IMPROVEMENTS IN BEHAVIORAL AND PHYSICAL VARIABLES FOR CHILDREN WITH AUTISM SPECTRUM DISORDER THROUGH YOGA

by

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ABSTRACT

Autism Spectrum Disorder (ASD) is a multi-system neurodevelopmental disorder characterized by social communication impairments and presence of repetitive/restricted behaviors. Children with ASD also display significant motor impairments, however there is limited literature evidence for motor interventions in ASD. The current study examines the role of a movement-based yoga intervention for children with ASD in an attempt to improve the physical and behavioral skills of children. The study is being conducted at the University of Delaware Move to Learn Autism Lab in Newark, Delaware. Seven male children with ASD between 5 and 12 years were assessed. The subjects underwent ten weeks of intervention, including two weeks of testing and eight weeks of training. Testing measures include standardized assessments to examine the child's flexibility, strength, and balance. In addition, the child's negative, sensory, stereotyped, and self-injurious behaviors were assessed. Training was provided four times a week, with two hourly sessions delivered by an expert trainer and two hourly sessions by a caregiver. The sessions include seven conditions/components: Hello song, Contact, Breathing, Looking, Poses, Relaxation, Goodbye song. The overall study will be completed in May 2016; the main observations indicated that children with ASD had greater imitation errors and use greater balance strategies while copying the yoga poses at their initial testing sessions compared to their final testing sessions. The subjects' flexibility was assessed using the motion analysis software Dartfish. Through the software, the subjects' flexibility

in their joints improved for some specific poses. However, due to limitations in this motion analysis software, the analysis for joint flexibility is not entirely accurate. The subjects' behavior was coded at their initial training session - Day 1 - and their final training session - Day 16. Most of the subjects improved their average behavior assessment scores. The average affect and verbalization scores improved over the course of the training sessions. Yoga therapies can be implemented as inexpensive treatments to address the motor and behavioral skills of children with ASD. The data suggests that frequent yoga sessions increase the balance, flexibility, and behavior of children with ASD, and could be a useful treatment tool for the disorder.

INTRODUCTION

Autism Spectrum Disorder (ASD) is a multi-system neurological disorder with a current prevalence of 1 in 68 children, which approximates to 57% increase over the past 4 years ("Autism Spectrum Disorders," 2014). Individuals with ASD are characterized by primary impairments in social-communication skills and the presence of restricted, repetitive behaviors (*DSM IV*, 2000), (Wing, Gould, & Gillberg, 2011). In addition, they also have secondary impairments in perceptuo-motor and behavioral skills (Bhat et. al, 2011), (Green et. al, 2009). Specifically, the social-communication impairments include reduced eye contact and ability to share attention with others, lack of social interactions and age-appropriate relationships, and delays in acquiring language (*DSM IV*, 2000) (Eigsti et. al, 2011). The restricted, repetitive behaviors include motor stereotypies such as hand-flapping, body rocking, inflexible routines or a desire for sameness, and preoccupation with non-functional parts of an object (*DSM IV*, 2000), (Leekam et. al, 2011).

The purpose of the University of Delaware's Move to Learn Autism Lab is to provide novel interventions for children with ASD that address the multisystem impairments of ASD. The primary study that is being conducted is the Play Intervention Study. The purpose of this study is to examine the effects of yoga, rhythm, and robot interventions in children with autism compared to the standard of care in children between 3 to 14 years of age.

Yoga, also referred as mind-body intervention, has gained popularity in the recent years as the third most common complementary and alternative therapy in children (Barnes et. al, 2008). Yoga is a Hindu spiritual and ascetic discipline, which has been popularized recently as a form of practice for mental and physical relaxation. The origins of Yoga are rooted in Indian culture, where it was used by disciples to maintain focus and to bind the physical self to the mental self (Feurstein & Wilbur, 4-7). Yoga, also referred as mind-body intervention, has gained popularity in the recent years as the third most common complementary and alternative therapy in children. Yoga is suggested to be a cost-effective tool to help address the various motor and behavioral impairments for children with autism; however, there has not been many controlled studies conducted to support this claim (Ehleringer, 2010). There have been other studies done on yoga therapies for different populations of school-age children. A study was conducted for three children with ADHD, aged four to six years old, to see if on-task attention spans improved, which it did; however, the investigator noted that further research needed to be done before yoga could be used as an effective intervention (Lawson, 2012). Thirty-four students, aged 13-18 years with learning disabilities showed significant improvement in social skills and decreased anxiety, according to a study conducted in 2008 by Beauchemin. One study has shown that a six-week course of yoga had fairly positive effects on children ages 7-18 years old with ASD, with notable reductions in anxiety, stress, and behavior; however, only eight subjects participated in this study, which is a relatively small sample size (Miller,

2011). One of the few, most recent studies that used yoga as a therapeutic tool for individuals with Autism Spectrum Disorder (ASD) was conducted by Radhakrishna in 2010 for children between 8 and 14 years of age. That study, however, reported positive findings without any statistical results. This particular study focuses on the effects of yoga intervention on school-age children. Based on multiple studies, reports show that school-age children have multiple stressors in their daily lives, such as work and bullying (White, 2012). Using yoga as a creative relaxation tool allows for students with ASD to be more engaged and independent, as there are few opportunities in schools to train students on how to be calm and alert (Goldberg, 2004). According to a study done by Serwacki and Cooke-Cottone in 2012, schools are increasingly being focused on as venues to inculcate a healthy lifestyle and yoga intervention being implemented in schools is a salutogenic practice. Using yoga as an interventional method for subjects with ASD, particularly school-age children, is a relatively unexplored field, with not many finds in the past five years.

1.1 STUDY AIMS

The purpose of this study was to evaluate the effects of embodied movement interventions, such as yoga, on the social communication and motor skills of children with autism spectrum disorder (ASD) between 5 and 12 years of age.

1.2 HYPOTHESES

The first proposed hypothesis is that children with ASD will display improved motor skills by displaying more accurate imitation of yoga poses and greater flexibility post yoga intervention. The second proposed hypothesis is that children with ASD will have reduced behavioral impairments by displaying fewer negative and maladaptive behaviors post training.

METHODOLOGY

This chapter will discuss the design, setting, sample, approvals, instrumentation, data collection, and data analysis for this study.

2.1 DESIGN – SINGLE GROUP (PRE/POST) DESIGN

This analysis is part of an ongoing study at the Move to Learn Autism Lab at the University of Delaware. The overall study is comprised of two sessions for two weeks of testing and two sessions for eight weeks of training, for a total of 20 sessions per subject. This study reports on the testing sessions as well as the early, mid, and late training sessions for the children. Pretesting and posttesting was done to assess the effects of the proposed intervention.

2.2 SETTING

The data was collected at the Move to Learn Autism Lab at the University of Delaware. The testing was done at the lab space provided by the university, the training was done at the subjects' home. This is an ongoing study from June 2015 and will be completed in May 2016. The purpose of the lab is to find novel, inexpensive intervention therapies for children and adults with ASD.

2.3 SAMPLE

The subject group consisted of seven children, aged 5 - 10. Demographic data included age, gender, and ethnicity (See Table 3.1). The subjects analyzed for this study were worked with from summer to winter of 2015. The ASD diagnosis was confirmed for the subjects by using medical reports and the Autism Diagnosis Observation Schedule (Lord et. al., 2000). The study excluded two subjects due to their inability to follow instructions and their non-compliance, which was seen during the first day of testing. Due to time constraints and recruitment issues, there was no control group for the sample.

Table 2.1 Demographic Characteristics of Study Sample

Subject ID	Age (years)	Sex	Ethnicity
41004	7	Male	White
41023	5	Male	Asian
41063	8	Male	Asian
41083	10	Male	White
41093	6	Male	White
41103	5	Male	Asian
41113	8	Male	White

2.4 INSTRUMENTATION – TESTING/TRAINING

The pilot data was compiled over the summer of 2015, after seeing subjects 41004 and 41023. Two of the seven children were part of the pilot study. Healthy children were used for the pilot study before the subjects 41004 and 41023. No substantial changes made during the pilot study.

After answering an initial questionnaire and filling out the compliance forms, the subjects underwent two pre-testing sessions over the course of two weeks. During the testing sessions, the graduate student tester and the undergraduate model student used yoga, flexibility, and behavior as testing measures. For the yoga testing poses, the graduate student would demonstrate the pose, and the subject would imitate the pose to the best of his ability. If needed, the subject would receive verbal or physical aid from the graduate student tester. The main poses used for the testing were Tree, Dancer, Sit-and-Reach, Pretzel, Frog, Bridge, and Dog. The subject would also need to demonstrate leg lifts for the Bridge and Dog poses. For the behavior, the tester and the model would see if the subject demonstrated any of the following behaviors: Negative (e.g. outbursts); sensory (e.g. oral); stereotyped (e.g. flapping hand); self-injurious (e.g. biting).

