the child to say goodbye and thank you to the horse, sidewalkers, and horse leader.



<b>Condition</b>	<b>Time</b>	<b>People Present</b>	<b>Target Treatment</b>
Play	5-10 min	OT	Fine motor, gross motor, visual integration, motor planning, social communication, reciprocal interactions
Mount	3-5 min	OT, horse leader, sidewalkers	Social communication, safety
Null1/warm up	8-10 min	OT, horse leader, sidewalkers	Posture, balance, visual integration, social communication
Hippotherapy	25-30 min	OT, horse leader, sidewalkers	Posture, balance, core strength, upper body strength, social communication, visual integration, proprioceptive input, sensory input
Activity	12-15 min	OT, horse leader, sidewalkers	Posture, balance, core strength, fine motor, gross motor, motor planning, social communication, visual integration, proprioceptive input, sensory input
Null 2	8-10 min	OT, horse leader, sidewalkers	Posture, balance, visual integration, social communication
Post/treat	5-10 min	OT	Fine motor, social communication, reciprocal interactions

Activity	Description/Instructions	Image
Logos (Child 4)	Child drew pictures of their favorite TV station logos and cut and pasted them onto foam pieces. For one activity, the pieces were placed on the fence posts and the horse leader led the horse in a figure 8 past the pieces (without stopping) and the child had to reach and retrieve the pieces. During which the OT reminded the child to “Make your plan” meaning the motor plan to retrieve the piece.	
Mr. Potato Head	Child was given the Potato base without any features and was prompted by the OT asking what features the toy needed. The child was encouraged to point to these same features on their own body.	
Fishing	The fish pieces of this toy were laid out on a flat surface and the child was instructed to pick up each one individually by only using the fishing rod and verbally identify the color of the fish.	
Bike	The child was asked to mount the bike by the OT. The OT encouraged the child to continuously pedal and control the steering although the therapist had control from behind of the direction for safety.	

Lacing	The child was instructed to take the pieces out of the container and take a lace and lace it through the holes in the animal pieces.	
Crayon/rings	The crayon piece was held for the child on one side of the horse and the rings were held on the other by the sidewalkers. The rings were placed slightly out of reach of the child and they were encouraged to reach for them, cross mid-line and place them on the crayon while announcing the color of the ring.	
Sponge ball	The child had to reach into a water bucket/bin and pick up the sponge pieces. There was a marker on a tree a few feet away and the child was told by the OT to aim and throw the sponge ball at the mark on the tree. The child was also made to use both dominant and non-dominant arms	

Pom Poms	<p>The pom poms were dumped out into the hand of the OT. The OT then told the child to open the container and one-by-one put the pom poms back into the container and close it</p>	
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