The training sessions had a triadic interaction between an expert trainer (graduate student), a student model (undergraduate student), and the subject. For the training sessions, the expert graduate student trainer and the undergraduate model would work with the subject through the eight conditions – Hello song, Contact game,

Breathing game, Looking game, Poses, Partner poses, Relaxation, and Goodbye song. These conditions involve social play and cooperative games, to help improve socio-communicational skills for the subjects. The poses would vary from session to session; however, for sessions 1, 8, and 16, the poses conducted with the subject were the same poses used in the testing sessions. This is because those training sessions were measured along with the testing sessions to see improvements in pose imitation from early, middle, and later in the training intervention.

Figure 2.1 – Sample Triadic Interaction for Training Sessions. The subject (left, bottom corner) and undergraduate student model (right, top corner) would sit diagonally across, facing the expert trainer (right, bottom corner). This interaction would be kept throughout the entirety of the session, so that the subject could directly copy the undergraduate model and still face forward and pay attention to the expert trainer.

Each of the testing and training sessions were recorded for further data analysis, with consent from the parents/guardians of the subjects.

2.5 STUDY APPROVALS

The videos collected and used for this thesis have already been approved by the Institutional Review Board at the University of Delaware for two separate studies under Dr. Bhat. The videos of the subjects were only used for analysis. All the information regarding the subjects are confidential. Numbers to the subjects were assigned to reference them in the study. Before participation in the pretesting sessions, the parent or guardian of the subject had to sign a parent consent form. Before every testing and training session, the subject signs a child assent form to confirm that he or she understands what is entailed in the sessions.

2.6 DATA ANALYSIS

The motion analysis software, Dartfish, was used to calculate joint angles for different yoga poses. The software has been troubleshooted and a manual was made on how to accurately measure joint angles. The children wore Band-Aids as markers so that joint angle calculations were more precise. The pretest and posttest sessions were used for flexibility analysis. The yoga poses that were measured for analysis were Tree, Dancer, Sit and Reach, Frog, Bridge, Right Leg Lift – Bridge, Left Leg Lift – Bridge, Dog, Right Leg Lift – Dog, Left Leg Lift - Dog. Before the subjects demonstrate the final pose, the graduate student tester had them hold an initial position for five seconds. The initial position was used to help the subject get into place to hold

the actual position. While the subject demonstrated the final position, the child was instructed to hold the pose for ten seconds. This was done so that during video analysis, the video can be paused and the joint angle, known as the “Ending Position Angle”, can be drawn accurately.

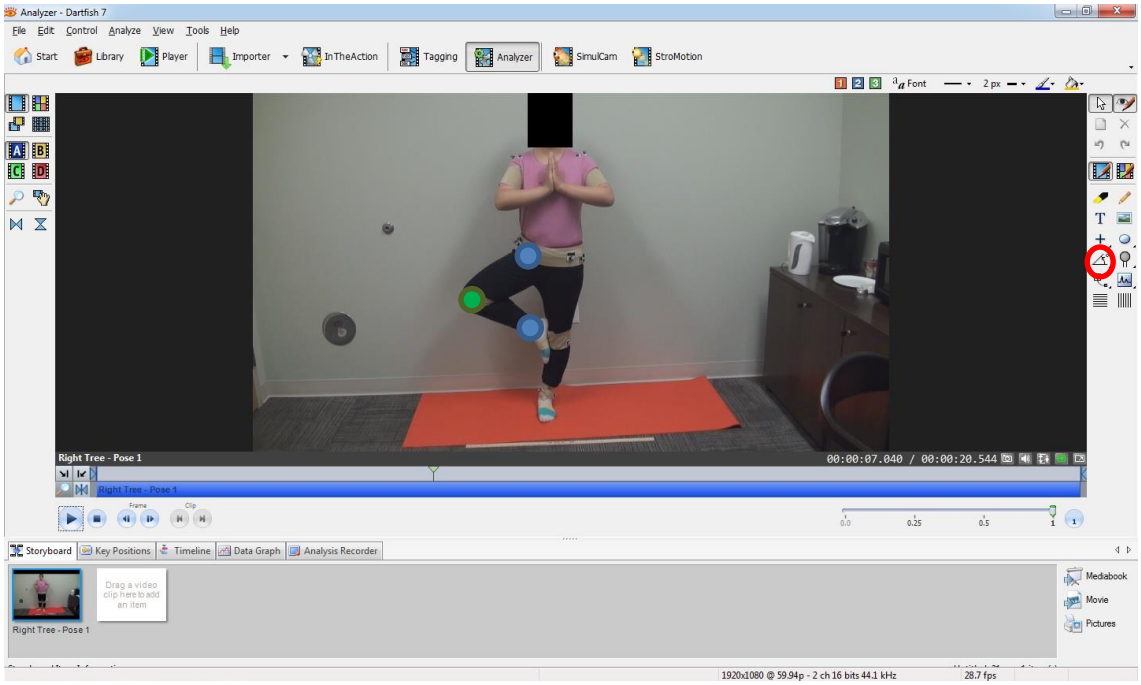

Figure 2.2 – Dartfish Interface for Video Analysis. By clicking on the angle tool (circled in red), the investigator placed the vertex on the marker (green circle), where the joint angle being measured. From the vertex, the investigator then drew rays extending to the markers on the major limbs (blue circles) that were creating the angle measured.

2.6.1 Explanation of the Poses

For reference, see Appendix A – Angles Measured on Poses.

The ideal angles were based on the Dartfish analysis done on the poses conducted by an undergraduate student who worked in the Move to Learn Lab.

For the Tree pose, the angle being measured has the rays facing the medial malleolus of the tibia and the anterior superior iliac spine of the hip, with the vertex of the angle centered at the medial epicondyle of the femur. During the initial position, the subject stood straight facing the camera with arms outstretched. For Right Tree, the subject externally rotated the right foot approximately 90° to the side. For the Left Tree, the subject externally rotated the left foot approximately 90° to the side. During the final position, the subject lifted either the right or left foot, depending on which type of Tree position is being displayed, and placed the foot on the opposite leg. Ideally, the foot should be placed high on the opposite thigh to create an approximate 55° angle.

For the Dancer pose, the angle being measured has the rays facing the lateral malleolus of the tibia and the anterior inferior iliac spine of the hip, with the vertex of the angle centered at the lateral epicondyle of the femur. During the initial position, the subject turned and stood either to the right side for Right Dancer or to the left for Left Dancer. The subject raised his/her arms straight out, parallel to the floor. During the final position, the subject grasped the right or left foot, depending on which type of Dancer position is being displayed, and lifted the leg by hyperextending the hip. In order to help balance, the opposite arm is outstretched. Ideally, the foot should be

raised to hip level with the knee pointing down to the floor, making an approximate 50° angle.

For the Sit and Reach pose, the angle being measured is the hip angle. The rays of the angle are along the trunk and the lower extremities, with the vertex of the angle centered at the greater trochanter. For the initial pose, the subject sat perpendicular to the camera with arms and legs outstretched and parallel to the floor. The angle for the initial pose ideally should be 90°. For the final pose, the subject leant forward, while keeping the legs straight, in order to have the hands touch the feet. The ideal angle for the final position should be less than the initial position angle; therefore, the ideal angle should be less than 90°.

For the Frog pose, there are two angles that are measured. The first angle - the ankle angle - has rays facing the distal phalanx on the big toe of the foot and the lateral epicondyle of the femur, with the vertex of the angle centered at the lateral malleolus of the tibia. The second angle - the hip angle - has rays facing the lateral epicondyle of the femur and the greater tubercle of the humerus, with the vertex of the angle centered at the anterior inferior iliac spine. During the initial position, the subject places the feet and hands flat on the floor and squats. During the final position, the subject leans forward, sits on his/her toes, and keeps the backside slightly raised. For the ankle angle, the ideal angle is 90°. For the hip angle, the ideal angle is 30°.

For the Bridge pose, there are two angles that are measured. The first angle - the hip angle - has rays facing the lateral epicondyle of the femur and the greater tubercle of the humerus, with the vertex of the angle centered at the anterior inferior iliac spine. The second angle - the knee ankle - has the rays facing the lateral malleolus of the tibia and the anterior inferior iliac spine of the hip, with the vertex of the angle centered at the lateral epicondyle of the femur. During the initial position, the subject laid down flat with the arm closest to the camera outstretched perpendicular to the body. During the final position, the subject bends the knees by placing both feet down on the mat, then raised hips. The ideal angle for the hip is 180°. The ideal angle for the knee is 90°.

The subject also conducted leg lifts for each leg after doing the Bridge pose. The angle measured for each leg lift is the knee angle, with rays facing the lateral malleolus of the tibia and the anterior inferior iliac spine of the hip. The vertex of the knee angle is centered at the lateral epicondyle of the femur. The subject first displayed the final Bridge position, then extended the leg closest to the camera as straight as possible and so it is parallel to the bent leg. The ideal angle for the leg lift is 180°.

For the Dog pose, the first angle - the hip angle - has rays along the trunk and the lower extremities, with the vertex of the angle centered at the greater trochanter. The second angle - the knee ankle - has the rays facing the lateral malleolus of the tibia and the anterior inferior iliac spine of the hip, with the vertex of the angle

centered at the lateral epicondyle of the femur. During the initial position, the subject placed both hands and knees on the floor while keeping the torso straight and parallel to the floor. During the final position, the subject lifts the knees off the floor and straightens the legs and stretches the hips so that both feet can lay flat on the floor. The ideal angle for the hip is 90°. The ideal angle for the knee is 180°.

The subject also conducted leg lifts for each leg after doing the Dog pose. The angle measured for each leg lift is the knee angle, with rays facing the lateral malleolus of the tibia and the anterior inferior iliac spine of the hip. The vertex of the knee angle is centered at the lateral epicondyle of the femur. The subject first displayed the final Dog position, then extended the leg closest to the camera as straight as possible and so it is parallel to the subject's arms. The ideal angle for the leg lift is 180°.

2.6.2 Imitation Coding Scheme

For reference to the Imitation Coding Scheme, see Appendix B – Imitation Coding Scheme.

In order to see if there were any errors during pose imitation for the subjects, an Imitation Coding scheme was made. The Imitation Coding template was used to code for errors for the Pretest session, Training Session 1, Training Session 8, Training Session 16, and Posttest sessions for the subjects. For the purposes of this

study, only the errors during the Pretest and Posttest sessions were examined. These errors included Limb Placement, Balance Strategies, Spatial Orientation, Movement Modulation, Positional Symmetry, Mirroring, Cues, Time to Initiate, and Hold Time. To ensure data reliability, two undergraduate coders underwent intra-reliability and inter-reliability. Two coders coded the same 25% of the data set. The data set underwent Pearson's correlation to determine reliability. The coding had to be 85-90% compatible with the previously coded data.

Table 2.2 Imitation Coding Scheme – Coding Variables

Limb Placement Error	Score of 1 given if the subject failed to perform the exact movement element. Ex: For the tree pose, a score of 1 was given if the child was unable to join hands overhead. This error was coded for a static video frame and the time the error took place was specified.
Balance Strategy Errors	Number of balance strategies used by the child while performing the pose was recorded. Ex: For the tree pose, the number of steps taken by the child to maintain balance was recorded. This scoring was done only for the final position not for the initial position.
Spatial Orientation errors	Score of 1 was given if the subject failed to orient the whole body or particular joints as demonstrated by the tester. Ex: For the tree pose, a score of 1 was given if the fingertips of joined hands are facing in front instead of pointing upwards.
Movement Modulation errors	Score of 1 was given if the subject's movements are insufficient or exaggerated in terms of range of motion and effort of movement. *Insufficient* - incomplete range of motions and movement appears to be weak.

	Exaggerated - an overshooted movement and more forceful without control.
Positional Symmetry errors	Score of 1 was given if the subject is unable to distribute weight equally on both sides of the body. Ex: For the tree pose, if the child tilted the body to one side instead of standing straight, the subject would receive a 1.
Mirroring errors	Score of 1 was given if the subject failed to mirror the tester's movements
Cues	The additional cues given by the tester were counted for errors. Different types of cues coded: • **focus (F)** on the task • specific **verbal (V)** cues about the pose two or more **demonstrations (D)** of the pose • **physical (P)** assistance to the child to complete the pose.
Time to Initiate	The time was recorded from the tester's end of movement to child's initiation of first attempt. If the child starts before the tester ended the movement, it was coded as a <1 sec, which is ideal.
Hold Time	The time for which the child holds the pose was recorded, from the start of child's movement to the end of child's movement. Ideally, the subject should be able to hold the pose for five seconds for the initial position and ten seconds for the final position.

Over the course of the training sessions, it was hypothesized that the amount of imitation errors would lessen. The imitation coding scheme helped to highlight if the subjects have improved in flexibility, focus/attention, balance, and mirroring. Although this coding scheme mainly focuses on the physical variables for the subjects, this also looks at behavioral variables during pose imitation. For example, if a subject

has to be reminded to focus while imitating a pose, that would be coded that as a Focus error.

Due to time constraints, only Limb Placement errors were coded and analyzed for this study. This seemed to be the ideal variable to analyze, due to the fact that the Limb Placement errors encompassed other errors as well. For example, if a subject lowered his hands to his chest during the Tree pose, instead of raising his hands above his head, that would be coded as a Limb Placement error. This could also be coded as a Balance Strategy error, since the subject focused his center of gravity lower by bringing his hands to his chest instead of keeping them raised above the head.

2.6.3 Behavior Coding Scheme

For reference to the Behavior Coding Scheme, see Appendix C – Behavior Coding Scheme.

In order to see improvements in behavior for the subjects, an on-task behavior coding scheme was made to code for affect, verbalization, and eye contact. There are six other conditions during the training sessions that were not focused on in the flexibility and imitation coding: Hello song, Contact, Breathing, Looking, Relaxation, Goodbye song. This on-task behavior coding scheme was made to see if the subjects are fully engaged and participating during these conditions. Only the first and last

training sessions were coded using this coding scheme - Training Session 1 and Training Session 16. Ideally, the subjects' attention and enthusiasm would improve throughout the sessions.

Table 2.3 Behavior Coding Scheme – Coding Variables

Affect	Defined as the facial expression and the emotional state of the subject. Score of 1 was given if the subject was negatively responding to the task (crying, angry, non-compliant). Score of 2 is given if the subject is neutral. Ex: Subject is attending to the task; however, he or she is not interested or excited and has a flat face. Score of 3 is given if the subject is interested by attending to the task, compliant, and exchanges some words with the model or trainer. S Score of 4 is given if the subject is positively responding to the task by paying attention, smiling, and verbally communicating (task-related).
Verbalization	See how the subject was responding to the task, trainer or model. Score of 1 was given if the subject is non-responsive, either by not paying attention or by not agreeing to answer. (1 – non-responsive) Score of 2 was given if the subject is low-verbal, occasionally verbalizing with the model or trainer when talked to directly. (2 – mid responsive) Score of 3 is given if the subject is responsive to the task and only speaks when asked by the model or trainer. (3 – high responsive/mid-spontaneous) Score of 4 is given if the subject is positive and spontaneously verbalizing (task-related) with the model or the trainer. (4 – high spontaneous)
Eye Contact	See if the subject was looking at the model or the trainer, based on who was speaking, in addition to paying attention to objects related to the task. Score of 1 was given if the subject was not looking at the model, trainer, or objects related to the task throughout the condition; reminders and redirections are being constantly given and there was no spontaneous gaze. Score of 2 was given if the subject was neutral and gives eye contact after constant reminders from the model or trainer.

	Score of 3 was given if the subject was responsive to the trainer or model and maintains eye contact for most of the condition, with only one or two reminders for the whole condition. Score of 4 was given if the subject has spontaneous gaze and maintains eye contact with the trainer, model, or with the objects related to the task for the entire condition.

For this coding scheme, ideally, the scores will improve if the subject is responding positively to the training sessions.

RESULTS

For the Dartfish analysis, there were four positive findings. The Tree pose decreased from pretest to posttest – closer to the ideal angle. The Sit and Reach pose and both the knee and hip angles for the Dog pose increased from pretest to posttest closer to the ideal angle (see Figure 3.1). The pretest and posttest values were compared and analyzed by using a paired two-tailed t-test.

Although the Dog – Hip pose is statistically significant, there were further deviations from the ideal angle, where many subjects actually increasing their hip angles past the ideal angle (see Table 3.1).

Table 3.1 Dartfish Analysis – Positive Findings

Poses	Tree	Sit and Reach	Dog - Hip	Dog - Knee
Ideal Angle	55	50	90	180
Pretest Average Angle	87.14	82.59	80.1	142.97
Pretest Standard Deviation	24.09	8.11	24.60	18.38
Posttest Average Angle	71.54	67.84	101.1	163.36
Posttest Standard Deviation	20.26	11.70	16.45	13.87
t/p-value	0.022	0.036	0.014	0.045

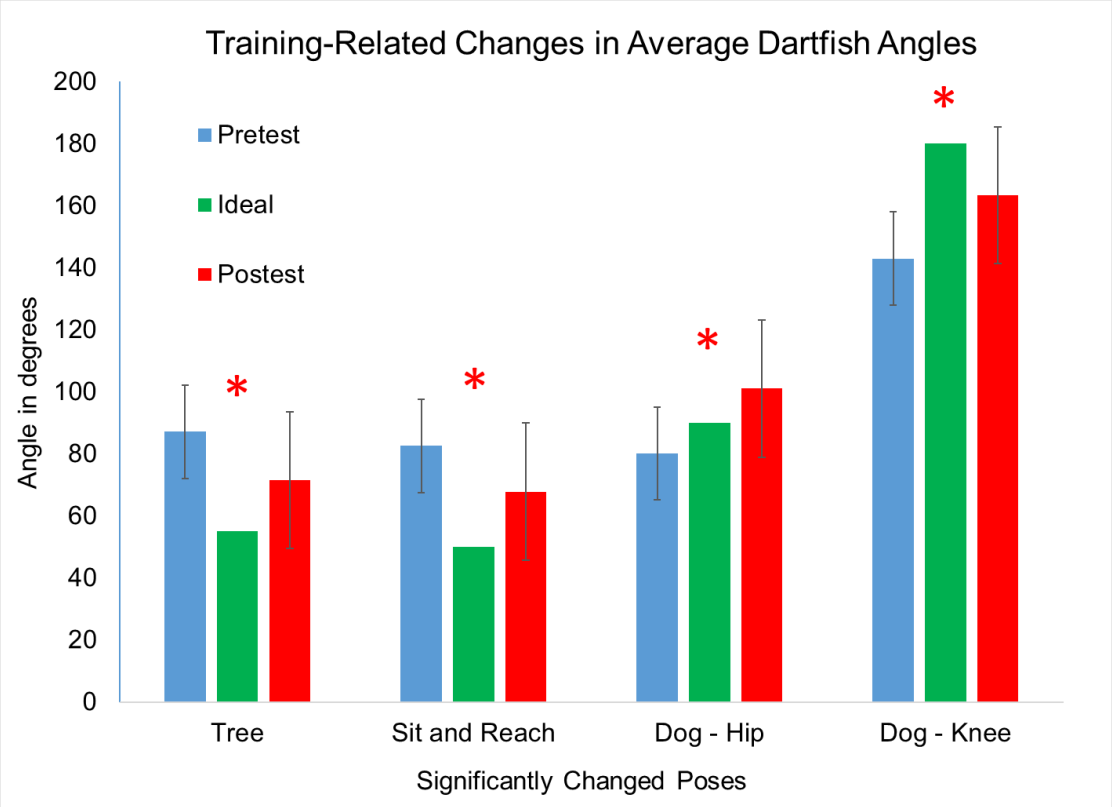

Figure 3.1 – Training-Related Changes in Average Dartfish Angles. The clustered column graph shows the calculated average pose angle values for the Pretest and Posttest sessions for all of the subjects for each pose that had a significant change. The standard deviation bars were calculated for each pose and are shown for each value. The pretest average values are in blue, the ideal angle values are in green, and the posttest average values are in red. All statistically significant improvements are marked with a red asterisk. The *Tree* and *Sit & Reach* average posttest angle values decreased significantly, getting closer to the ideal angle values. The *Dog – Hip* and *Dog – Knee* average posttest values increased significantly, getting closer to the ideal angle values. Statistical significance was determined by using a paired two-tailed t-test, with a p-value of < 0.05.

For the Imitation Coding, all of the limb placement errors were compiled and the averages were calculated for each pose. The pretest values were compared to the

posttest values by using a two sample t-test. The sit & reach, frog, bridge, and pretzel - did not have statistical improvement (see Table 3.2).

Table 3.2 Average Limb Placement Error for Testing Sessions

Pretest				
	Tree	**Dancer**	**Butterfly**	**Right Leg Lift Dog**
Average Error	0.41	0.68	0.32	0.45
SD	0.15	0.15	0.19	0.19
Posttest				
	Tree	**Dancer**	**Butterfly**	**Right Leg Lift Dog**
Average Error	0.21	0.54	0.13	0.33
SD	0.13	0.14	0.10	0.14
ttest-p value	0.06	0.09	0.05	0.05
Average change	-0.20	-0.13	-0.18	-0.12

There were statistically significant improvements in error for four poses – Tree, Dancer, Butterfly, and Dog (see Figure 3.2).

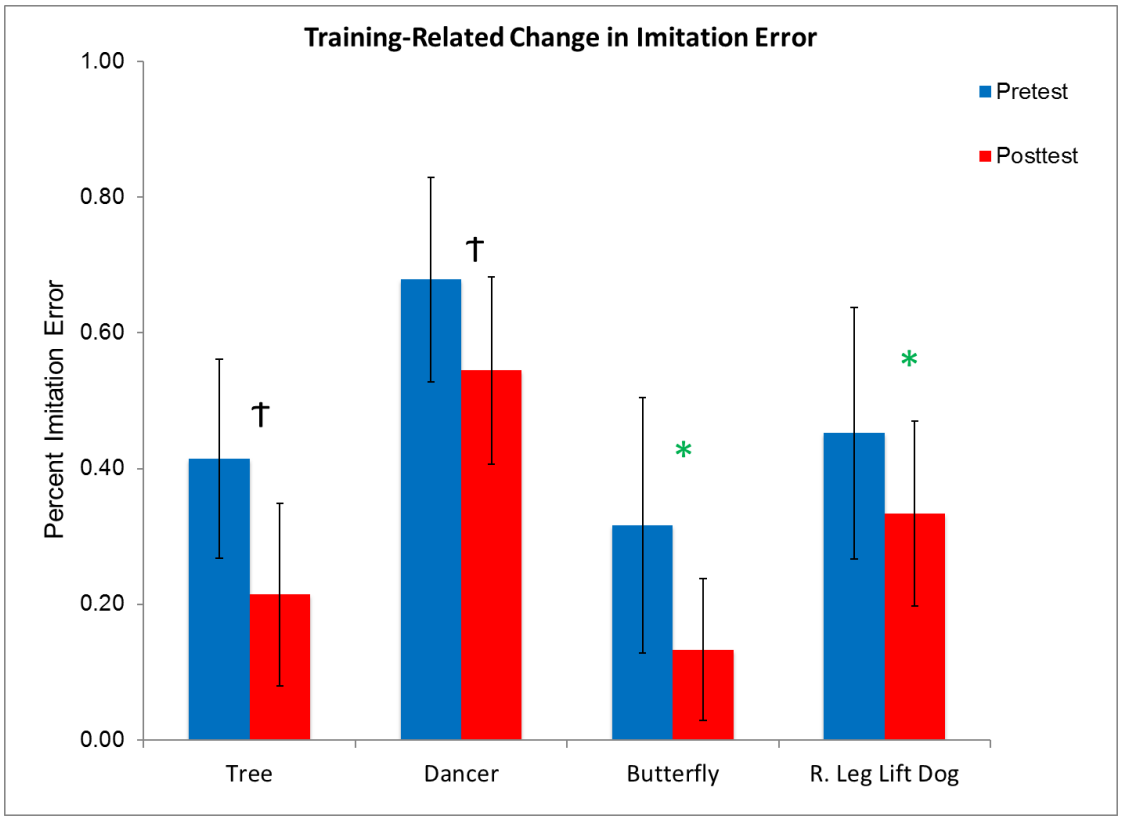

Figure 3.2- Training-Related Change in Imitation Error. The clustered column graph, with standard deviation bars, shows a statistically significant decrease in percent imitation error from pretest (blue) to posttest (red). To analyze the data, the average error values from all of the subjects were compiled for each pose, then the total number of errors were calculated. The average error values for each pose were divided by the total number of errors to give a percent imitation error. To calculate statistical significance, a paired two-tailed t-test was conducted for the pretest and posttest values. The poses marked with the dagger show a significant decrease in error percentage from pretest to posttest using a p-value of < 0.10 (Tree and Dancer). The poses boxed and marked with a green asterisk show significant decrease in error percentage from pretest to posttest using a p-value < 0.05 (Butterfly and Right Leg Lift Dog).

To determine whether the values found were statistically significant, a p-value of 0.10 was used for a paired two-tailed t-test. The Tree pose had a p-value of 0.06, the Dancer pose had a p-value of 0.09, the Butterfly pose had a p-value of 0.05, and the Right Leg Lift – Dog pose had a value of 0.05. These poses had a significant reduction

in average percentage of errors. The other poses did not have statistically significant p-values that indicated improvement in average percentage of errors.

For the On-task Behavior Assessment Coding, the average values for affect, verbalization, and eye contact were calculated for each subject. The pretest average values for each subject were compared to their posttest values by using a paired two tailed t-test.

Table 3.3 Average Values for On-Task Behavior Variables

Scores	Early Session	Late Session	t/p-value
Affect – Average	2.59	3.05	0.07
Standard Deviation	0.21	0.66	
Verbalization	2.57	3.20	0.08
Standard Deviation	0.48	1.01	
Eye Contact	2.71	2.96	0.43
Standard Deviation	0.29	0.71	

By using a paired two-tailed t-test with a p-value of 0.10, there is significant statistical improvement in affect and verbalization. Eye contact did not statistically improve (see Figure 3.3). Although there were improvements in most of the subjects

for on-task behavior conditions, only subjects 41004, 41023, 41063 had statistically significant improvement. The only subject that decreased in affect was subject 41083.

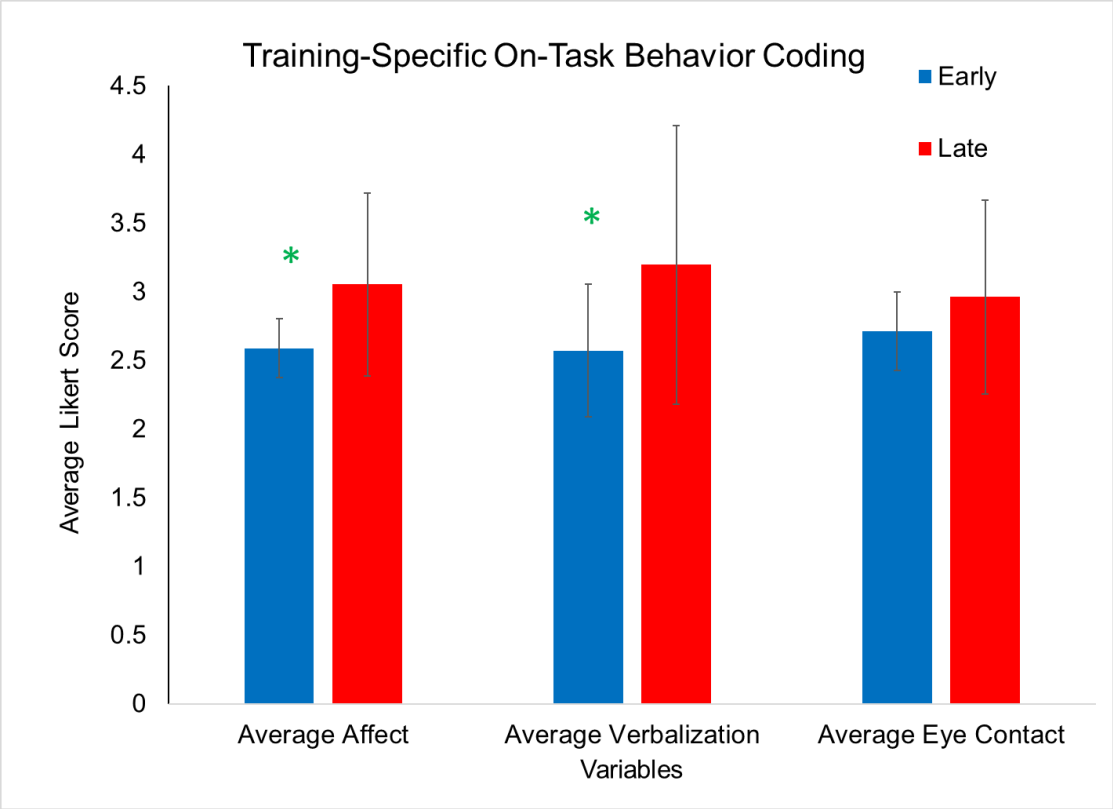

Figure 3.3- Training-Specific On-Task Behavior Coding. This data was compiled from the average Likert score values for all of the subjects from the Day 1 (early) and Day 16 (late) training sessions. The bars in blue mark the average score for the early training session, and the bars in red mark the average score for the late training session. The data was analyzed using a paired two-tailed t-test. The clustered bars marked with a green asterisk show significant improvement for affect and verbalization from the early to the late training session using a p-value < 0.10.

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Prior to this study, there has been limited literature on yoga-intervention based therapies for children with ASD. This study explored the benefits of having children with ASD participate in eight weeks of yoga-intervention training, and measuring improvements in behavioral and physical variables by comparing the pretest results with the posttest results. Results confirmed that there are some improvements in flexibility during pose imitation, on-task behavior during conditions, and amount of errors made during pose imitation.

4.1 Discussion

The purpose of this study was to evaluate the effects of embodied movement interventions, such as yoga, on the social communication and motor skills of children with autism spectrum disorder (ASD) between 5 and 12 years of age. There were three main training-related variables in this study: flexibility during pose imitation for the testing sessions; limb placement error during pose imitation for the testing sessions; and on-task behaviors, such as affect, verbalization, and eye contact, during the various conditions of the early and late training sessions.

For flexibility, the motion analysis software Dartfish was used to assess joint flexibility in the pretest and posttest sessions. As seen in Table 3.1, there were four positive findings from the joint flexibility analysis – the Sit and Reach pose, the knee angle and hip angle for the Dog pose, and the Tree pose. For the *Sit and Reach pose*, if

the subject displayed improved flexibility, the hip angle in the posttest would be less than the angle measured in the pretest. With the exception of subject 41063, all of the subjects had their hip angles decrease from their hip angles measured in the pretest. This improvement was statistically significant, with a p-value of 0.0355 from the paired two-tailed t-test. For the *hip angle of the Dog pose*, the subjects needed to either increase or decrease their respective angles to get closer to the ideal angle of 90º. Three subjects, 41063, 41083, and 41103 got closer to 90º. The other four subjects increased their angles, surpassing 90 º. However, this can be noted positively, since this can show that all of the subjects increased hip flexibility by improving their hip angles. Also, this improvement was statistically significant, with a p-value of 0.013 from the paired two-tailed t-test. For the *knee angle of the Dog pose*, the subjects needed to keep their leg straight, making a 180º at the knee vertex. All of the subjects improved their knee angles by increasing their knee angles and getting posttest values closer to 180º. This improvement was statistically significant, with a p-value of 0.0448 from the paired two-tailed t-test. Although the changes in the *knee angles for the Tree pose* was statistically significant, with a p-value of 0.022 from the paired two-tailed t-test, nearly all of the subjects' knee angles deviated significantly from the ideal angle and did not get closer to the ideal angle of 55º. The only improvements in getting closer to the knee angle were seen in subjects 41004 – both left and right tree, 41023 – right tree, 41063 – left tree, and 41103 – left tree position. There are a few reasons as to why this data did not show too much improvement, which is discussed in further detail in the Limitations section.

There are not many studies that focus on improvements for children with ASD through yoga intervention. According to a systematic review conducted by Birdee et. al

in 2009, there were studies conducted for the application of yoga therapy for the pediatric population that focused on cardiorespiratory and physical fitness. The studies reviewed showed that there were improvements for both types of fitness; however, there is not much detail on how exactly those were measured and whether the investigators looked at flexibility as a fitness measure.

To analyze the amount of errors made by the subjects, an Imitation Coding Scheme was made. The errors analyzed for this study were Limb Placement errors. If a subject made no errors while imitating a pose, then there was a score of zero was given. If the subject conducted an error while imitating a pose, then a score of one was given for each error. Ideally, the average percentage of errors conducted for each pose would decrease significantly from the average percentage of errors for each pose from the pretest values. The improvements specifically for the Tree and Dancer poses were significant. The Tree and Dancer poses are single leg stance poses, which are technically more difficult. By having the subjects lessen the amount of errors conducted for the Tree and Dancer poses, this data shows that the subjects were able to improve significantly over the course of the training sessions with the more difficult poses.

A systematic review was conducted by Galentino et. al in 2008 that focused on the therapeutic effects of yoga for children. The papers analyzed in this review suggested that pose imitation requires balance and strength, motor planning (praxis), and higher cognitive ability. Neuromuscular performance also plays a large factor in accurately imitating the poses.

To analyze the subjects' on-task behavior during all of conditions in the first and last training sessions, an on-task behavior assessment coding scheme was used. Ideally, the subjects' overall score would improve from the first training session to the last training session. Most of the subjects improved in overall average score; however, the only subjects with statistically significant improvement were subjects 41004, 41023, and 41063. Subject 41083 is the only subject that decreased in overall on-task behavior from Training Session 1 to Training Session 16.

Subject 41004 is low-verbal and lower functioning. During Training Session 16, the subject improved in affect.

Subject 41023 is relatively high-functioning. His spontaneous verbal was high during Session 1 and Session 16, and he answered model's questions very enthusiastically; however, the subject got distracted easily. The subject was not willing to try difficult poses in Session 1. During Training Session 16, his affect for poses and partner poses improved.

Subject 41063 is relatively high-functioning. During Training Session 1, the subject paid attention; however, he was not very enthusiastic. For Training Session 16, the subject's spontaneous verbalization and affect improved.

Subject 41083 is very low-functioning and non-verbal. Only a score of 2 or below was given for his verbalization during the coding. During Training Session 16, the subject had low affect -he was uncooperative, laid down on the ground and would not participate. The parent had to interact with subject to get him to participate. He did

not complete hello song, contact game, or the looking game conditions, and he covered his ears for the goodbye song.

Subject 41093 had averted eye contact in Training Session 1, but during Training Session 16, his eye contact and spontaneous verbalization improved.

Subject 41103 had low verbalization during Training Session 1, but during Training Session 16, he displayed high spontaneous verbalization in session 16.

Subject 41113 is relatively high functioning. During Training Session 1, he did not want to participate in conditions he did not understand. During Training Session 16, the subject voiced concerns about participating in difficult activities; however, he completed the activities and had high spontaneous verbalization.

There have been many studies done on how yoga therapies for different populations of school-age children can have positive effects on behavior. A study was conducted for three children with ADHD, aged four to six years old, showed that on-task attention spans improved (Lawson, 2012). Thirty-four students, aged 13-18 years with learning disabilities showed significant improvement in social skills and decreased anxiety, according to a study conducted in 2008 by Beauchemin. One study has shown that a six-week course of yoga had notable reductions in anxiety, stress, and behavior on eight subject ages 7-18 years old with ASD (Miller, 2011). These improvements in affect coincide with the finding from this study; however, there is not much written in past literature that addresses eye contact and verbalization.

4.2 Limitations of the Study

This study had some limitations when it came to sample size, quality of software, and joint angle calculations. The validity of this study comes into question due to the following.

1. The sample size was small. There were only seven subjects that were seen upon completion of this particular study. There are more being seen currently; however, they cannot be included in this study due to time constraints. The sample size comprises of only male subjects. However, this is understandable since approximately 75% of the population with ASD are male (*CDC*, 2014).
2. There were no control groups, due to time constraints and recruitment issues. However, there are multiple possible control groups that could have been used, if given the time and resources. For example, a control group of subjects with ASD just undergoing the pretest and posttest sessions, not the training sessions, could be compared to the subjects that undergo the testing and training sessions. This way, we could see if the pose improvement was a result of the training or if it was a result of the subjects recalling the poses from the pretest sessions. The issue with this control group is that the subjects just doing the testing sessions will not be able to be used for the behavioral analysis, since that variable is only training-specific. Another control group that could be used is a group of typically developing (TD) children. Each TD subject would ideally be paired with a subject with ASD, sharing a similar body type and age.

The TD subjects would undergo the testing and training sessions, similar to the subjects with ASD. The results would be analyzed using paired t-tests, since the study would be centered around a matched-pair sample.

3. The motion analysis software Dartfish measures the joint angles by using a still frame from the recordings. The issue with using a still frame is that the exact angle cannot be recorded if the subject is slightly rotated. During the Imitation Coding, it was noticed that many subjects were coded for errors for Spatial Orientation for the Tree pose. This could have occurred because the subjects would not fully rotate their feet 90º to the side for the initial position, then lift the fully rotated foot to the side of their legs. Another reason for the errors coded for Spatial Orientation is that the child did not face the camera straight-on, and was slightly rotated. In fact, the main reason why Dartfish analysis was only conducted for the testing sessions was because the training sessions had the subject oriented in a different plane due to the triadic interaction. This cannot be easily seen in the 2-D analysis from Dartfish. If the motion analysis software could capture the subjects in a 3-D environment, then the angles measured could more accurately reflect how the subject's flexibility has improved.
4. The joint angles were measured by a tester drawing the angle onto the subjects' joints subjectively. This could have resulted in errors in joint calculation. Ideally, the motion analysis software should be able to draw angles automatically, therefore leaving out the subjectivity of a student tester.

4.3 Recommendations

The results of this study have implications for cost-effective, creative, easy to deliver multisystem intervention therapies for children with autism spectrum disorder. This section presents recommendations based on study results.

Research

Based on the findings of this study, the following recommendations for further research are suggested.

1. The study should be replicated with a larger sample size, preferably with some female subjects. If possible, typically developing children should be included and compared as a control group to the subjects with ASD. This could be realistically accomplished by recruitment efforts through the Tri-State Area, by contacting centers catering to those with ASD near Delaware.
2. Further investigation of the use of different motion analysis software would be useful in assessing the validity and reliability of calculating joint angles as a measure for flexibility. This could be accomplished by investing in different software and comparing the results of the joint angle measurements between the different software.
3. Since the conditions in the training sessions are relatively sedentary, incorporating a few different conditions that involve moving around is preferred to get the subjects more involved. This could be realistically

accomplished by different games that involve standing or moving in place for each training session.

4. Analyze data using different variables, such as age, low-functioning versus high-functioning, gender, to see if that influences flexibility, imitation errors, or on-task behavior.

4.4 Conclusions

The results of this study show that there are some improvements in flexibility, errors for limb placement during pose imitation, and on-task behavior. Although there were only a few positive findings from the joint flexibility analysis, there could be more if a different motion analysis software was used. The amount of pose imitation errors decreased significantly for some of the analyzed poses from pretest to posttest. Most of the subjects improved in overall average on-task behavior from the early to late training sessions. The results from this study show that there were improvements in socio-communicative and motor skills for some of the children with autism spectrum disorder by providing eight weeks of yoga intervention therapy.

There are very few studies done on different, novel therapies for children with ASD. There is a need for inexpensive, multisystem, novel intervention therapies for children with autism spectrum disorder. The data suggests that frequent yoga sessions increase the balance, flexibility, and behavior of children with ASD, and could be a

useful treatment tool for the disorder. Yoga therapies can be implemented as inexpensive treatments to address the motor and behavioral skills of children with ASD.

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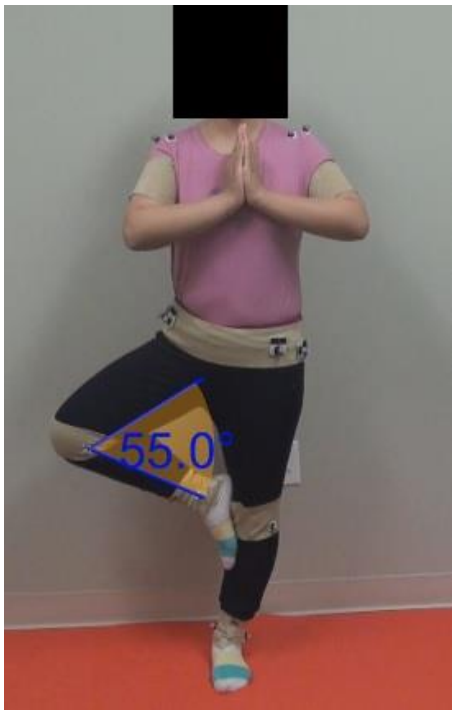
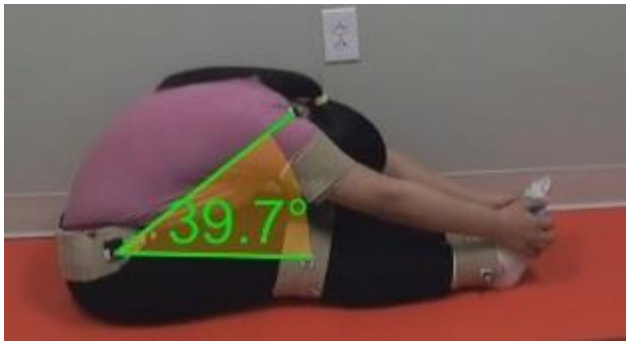
Appendix A ANGLES MEASURED ON POSES FOR DARTFISH ANALYSIS

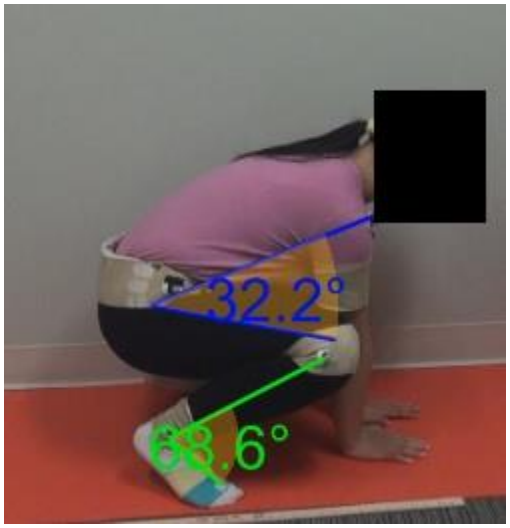


Right Tree – Sample Ending Position Angle

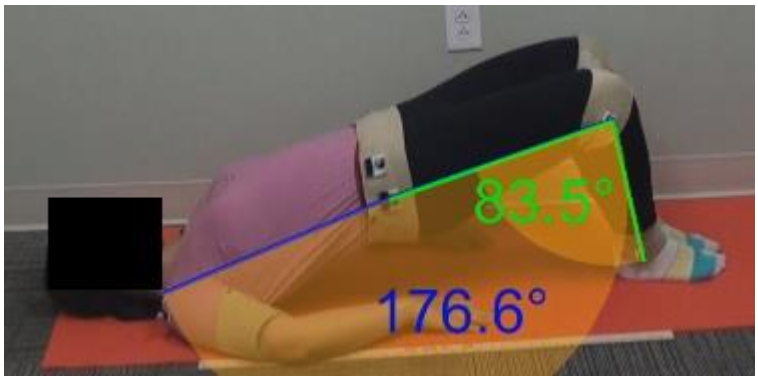
Right Dancer – Sample Ending Position Angle



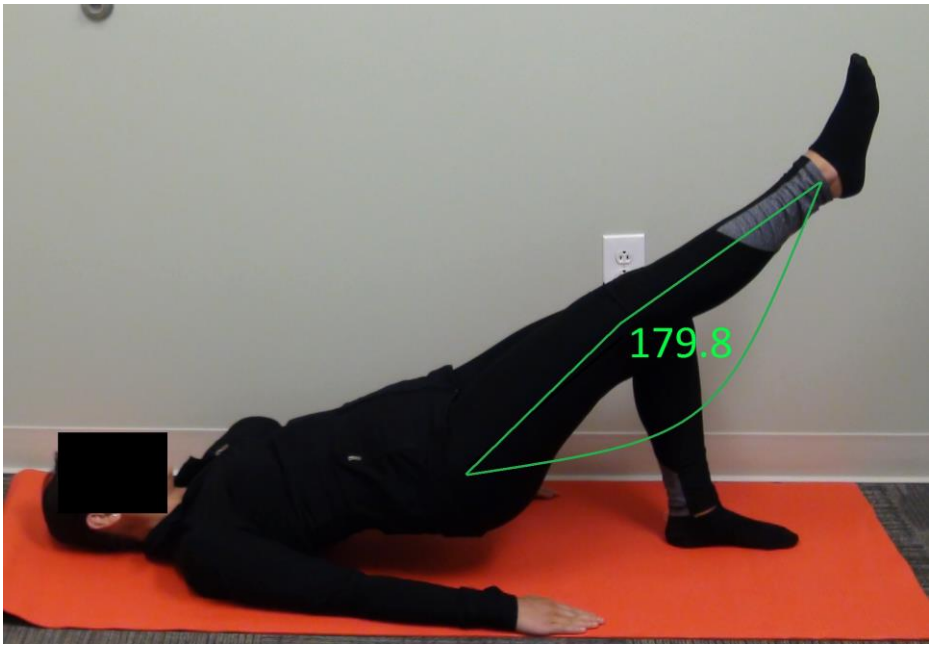
Sit and Reach – Sample Ending Position Angle



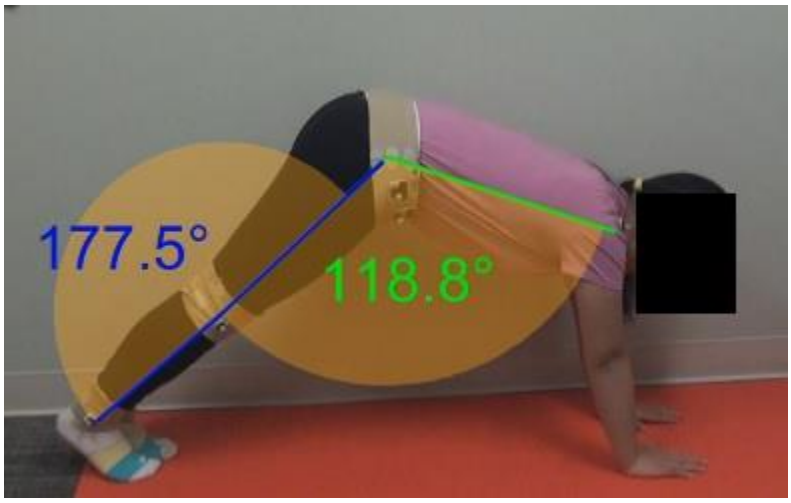
Frog – Sample Ending Position Angles
Blue – Hip Angle
Green – Knee Angle



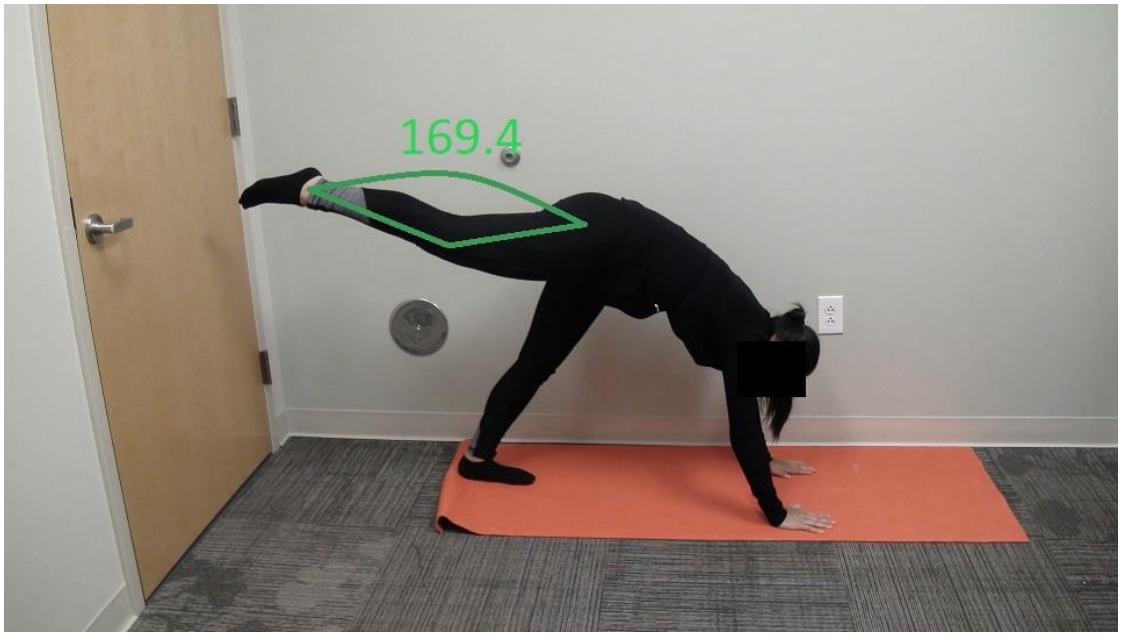
Bridge – Sample Ending Position Angles
Blue – Hip Angle
Green – Knee Angle



Right Leg Lift Bridge – Sample Ending Position Angle



Dog – Sample Ending Position Angle
Green – Hip Angle
Blue – Knee Angle



Right Leg Lift Dog – Sample Ending Position Angle

Appendix B IMITATION CODING SCHEME

1. **Limb/body placement error**: A score of 1 is given if the child fails to perform the exact movement element, for example for tree pose, a score of 1 will be given if the child is unable to join hands overhead. This error is coded for a static video frame; please make sure to specify the time when the error is coded.
2. **Balance strategies**: Count the # of balance strategies used by the child while performing the pose, for example for tree pose, count the # of steps taken by the child to maintain balance. This scoring is done only for the final position.
3. **Spatial orientation**: A score of 1 is given if the child fails to orient the whole body or particular joints as demonstrated by the tester, for example for tree pose, a score of 1 is given if the fingertips of joined hands are facing in front instead of pointing upwards.
4. **Movement modulation**: A score of 1 is given if the child's movements are insufficient or exaggerated in terms of range of motion and effort of movement. *Insufficient* would be incomplete range of motions and movement appears to be weak. *Exaggerated* would be an overshooted movement and more forceful without control.
5. **Positional symmetry:** A score of 1 is given if the child is unable to distribute weight equally on both sides of the body, for example for tree pose, the child tilts the body to one side instead of standing straight.
6. **Mirroring:** A score of 1 is given if the child fails to mirror the tester's movements.
7. **Cues**: Score the additional cues given by the tester, i.e. cue to **focus (F)** on the task, specific **verbal (V)** cues about the pose, 2nd or more **demonstrations (D)** of the pose, and **physical (P)** assistance to the child to complete the pose.
8. **Time to initiate:** From the tester's end of movement to child's initiation of first attempt. If the child starts before the tester ended the movement, give it a <1 sec.
9. **Hold time**: Count the time for which the child holds the pose, i.e. from the start of child's movement to the end of child's movement.

ID#: _____ Yoga poses imitation errors Session: Pretest/Posttest/1/8/16 Scorer Initials: _____

Limb/body placement		Balance strategies	Spatial orientation	Movement modulation	Positional symmetry	Mirroring	Cues F/V/D/P	Time to initiate	Hold time
R. Tree - Initial position									
Arms stretched out R. Foot turned L. Foot straight	0/1 0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									
R. Tree - Final position									
Hands joined overhead/chest/ didn't do it R. Foot bent up to opposite thigh/knee/leg/not lifted	0/1/2 0/1/2/3	# of trunk strategies # of arm strategies # of steps with NWB foot # of times NWB leg moved # of steps with WB foot List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
L. Tree - Initial position									
Arms stretched out L. Foot turned R. Foot straight	0/1 0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									
L. Tree - Final position									
Hands joined overhead/chest/ didn't do it L. Foot bent up to L. thigh/knee/leg/not lifted	0/1/2 0/1/2/3	# of trunk strategies # of arm strategies # of steps with NWB foot # of times NWB leg moved # of steps with WB foot List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
R. Dancer – Initial position									
Looking ahead Arms in front	0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									

ID#: _____ Yoga poses imitation errors Session: Pretest/Posttest/1/8/16 Scorer Initials: _____

Limb/body placement		Balance strategies	Spatial orientation	Movement modulation	Positional symmetry	Mirroring	Cues F/V/D/P	Time to initiate	Hold time
R. Dancer – Final position									
L. arm straight at shoulder R. hand holds bridge of foot/heel or ankle/leg R. foot above hip/at hip/below hip L. leg straight Trunk bend/ partial bend/ straight	0/1 0/1/2 0/1/2 0/1 0/1/2	# of trunk strategies # of arm strategies # of steps with NWB foot # of steps with WB foot List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
L. Dancer – Initial position									
Looking ahead Arms in front	0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									
L. Dancer – Final position									
R. arm straight at shoulder L. hand holds bridge of foot/ heel or ankle/ leg L. foot above hip/ at hip/ below hip R. leg straight Trunk bend/ partial bend/ straight	0/1 0/1/2 0/1/2 0/1 0/1/2	# of trunk strategies # of arm strategies # of steps with NWB foot # of steps with WB foot List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
Pretzel – Initial position									
Trunk straight/ slouch Sitting crisscross	0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									
R. Pretzel – Final position									
Hands flat on floor Trunk & head rotated/ head rotated/ no rotation Sitting crisscross	0/1 0/1/2 0/1		0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									

ID#: _____ Yoga poses imitation errors Session: Pretest/Posttest/1/8/16 Scorer Initials: _____

Limb/body placement		Balance strategies	Spatial orientation	Movement modulation	Positional symmetry	Mirroring	Cues F/V/D/P	Time to initiate	Hold time
L. Pretzel – Final position									
Hands flat on floor	0/1		0/1	0/1	0/1	0/1	0/F/V/D/P		
Trunk & head rotated/ head rotated/ no rotation	0/1/2								
Sitting crisscross	0/1								
Comments:									
Butterfly – Initial position									
Trunk straight/ slouch	0/1		0/1		0/1	0/1	0/F/V/D/P		
Sitting crisscross	0/1								
Comments:									
Butterfly – Final position (T1)									
Arms & elbows straight	0/1		0/1		0/1	0/1	0/F/V/D/P		
Hands flat on floor	0/1								
Hands beyond foot/at foot/ behind foot	0/1/2								
Thighs touch floor/partial touch/ completely off floor	0/1/2								
Soles of feet joined	0/1								
Comments:									
Butterfly – Final position (T2)									
Arms & elbows straight	0/1		0/1		0/1	0/1	0/F/V/D/P		
Hands flat on floor	0/1								
Hands beyond foot/at foot/ behind foot	0/1/2								
Thighs touch floor/ partial touch/ completely off floor	0/1/2								
Soles of feet joined	0/1								
Comments:									
Sit & Reach – Initial position									
Both arms straight at shoulder	0/1		0/1		0/1	0/1	0/F/V/D/P		
Looking ahead	0/1								
Trunk straight/ slouch	0/1								
Both legs straight	0/1								
Comments:									

ID#: _____ Yoga poses imitation errors Session: Pretest/Posttest/1/8/16 Scorer Initials: _____

Limb/body placement		Balance strategies	Spatial orientation	Movement modulation	Positional symmetry	Mirroring	Cues F/V/D/P	Time to initiate	Hold time
Sit & Reach – Final position (T1)									
Both elbows straight Hands beyond feet/at feet/ at leg/ knee Knees straight	0/1 0/1/2/3 0/1		0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
Sit & Reach – Final position (T2)									
Both elbows straight Hands beyond feet/at feet/ at leg/ knee Knees straight	0/1 0/1/2/3 0/1		0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
Frog – Initial position									
Trunk straight /slouch Elbows straight Hands flat on floor Feet flat	0/1 0/1 0/1 0/1	# of fallbacks # of arm strategies List other issues in comments	0/1		0/1	0/1	0/F/V/D/P		
Comments:									
Frog – Final position (T1)									
Elbows straight Hands underneath shoulders Buttocks at or above knee level Heels raised	0/1 0/1 0/1 0/1	# of fallbacks # of arm strategies List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
Frog – Final position (T2)									
Elbows straight Hands underneath shoulders Buttocks at or above knee level Heels raised	0/1 0/1 0/1 0/1	# of fallbacks # of arm strategies List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									

ID#: _____ Yoga poses imitation errors Session: Pretest/Posttest/1/8/16 Scorer Initials: _____

Limb/body placement		Balance strategies	Spatial orientation	Movement modulation	Positional symmetry	Mirroring	Cues F/V/D/P	Time to initiate	Hold time
Bridge – Initial position									
Arms straight out at shoulder Both legs straight	0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									
Bridge – Final position									
Arms straight Hip-knee-shoulder straight/ angled/ hips not lifted Feet flat	0/1 0/1/2 0/1	# of arm strategies # of trunk strategies # of WB feet slides	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
R. Leg Lift Bridge									
Arms straight R. Leg straight/ bent/ not lifted R. Hip-knee-shoulder straight/ angled/ hips not lifted L. Foot flat	0/1 0/1/2 0/1/2 0/1	# of arm strategies # of trunk strategies # of times WB foot slides # of times NWB foot moves # of times NWB foot touches floor	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
L. Leg Lift Bridge									
Arms straight L. Leg straight/ bent/ not lifted L. Hip-knee-shoulder straight/ angled/ hips not lifted R. Foot flat	0/1 0/1/2 0/1/2 0/1	# of arm strategies # of trunk strategies # of times WB foot slides # of times NWB foot moves # of times NWB foot touches floor	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
Dog – Initial position									
Both elbows straight Hands flat on floor Knees bent & aligned with hips	0/1 0/1 0/1		0/1		0/1	0/1	0/F/V/D/P		
Comments:									

ID#: _____ Yoga poses imitation errors Session: Pretest/Posttest/1/8/16 Scorer Initials: _____

Limb/body placement		Balance strategies	Spatial orientation	Movement modulation	Positional symmetry	Mirroring	Cues F/V/D/P	Time to initiate	Hold time
Dog – Final position									
Both elbows straight Hands flat on floor Both legs straight Feet flat	0/1 0/1 0/1 0/1	# of upper body strategies/upper body movements # of feet slides, knee touches floor Broad base of support List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
R. Leg Lift Dog									
Both elbows straight Hands flat on floor Lifted leg straight/ bent/ not lifted L. leg straight L. foot flat	0/1 0/1 0/1/2 0/1 0/1	# of arm strategies # of upper body strategies/trunk rotations # of times WB feet slides, knee touches floor # of times NWB foot moves # of times NWB foot touches floor Broad base of support List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									
L. Leg Lift Dog									
Both elbows straight Hands flat on floor Lifted leg straight/ bent/ not lifted R. leg straight R. foot flat	0/1 0/1 0/1/2 0/1 0/1	# of arm strategies # of upper body strategies/trunk rotations # of times WB feet slides, knee touches floor # of times NWB foot moves # of times NWB foot touches floor Broad base of support List other issues in comments	0/1	0/1	0/1	0/1	0/F/V/D/P		
Comments:									

Appendix C ON-TASK BEHAVIOR ASSESSMENT CODING SCHEME

1. **Affect** – See the facial expression and the emotional state of the subject. A score of 1 is given if the subject is negatively responding to the task (crying, angry, non-compliant). A score of 2 is given if the subject is neutral – the subject is attending to the task; however, he or she is not interested or excited and has a flat face. A score of 3 is given if the subject is interested by attending to the task, compliant, and exchanges some words with the model or trainer. A score of 4 is given if the subject is positively responding to the task by paying attention, smiling, and verbally communicating (task-related).

2. **Verbalization** – See how the subject is responding to the task, trainer, or model. A score of 1 is given if the subject is non-responsive, either by not paying attention or by not agreeing to answer. A score of 2 is given if the subject is low-verbal, occasionally verbalizing with the model or trainer when talked to directly. A score of 3 is given if the subject is responsive to the task and only speaks when asked by the model or trainer. A score of 4 is given if the subject is positive and spontaneously verbalizing (task-related) with the model or the trainer. (1 – non, 2 – mid responsive, 3 – high responsive/mid-spontaneous, 4 – high spontaneous)

3. **Eye Contact** – See if the subject is looking at the model or the trainer, based on who is speaking, in addition to paying attention to objects related to the task. A score of 1 is given if the subject is not looking at the model, trainer, or objects related to the task throughout the condition; reminders and redirections are being constantly given and there was no spontaneous gaze. A score of 2 is given if the subject is neutral and gives eye contact after constant reminders from the model or trainer. A score of 3 is given if the subject is responsive to the trainer or model and maintains eye contact for most of the condition, with only a few reminders for the whole condition. A score of 4 is given if the subject maintains eye contact and has spontaneous gaze with the trainer, model, or with the objects related to the task for the entire condition.

ID #: _____ On-task behavior assessment Session: 1/16 Scorer Initials: _____

Conditions	Affect	Verbalization	Eye Contact
Hello Song	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Contact	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Breathing	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Looking	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Poses	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Partner Poses	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Relaxation	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			
Goodbye Song	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4
Comments:			